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Editorial

Brigadier-General Julien Sabéné

Vortex: this both sharp and original title refers to more than just a physical phenomenon.

The term "vortex" commonly alludes to the swirling motion that airplanes leave in their trail, which is very difficult to scientifically conceptualize. We use it here as a metaphor for ever-evolving thought processes and passionate discussions. Once the effervescence has passed, air masses cease their disordered motion allowing stillness to return. Likewise, debates are appeased when they are settled by the honest yet fruitful confrontation of ideas.

This is this journal's ambition: promoting the *urbi* and *orbi* exchanges on the political, strategic and operational aspects of aerospace power, a power that has succeeded in establishing itself, in little over a century, as one of the structuring elements of modern wars and crises.

The French Centre for Strategic Aerospace Studies (*CESA*) is redefining its missions to meet the French Air and Space Force's new ambitions in terms of outreach, under the leadership of General Philippe Lavigne. *Vortex* intends to raise airmen's contribution in terms of national and international reflection to the level of their high operational commitment, hence the decision to publish this bi-annual journal in both English and French.

Available in hard copy and online on the *CESA* website, *Vortex* aspires to gather wordsmiths from the aerospace community, whatever their nationality, to express themselves in these columns and provide food for thought.

At a time where the world has never produced so much data, in which it is becoming increasingly difficult to distinguish the prescriber from the despiser in the media and where news stories are released at a frenetic pace, *Vortex* aims to become a place where thought can develop freely and serenely.

As a conclusion, I would like to wish Jean-Christophe Noël every success: he is the instigator of this journal, which is now launched thanks to his remarkable commitment and the motivated team surrounding him. May they all be warmly thanked.

Foreword

Jean-Christophe Noël

Dear Reader,

Welcome to *Vortex*, the French Air and Space Force's brand-new professional journal. This is not, in fact, the first time that the French Air Force has held such a journal. Old-timers will remember *Forces Aériennes*, published between 1946 and 1971. Younger readers may recall *Penser les Ailes Françaises*, which contributed to their reflections in the early 21st century.

In this day and age, as the French Air and Space Force (the FASF) regularly trains to project itself all over the globe, the time may have come to launch a new impetus, which can be read in both French and English by airmen of all nationalities. Primarily intended for air power professionals, this journal hopes to contribute to intellectual reflections on the use of aviation in war. In broader terms, it also wishes to reach those who are interested in such topics, whether members of other armies, industrialists, academics, journalists, analysts, or simply the curious-minded. The idea is to put forward a set of articles that will present the conceptual and operational issues that airmen face, in terms understandable by all. As for air warfare, reflections surrounding conflicts, which are fueled by United States, are ever evolving. American concepts generally find their way across the planet with a slight delay, until it reaches allies that adapt them and rivals who try to counter them. The scene is beyond doubt very lively. It is therefore necessary to design a space in which our readers can gather to update their knowledge and stimulate their thinking.

Along with a will to render them more accessible, we also wish to take part in these debates on air power and elevate them with the voices of all those who think they can contribute, primarily airmen. In France, as elsewhere, they do not always have the reputation of being great intellectuals. Favoring their lustrous machines over books, spiteful tongues would allege that they thrive more in mastering advanced technologies than in the writing of scholarly articles. Ok for Top Gun, but drop *Il dominio dell'aria* for now... However, we are betting that there is a community of airmen out there ready to put their thoughts in writing and share their practices. Maybe all

they were missing was an arena to do so. We are offering that *Vortex* be that arena, to broadcast their ideas and put them to the test of the air power community at large.

For us, however, there is nothing worse than staying in conquered land and wallowing in the same standpoints. That is why we are also more than happy to receive contributions from other experts wishing to support or develop the debate. They are all welcome, regardless of their profession or nationality. This is why the Editorial Board is made up of equal numbers of serving and retired Air Force officers and civilian experts from the university and the think tank community. We would like to take this opportunity to thank them for their involvement.

Thus, *Vortex*, as a journal, aims to reach a French and more international readership, via an editorial line focusing on the operational aspects of air power which is open to all experts of the field. But what exactly does this involve?

Vortex is structured in five different parts: a case study, some varia, a historical article on the French Air Force, an interview with an air strategist and book reviews. This frame will probably evolve as *Vortex* grows, with the addition or removal of certain sections, but we will strive to stay true to this initial spirit.

This first issue already veers from this structure, as its first article welcomes an opening courtesy of the French Air and Space Force's Chief of Staff, General P. Lavigne. We must first pay tribute to him, along with his former collaborator, General E. Autellet, for making this adventure possible. Next, we must thank him for setting an example by sharing with us his vision of the use of air and space power for the average yet ambitious nation that is France. We hope that he will inspire French airmen to also take up writing.

For this first issue, the Editorial Board has chosen as the focus of its main section the topic of *Multi-domaine/multi-champs* (*MDMC*), better known as Multidomain (MD) outside our borders. There were two main reasons to the Committee members' choice. The term has flooded military literature, hence the importance of understanding both the reasons to its success and comprehend what it implies. The FASF, like the other French forces, is in the process of absorbing it by producing a doctrinal corpus. It may be relevant to reinforce this process by providing some reflections as part of a non-institutional framework.

The case study begins with an article by J. C. Noël, presenting a short genealogy of the term. As opposed to some preconceived ideas, this term is much more than a buzzword. It summarizes a number of considerations

that have been on the table for some forty years and could still be developed further. V. Tourret describes the way the Russian and the Chinese reacted to this new American concept. Given their specificities and their strategic cultures, they are developing their own conceptions rather than settling for defensive or wait-and-see attitudes. General Péna, who takes part in the doctrinal work on MDMC, then describes the principles guiding the FASF's action in the area of C2.

Space, into which the FASF has just extended its organic prerogatives, is also an essential part of the thinking processes within MD. Three articles are therefore devoted to this theme. First comes P. Steininger, who explores the links uniting sky and space. These are somewhat tenuous due to the physical difference between the two environments, though they could get closer thanks to the potential development of an aerospace plane. Next, X. Pasco sums up over 75 years of military activity in space. His conclusion is close to that of G. Penent, who tackles this issue more specifically: there has never been and probably never will be a war in space... at least in the short and medium term. Lastly, the "Free speech" section suggests some brief reflections about MD.

The "Varia" section is composed of three very different articles. First, P. Grasser offers us his very informed and discerning view of the recent Nagorno-Karabakh conflict. The use of loitering munitions made headlines, heralding a new era in the art of war. The article presents a more nuanced standpoint. F. Morilhat then proposes a very accomplished reflection on the ethics of air power. He describes the moral consequences of these engagements, as airmen's kinetic actions are now initiated further and further from their targets, in contrast with traditional modes of action. Finally, D. Pappalardo discusses the catch-22 that reappears each time air forces are engaged in counterinsurgency conflicts: should fleets be upgraded through the acquisition of aircraft specifically designed for this purpose?

Each issue of *Vortex* will publish an article about a glorious or tragic page of the French Air Force's history, to shed light on an event and to show how our elders reacted to the quandaries they were faced with. This time, S. Rookes will evoke France's early use of helicopters during the Algerian War and demonstrate that the knowledge that was developed inspired the Portuguese and Rhodesian military when they were also faced with insurgency a few years later.

Each issue will also invite a famous airpower thinker to let him express his point of view, both to get better acquainted with the man behind the thinker and also, of course, to discuss his theses. What more obvious choice for this first issue than J. A. Olsen, the most prolific author on the topic of air power over the last two decades? I would like to thank him sincerely for

having agreed to take part in this exercise which is quite unique within our discipline. I hope that this article will encourage readers to delve into his abundant and fascinating work.

Lastly, four reviews of articles or books close this issue. Three French authors have center stage, demonstrating a certain elation in France on the topic of air power.

The success or failure of *Vortex* depends, of course, on the team that conceives and nurtures it. This team, made up of enthusiasts, is only small for now. Many defects will have made their way into the making of this issue. But it is a learning curve, and our goal is to improve *Vortex* with every new issue. *Vortex*'s fate is also in your hands. We are eager to receive your comments, advice and possibly your suggestions for articles. To do so, please do not hesitate to contact us at vortexlarevue@gmail.com.

We wish you an excellent reading and hope that you will accompany us as far as the adventure of *Vortex* will carry us.

The French Armée de l'Air et de l'Espace. Preserve a model adapted to the challenges, develop agility as an asset, obtain value and optimize use.

"Never in the field of human conflict was so much owed by so many to so few."

W. Churchill, August 20, 1940

Air Force General Philippe Lavigne

The experience of the French *Armée de l'Air et de l'Espace* (AAE) is the result of more than 100 years of aeronautical history and nearly 50 years of participation in the space adventure. Although it is the youngest of the three military services, it can legitimately say that it sets the standard in the military use of the third dimension, now extended to Space. Its broad experience is based on the lessons it has learned from the air operations it has conducted. The principles of airpower effectiveness have thus been progressively consolidated, both nationally and internationally, thereby increasing the capabilities of the AAE.

Our aerospace experience took shape at the beginning of the 20th century thanks to the pioneers of aviation, exceptional military and civilian figures, who already had a revolutionary vision of a third strategic dimension. This history of military aeronautics is a history of convictions. It is necessary to convince, on a regular basis, of the merits of a stronger, more autonomous, more integrated and integral air force, better employed and ultimately more efficient. In 1934, its creation as a full-fledged branch of the military was a fundamental step forward on this path. Today, the stakes of power are strategic and cover many fields: political, diplomatic, military, economic and societal.

The air environment, which like the space environment covers the entire globe, also gives rise to the concepts of air-land and air-sea engagements, which prove that operators in the land and maritime environments cannot

conceive of their operations without the 3rd dimension. However, the use of the word "air" underlies the idea that air is only of interest in support of the environment it serves. The numerous doctrines that describe air-land or air-sea combat reduce air power to a support weapon, which is certainly indispensable, but whose scope only extends to the tactical field.

What the Air and Space Force wishes to promote is the amplitude of its spectrum of use, which gives it a tactical, operational and strategic scope. The youth of our military, and the relative lack of knowledge of air strategies developed and put into practice since the First World War, contribute to an underestimation of the strategic dimension of airpower, which has become essential.

Finally, although the common uses of aircraft are many[1] the military stakes jointly involve all branches of the armed forces. The AAE may be autonomous, but by its very nature it integrates the other environments since it continuously interacts with them. And Space brings no contradiction to this assertion, it even reinforces it. The unique nature of command within the AAE, its organization concentrated around a central C2 that is open and promotes subsidiarity, distributed as closely as possible to the action, is the basis for this ability to integrate and aggregate multiple actors, whether between military branches or between departments. The *Multi-Milieux/Multi-Champs* (M2MC) approach, as an extension to the American Multi-domain approach, is very similar to the integration of multiple skills within an airbase to achieve outcomes. This is probably why the U.S. Air Force has been tasked with thinking about "All Domain C2 Operations" on the other side of the Atlantic.

It is the understanding of air and space power, of the strategic and tactical stakes entailed, of assets as well as limits, that guarantees an optimized use, in the service of the efficiency expected by our political and military decision-makers.

The stakes of air and space power

Political issues

From a political point of view, the stakes of air and space power are high. Indeed, air power and control of space offer political decision-makers a very wide range of options, allowing them to react rapidly to a crisis as well as to act in time, having evaluated the expected effects and weighed their consequences. It gives them the assurance of obtaining the desired effect at the lowest human cost.

1. Air power is multi-dimensional and can be found in the scientific, technical, industrial, commercial, tourist, normative, cultural, and military fields.

It is therefore imperative to maintain this capacity for immediate implementation of airpower, allowing the President of the Republic, when the situation so requires, to give concrete expression to his determination. Air power is sometimes demonstrative, as in Libya in 2011, when the French commitment was announced even as the planes were heading towards their targets, and sometimes discreet when it comes to special operations that are subject to delayed communication.

It is also the capacity to permanently protect the national territory from any threat from the air, to dissuade a potential adversary from threatening France's vital interests. This defensive posture has never been interrupted since its inception: it has been active 24 hours a day for nearly 60 years. September 11, 2001 put the Permanent Security Posture in the political and media spotlight, but the rest of the time, all these hours, weeks and years of uninterrupted alerts were held in silence.

Diplomatic issues

This political issue is also closely linked to the notion of diplomacy. Air diplomacy is also an age-old reality. From the Berlin airlift in 1948-1949 to the deployment of *Rafale* aircrafts in Cyprus last year, the demonstration of an air projection capability, without engaging in hostile behavior, is the expression of political and diplomatic determination in the face of a State whose behavior does not comply with international law, for example. Only air power can react in the shortest possible time and provide proof of a country's determination, anywhere in the world in less than 48 hours.

Military air diplomacy is, as Professor Couteau-Bégarie rightly emphasized, the use of air power in the service of foreign policy, outside the logic of war. Its flexibility of use, its modularity and its small footprint give it unparalleled advantages in this respect.

In the range of diplomatic messages that punctuate international relations, the demonstration of power by fighter aircraft being present in a given area sends a clear signal when one wishes to make such presence visible. The French AAE is obviously not the only one to be active in this way, since the French Navy, with its permanent presence on all the world's seas, also expresses French determination when necessary. When they are engaged abroad, our land-based forces embody an even stronger political will, through their footprint on the ground. Finally, in the Space and Cyber domains, while most actions used to take place below detection thresholds, they are now also used in the field of international diplomatic relations (official protests of space maneuvers, attribution of cyber-attacks).

Here again, the difference lies in the nature of the intended outcomes, but also in the speed of reaction expected by the political authority. With this in mind, the AAE is preparing to be able to deploy 20 *Rafales* and 10 MRTTs within 48 hours, 20,000 km from mainland France, i.e. to any point on the globe where there is a landing strip. If the volume of our assets prevents us from being present everywhere at all times, this capacity for massive and rapid projection is the prerogative of a very small "club" of nations. The *Skyros* deployment in February 2020 was the first demonstration of this type of capability. The diplomatic contribution of such a mission is enormous in the field of bilateral cooperation, but also in that of the French presence. This mission, made up of 4 *Rafale*s, 2 A400Ms and an A330 MRTT, covered 16,000 km in 16 days, with 4 stopovers in India, the United Arab Emirates, Egypt and Greece, conducting intense operational preparation missions in each case, all in an autonomous manner and in the context of a very restrictive COVID19 pandemic.

These phased demonstrations illustrate the strategic scope and the need to maintain a high level of cooperation with partner countries that also represent potential points of support.

The challenges of international cooperation also concern the ability to act together. For example, for the past ten years, we have been participating with our American and British allies in a trilateral strategic initiative, to reflect on the use of air weapons and prepare to intervene together in the most demanding circumstances. This is reflected in first-time exercises, such as the "Atlantic Trident" exercises, the first French edition of which was held in May 2021 at the Mont-de-Marsan base.

The Atlantic Alliance is also defined as a pillar for building interoperability and allows joint operations to be carried out without delay, at a very modular level of integration, from a few aircraft to more substantial deployments. This is the "*plug and fight*" concept.

The development of combined European resources such as the European Air Transport Command (EATC) is another exemplary illustration of this pragmatic and operational approach, which combines the capabilities of seven European air forces. In 2019, 200 aircraft were delivered, and 20,000 people transported, making this European joint exercise one of the most significant and effective.

Military issues

Military air power and control of space are essential elements of operational superiority and as such constitute a major concern of sovereignty and power. As air and space cover all land and sea areas, the AAE interacts on an ongoing basis with other environments (land, sea, space, cyber) and other fields (electromagnetic and information). It will have to continue to maintain peak performance in the coming decades in order to guarantee the capability to deliver multiple impacts in near-immediate timeframes.

In keeping with the fundamental strategic principles, the armed forces must preserve their freedom of action, concentrate their efforts and economize their resources in order to prevail. To this end, air superiority and control of Space provide opportunities to both deny the adversary's freedom of action, and to ensure retention of maximum freedom of action, even if it is only local and temporary.

The AAE also contributes to the freedom of action of our forces by anticipating through the ability to see and observe from the sky and space, by protecting land, sea, air and space forces and by striking the enemy (at the heart of its system, its centers of gravity, its supply lines) to dissuade, immobilize or paralyze it or cause the breakdown of its capabilities.

Space issues have become even more important than in the past, in a context of rampant weaponization and easier access to space (the *New Space*). The multiplication of objects placed into orbit increases the risks of saturation, incidents or concealment, which requires that we actively pursue the ramp-up of the Space Command. Knowing what is happening in orbit at all times, being able to protect ourselves from all types of threats (debris, hostile approaches), protecting our assets and making better use of space are at the heart of our nation's sovereignty, our European ambition in space, and our ability to conduct airborne operations anywhere in the world. The issues are many: the versatility of satellites, which are becoming multi-role (communication, observation, etc.); the deployment of constellations; the advent of a major European project that will make it possible to join in our ambitions to obtain near real-time data transmission; improve the resilience of our resources; expedite responsive satellite launches, for greater agility and simplicity of deployment for lighter satellites.

Economic stakes

The French aerospace industry is one of the most important sectors of our economy. Having inherited the legacy of the pioneers of aviation and space, our major industrial groups and their hundreds of subcontractors are an economic driver and demonstrate our very high level of expertise. The AAE are of course directly linked to this eco-system, in which all the players

are mutually supportive. We must have the operational and therefore technological advantage to win wars and ensure that we can master the space environment. Our current credibility, supported by our operational successes, in turn provides natural support to the aerospace industry in their development and export policies.

Societal issues

Finally, while the resources available to the AAE are technically advanced, the combat system depends on the airmen and airwomen who use them. It is the inventiveness, combativeness and agility of our teams on the air bases and in our headquarters that enable us to carry out operations successfully today. This is the ambition behind the transformation of our human resources system, DRHAA 4.0. The AAE thus responds within the Ministry of Armed Forces to the challenges of society. More than 3,000 young people are recruited annually, from all social and geographical backgrounds, attracted by the aerospace and military worlds. Societal issues are also taken into account through the Youth Air Escadrilles, whose aim is to develop bonds with young people through contact with aeronautics, the values of airmen, as conveyed by their history and traditions.

AAE assets: agility and power

Airborne weaponry and control of space have assets specific to their environment: reach, speed, power, permanence, responsiveness, modularity.

Agility

The physical limits in the third dimension constrain certain parameters and impose compromises: the mass, the autonomy of air or space flight linked to the propulsion energy, the physical payloads and aerodynamic constraints, the hostility of the environment. However, technical progress has already made it possible to achieve a remarkable level of performance and versatility, and the combination of airborne resources quickly multiplies the effects produced. The Rafale, the emblematic figure of versatility, alone replaces all the aircraft fleets of the previous generation. The armed *Reaper* UAV is of major interest for Operation Barkhane, but coupled with the detection of an AWACS, it also offers remarkable intervention capabilities over the sea, as in the Mediterranean.

This search for efficiency through the combination of assets is at the heart of air operations planning. Moreover, every flight, including training flights, is an opportunity for an operational mission. Particularly well integrated within the Permanent Security Posture, each military aircraft flying over

French territory can participate in a real mission[2]. This versatility of use of air assets, which could be extended to the space domain, is a perfect illustration of the agility that the AAE puts forward.

It is the specific organization of the AAE that makes its agility possible. Command and control are centralized in Lyon. The Air Operations Planning and Control Center (CAPCO) is responsible for the planning and control of all military air operations, both over the national territory and in external operations, starting from the national territory and extended to specific theaters of operation. On the other hand, execution is completely decentralized to the air bases, which are able to carry out their missions 24 hours a day.

This availability and responsiveness require a specific, adaptive organization at airbases, which are vital and protected assets, empowering a seamless continuum of training, crisis management and war.

Composed of multiple units that all contribute to the mission and can act together or separately according to need, the organization of an air base thus responds to the same ongoing principle of agility, responsiveness and adaptability. The staff who serve at an air base may be temporarily deployed, most often individually, to form a projected air base that will respond exactly to what the mission requires. This flexibility and modularity are key to a high level of responsiveness and enable a minimal footprint in a projection scenario. It is possible to rapidly assemble or recompose the airborne detachments required for the required outcome. The objectives can be achieved very quickly by adjusting the responses at the tactical and local levels. This highly modular approach also makes it possible to maintain operational readiness at air bases, within the limits of the demands in the framework of operational contracts. On average, 10 to 15% of the air force personnel at air bases may be mobilized for missions and external operations.

The power

The advantage of using airborne weapons also depends on their performance. Here again, this can be adjusted according to the desired effect. From nuclear strike to demonstration of force without firing ammunition, the spectrum of use is extremely vast and allows the political decision-maker to scale the response at low cost. These effects can be cumulative: while the airborne component of deterrence can be deployed at any time, operations continue on a daily basis in the Sahel, shows of force in Iraq carried out by Rafales regularly contribute to the tactical advance of ground forces, and a massive raid can suddenly be launched against targets in Syria.

2. Recovery and rescue of aircraft in distress by fighter school aircraft; on initial training missions, rescue and assistance by Fennec aircraft for a person lost in Provence; collection of information or contribution to the air situation by our AWACS or tankers, during convoy missions.

Space also brings an additional asset. Beyond its position overlooking other environments, it offers permanence, as in telecommunications, and the possibility of regular data updates. In the air, the lack of permanence is compensated by the responsiveness, speed and reach of airborne vectors, whose range is constantly increasing (in-flight refueling, drones). In space, satellites in orbit have a lifespan that makes for uninterrupted availability. The increase in the number of satellites deployed and the continuous increase in technological performance will gradually make it possible to complement or even eliminate certain resources currently deployed on the ground, at sea or in the air, particularly in the fields of connectivity and networks.

Finally, a major asset of airpower is its proven credibility, which is foremost operational. The AAE, engaged in all theaters of operations from the first to the last day of the intervention, permanently mobilized on the national territory, in interministerial as well as international operations, responds to each request with the best adapted resources at its disposal. These operational successes confirm the modes of action used.

Credibility is also technical in nature. The air and space assets entrusted to the AAE are of the highest quality. Recognized by our partners, feared by those who are subjected to their impact, they are the result of continuous efforts to improve performance in order to achieve ever greater efficiency and flexibility. Innovation, which was at the heart of pioneers such as Roland Garros, who developed the "through-the-propeller" shot, is still present in our teams of airmen who seek to maintain air superiority and outperform adversaries who are also deploying new offensive, defensive and access denial technologies.

Enhance and optimize the use of the AAE.

In order to avoid under-utilizing Air Force and Space assets, which are sometimes limited to providing support for actions in other environments, it is necessary to continue efforts to define the decision-maker's intentions and the effects he or she wishes to achieve in order to propose options and the means to achieve them. Moreover, the possibilities offered by the multi-role capabilities, and the extent of the combinations of various types of interventions, require mastery of the entire spectrum and a centralized vision of resources available. This is how they can be used to best effect, in planning or in operations. Optimizing the use of airpower can also be embodied in the use of all phases of a flight. This is why, during transit or when rejoining a flight path, the onboard sensors of our aircraft also contribute to improving the understanding of the environment (Situation Awareness). This optimization of missions will only be possible with the resources to manage large amounts of digital data. The perspectives offered by artificial intelligence and quantum technology are becoming a major factor here. This challenge

is shared by all in the multi-milieu-multi-field approach which is today the response envisaged to many present and future operational challenges, from hybrid to high intensity commitments.

This logical approach to outcomes is closely associated with targeting. Introduced by U.S. Airman John Warden in the late 1980s, and adopted and constantly improved since then, targeting contributes directly to achieving the military objective of operations and fully participates in the success of the mission, while optimizing the resources deployed. The National Targeting Center, which is part of the Air Defense and Air Operations Command, has proven itself over the past 20 years in dealing with continually changing types of conflicts. The Center also plays a key role in synchronizing joint actions, both in the planning and operational phases, and will play a central role in the future in the face of more agile adversaries in unified battlespaces; (i.e. not segmented by environment and weapon systems).

On another note, the increase in the distances that can be covered by aircraft, their speed and the ability to command and conduct air operations remotely, have gradually led the AAE to establish a single operations center in Lyon. Today, for interministerial coordination of action in the third dimension over national territory, for carrying out operations departing from national territory, or for conducting operations in the Sahel, all of these operations are handled from within the Air Operations Planning and Control Center. It is through this centralization and concentration of resources that we are able to optimize the impact of our operations. This approach also makes it possible to break away from a rationale of restriction to a limited geographical area, sometimes preferred by local or regional authorities. Such a rationale could tend to deplete resources locally, since locally the number of available aircraft may be limited. Even to cover large geographical areas, agility should be preferred to static positioning, as our assets can cover huge areas in a very short time frame. Moreover, in order to establish orders of magnitude, the Mediterranean area represents 1.5 hours of flight time along the North-South axis and 4.5 hours along the east-west axis, times very similar to those of the Sahelo-Saharan strip. As a reminder of the objectives mentioned at the beginning of this paper, the ambition of air operations is to be able to rapidly undertake operations anywhere in the world with a substantial deployment in only 48 hours.

Nevertheless, the punctual concentration of airborne resources in certain areas or following specific agreements with partner countries, makes it possible to define preferential areas for action. Projected Airbases respond to these challenges, when operations must be sustained over time and the assets are stationed close to the theater. These assets remain available to be engaged in other theaters if necessary and to facilitate rapid shifts in the use

of resources. The pitfall to be avoided, which is a lesson from the First World War, is the scattering of air assets placed under different regional commands, which greatly reduces their effectiveness.

This focus on unity of command is fully valid on the national territory. In addition to air defense, which takes into account air threats to the national territory, and which is placed under the direct responsibility of the President of the Republic and the Chief of the Defense Staff (CEMA), the AAE is responsible for 5 national missions under the direct authority of the Prime Minister. These missions are defined as being under the "Airborne State Action" category, including air security, national sovereignty, search and rescue, air safety and coordination of airborne resources in the event of a crisis on national territory. This last mission covers assistance to the population in the event of adverse weather conditions or an industrial accident, or the 3D coordination of the State's air resources (in particular for the transport of patients suffering from COVID within the framework of Operation Resilience), as well as the security of major events, through the deployment of special air security systems (DPSA).

The development of anti-drone warfare in the face of the increase in the use of drones and the implementation of the Single European Sky are additional factors of complexity that are taken into account in upgrading our command-and-control systems for air operations.

Meeting the challenges of future operational commitments

In the light of the above principles, it is essential to consider the threats and challenges of the coming decades in order to maintain freedom of action in combat.

While the advantages of airborne weaponry are numerous, they obviously also have their limits. The search for mass (numbers of aircraft), permanence and saturation in the face of increasingly robust defenses are at the heart of collaborative combat and connectivity. To win the war, and more particularly the air war, one must be able to seize opportunities that are sometimes very fleeting. The use of a combination of drones, piloted aircraft, autonomous sensors, and robotic team members will allow us to use the most appropriate resources at the best time. This approach concerns all three branches of the armed forces since this type of operation is by nature joint. Without waiting for the Future Air Combat System to come into service, connectivity between the *Rafale*, MRTT, A400M and UAVs is an essential priority in the very short term.

LASER and hypervelocity are two fields that are expected to be decisive for the future. The first offers the ability to neutralize, blind or destroy adversary assets, including in space, but also contributes to transmissions and communications. The second conveys an image of invulnerability. Speed is a basic component which, coupled with maneuverability, affords a major operational superiority. These technological developments are important milestones, but they should not mask the continuous innovation that is constantly developing in multiple fields. The digital transformation of the AAE meets the challenge of this agility. Mastering the digital culture, agile design and operational development will be the guarantees of our ability to stay on top. By supporting the "Air Dev Ops" project, the AAE have chosen to rely on the skills of each individual and on integrated teamwork (airmen, developers, engineers) to experiment and improve their ability to fulfil their missions. The "Flight OPS NG" project concerned the development of a unique software program that allows each operator (flight crew, mechanic, operations officer, etc.) to quickly consult or modify the information they need by automating the creation of missions, thereby simplifying the process of preparing and deploying missions. By supporting the "Air Dev Ops" project, the Air Force and the Space Agency have chosen to rely on the skills of each individual and on integrated teamwork (airman, developer, engineer) to experiment and improve their ability to fulfil their missions. The "Flight OPS NG" project concerned the development of a unique software program that allows each operator (flight crew, mechanic, operations officer, etc.) to quickly consult or modify the information they need by automating the creation of missions, thereby simplifying the process of preparation and allocation of aircraft to missions. Developed for the A400M, this software can be used for any flight unit.

Finally, at the heart of our operational commitments, the airmen and airwomen of the AAE play an essential role. As the guarantors of the implementation of our capabilities and ready to ensure the permanence and responsiveness of our missions, they form an inseparable team. This invaluable resource also represents a major challenge: it must be preserved and constantly renewed, with young people whose expectations must be well understood and who must be able to carry out their missions under all circumstances. Everything starts with modern training, as close as possible to the reality of the field. The digital tools available are being used (augmented reality, paperless course materials for more flexible transmission, augmented reality training supports). Continuing professional training must keep pace with upgrades in working environments, as with the maintenance hangar of the future project developed in Mont de Marsan as part of the Operational Support 4.0 project. In an increasingly standardized world and in a fast-changing society, the AAE will have to pursue its efforts in support of its airmen and women in order to maintain the achievements already accomplished.

In conclusion, it is important to say that the use of aircraft, whether manned or unmanned, the implementation of detection and control systems for all types of air or space platforms, and even the targeting of a characterized threat, are based on clear and proven principles: unity of command, concentration of effort, and economy of resources, with the objective of maintaining our freedom of action and fulfilling our mission. The distribution of C2's central roles and the responsive postures of our air bases meet these challenges. Global planning and centralized management optimize resources and their deployment for the benefit of the armed forces. While there are still adaptations to be made, new solutions will enable us to continue to meet these challenges. I believe it is essential to maintain the right level of technology and a combination of means that provide effects in sufficient numbers to provide our leaders with operational superiority and a range of effects at the political, strategic and tactical levels. This approach is, moreover, perfectly compatible with any joint and henceforth M2MC action, which is necessary to continue to be successful together in operations in the service of France.

Multi-Domain Operations

The American origins of the Multi-Domain concept

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The notion of Multi-Domain (MD) would seem to be the latest avatar in a series of American military concepts, often referred to by their acronyms, that have sprung up over the past 30 years. The appearance of other variations, requiring longer abbreviations, such as MDB, MDO or MDC2[1], seems likely to ensure a promising future, even if the concept of Mosaic Warfare may soon supplant it.

Despite this encouraging start, Multi-Domain has not escaped, like its predecessors, the recurring questions that arise with the emergence of a new concept. The legitimacy and appeal of such concepts are slow to convince some experts, who wonder if it is not a question of stating, in an obscure and complicated manner, approaches that have been followed for centuries, or of restating common-sense methods of action. Others wonder if they do not correspond to fashions launched by a political administration or chiefs

1. Respectively Multi-Domain Battle, Multi-Domain Operations, Multi-Domain C2.

of staff to assert their power, to mark their own legacy, only to fade into oblivion once these people have been replaced.

Do the recipes for triumphing on the battlefield thus need to be constantly renewed? S. Biddle believes, for example, that the roots of land combat have remained the same throughout the 20th century[2]. They correspond to the search for minimal exposure to fire and the possibility of encouraging the movement of one's troops while slowing down the opponent's[3]. Victory goes to the side that can master the "Modern System" of tactics, the offensive side of which consists in cover, concealment, dispersion, suppression, independent maneuvers of small units, and combined arms integration[4], while the defensive side values the use of ground, deep positions, reserves and counterattack[5]. Simply put, this litany of concepts and acronyms is not fundamentally necessary. It is better to understand how modern warfare works in order to think about how best to utilize one's troops and to articulate sustainable principles.

In this article, we will attempt to ascertain whether, despite their diversity, the main concepts that have shaped the thinking of the American military community over the last forty years have shared some common ground. Without passing judgment on their quality, their relevance, or the institutional, partisan or opportunistic causes that have fueled their development, our goal is to show that the same quest has been driving the originators of American military doctrine for decades: to think as accurately as possible about the contribution of technology and the articulation between joint forces in varied environments in an ever-expanding battlefield.

In an attempt to answer this question, a brief history of the MD concept will be traced by exploring the origins and content of Airland Battle, Revolution in Military Affairs (RMA), Air-Sea Battle (ASB), Anti-Area, Anti-Denial (A2/AD), and Third Offset Strategy (TOS).

2. S. Biddle, *Military Power*. Princeton, Princeton University Press, 2004.
3. *Ibid*, p.190.
4. *Ibid*, p.35.
5. *Ibid*, pp. 44-48.

How to face the Soviets? *Airland Battle*

Containment was the overarching strategy that guided the actions of American administrations from the late 1940s to the 1980s. Its goal was to prevent the expansion of the Soviet Union throughout the world. This "containment" was achieved in Western Europe through the deployment of American forces (Forward Deployment), positioned facing the Warsaw Pact troops and ready to take immediate action if the "Iron Curtain" was breached.

However, the success of this grand strategy was called into question in the mid-1970s. Despite its strong involvement, the US Army left Vietnam without having won decisively on the ground. It was going through an unprecedented crisis in morale. The reconstruction of this institution required numerous measures, including studies to renew its doctrinal foundations. General W. E. DePuy contributed to this intellectual renewal by creating TRADOC[6], the Army doctrine center. While examining the recent Yom Kippur War between Israel and its Arab neighbors in 1973, he was struck by the extent of the losses suffered by the various adversaries as a result of the increase in the range, precision and lethality of weapons[7]. In 1976, when a new version of the FM-100-5 was published, his recommendation[8] was to take advantage of this increased firepower, to rely on the terrain and to use all available manpower to win the very first battle against the communist forces that were penetrating Western Europe. They would be stopped in this way along the front line renamed Forward Edge of the Battle Area (FEBA)[9]. This is Active Defense, where units are expected to move from one holding position to another to exhaust the momentum of their enemy.

This new doctrine was slow to gain support. Many criticized its static approach or the risk of losing the war during the very first clashes. The policy was again reviewed under the aegis of the new commander of TRADOC, General D. A. Starry. A new version of the doctrine, FM-105, was soon submitted and tested in 1981, putting forward the Airland Battle concept[10]. The program may seem demanding to implement, since the goal was now to defeat the enemy by conducting sustained operations in a specified space-time, by fighting simultaneous and sequential battles. More simply, this insistence on temporal aspects embodied a strong ambition, by emphasizing

6. United States Army Training and Doctrine Command

7. The FMs are the field manuals, C1, *FM 100-5*. Headquarters Department of the Army, Washington DC, 29 April 1977, p.2.1-2.10 , available at http://www.survivalebooks.com/free%20manuals/1976%20US%20Army%20Vietnam%20War%20OPERATIONS%20201p.pdf

8. C1, *FM 100-5*, Headquarters Department of the Army, Washington DC, 1 July 1976.

9. The line formed by the most advanced friendly troops.

10. C1, *FM 100-5, Operations (Final Draft)*. Headquarters Department of the Army, Washington DC, 4 September 1981.

the need for tactical maneuvers to counter Soviet military "art". A greater autonomy was granted to subordinate cadres who had to take advantage of the opportunities that appeared on the battlefield by their own means. The use of nuclear weapons was not mentioned, although they were available in significant numbers in the arsenals of the actors.

Above all, the way in which the battlefield was conceptualized evolved. Now far from being reduced to a single dimension (as a cursory reading of the previous FM 100-5 might lead one to believe[11]), it now extended in depth[12] and over three dimensions. General Starry spoke of an "extended battlefield"[13]. Rather than limiting attacks to the forces in actual contact, he advocated taking action against the forces of the second echelon of the Warsaw Pact. These forces of the Warsaw Pact, whose role was to exploit the gaps created by the first echelon forces, were located about 50 km from the FEBA. But the whole operation could be extended to a depth of about a 150 km, to maintain the thrust in case of a prolonged halt or slowdown of the forces engaged in the first line. By preventing, or at least hindering, the arrival of these reinforcements, by striking even more distant logistics centers and supply depots, the momentum of Warsaw Pact troops could be seriously impacted. Local superiority could even be reversed, opening up "windows of opportunity" for ground forces to exploit[14].

The US Army did not have the capability to disrupt enemy forces so far from its lines. It then turned to the US Air Force (USAF) to consider how to cooperate more closely. Discussions began between TRADOC and the Tactical Air Command (TAC), which brought the two organizations' points of view closer together. Although infantrymen and airmen were becoming more aware of each other's requirements, serious differences remain. NATO air forces[15] were considering alternative responses to Army requests. The TAC would prefer to strike with vigor and force into the depth of the Soviet posture, while the Royal Air Force was more in favor of repeated strikes within close range of the FEBA, undertaken by patrols of two aircraft. Furthermore, it was a struggle for the Army and the Air Force to match the respective levels of command that should be in charge of air operations. They were unable to agree on the criteria for the linear separation of ground and air force areas of operation. Each claimed the largest possible area of command.

11. General DePuy also relied on the USAF to stem the advance, but did not make it the cornerstone of his concept.

12. This notion of depth is imported from the Soviet vision of the battlefield.

13. General D. A. Starry, "Extending the Battlefield", *Military Review*, March 1981, pp. 31-50.

14. *Ibid*, p. 44.

15. North Atlantic Treaty Organization.

The legacy of Airland Battle doctrine is still under discussion. The concept was never adopted by the USAF. Its influence on the way the Gulf War was fought remains a source of dispute[16]. But this attempt at joint cooperation is emblematic of a decade in which solutions were sometimes sought to overcome the way armed forces worked in "silos", and to remedy their lack of interoperability, as highlighted by the Vietnam War or the Grenada expedition in 1983[17]. A division of labor between the joint forces was envisaged to reduce the striking power of an invading army by extending the coverage of its combat forces over an average depth of 100 km.

Dominating the battlefield

The end of the Cold War and the triumphant victory in the Gulf War heralded a new era for the United States. In the absence of enemies of its own size, and despite a few setbacks such as Somalia in 1993, it was able to impose its methods on the battlefield and enforce the democratic international order. Air power was the strong arm of America as a superpower, to the point that renowned experts warned of its limits[18]. The American air force played a decisive role in the coercive campaigns conducted in the Balkans in the 1990s to bring the enemies to the negotiating table.

One question remains, however. How to maintain this military superiority over time? An answer was emerging with the dissemination of the concept of the Revolution in Military Affairs (RMA). Two of the most prominent members of the Center for Strategic and Budgetary Assessments (CSBA) think tank, A. Marshall and A. Krepinevich, sought to further extend the insight of Soviet thinkers who believe that the advent of electronics will bring about major changes in the art of warfare. In accordance with the spectacular results of the Gulf War, these two American researchers' conclusions confirm those of the Soviets, but they also point to the decisive role that the mastery of information will play on the battlefield. A RMA was underway.[19]

16. Cf. for example M. Dietz, "Towards a More Nuanced View of Airpower an Operation Desert Storm", *War on the Rocks*, 6 January 2021, available at https://warontherocks.com/2021/01/toward-a-more-nuanced-view-of-airpower-and-operation-desert-storm/ and D. Deptula, "Desert Storm at 30: Aerospace Power and the US Military", *War on the Rocks*, 1 March 2021, available at https://warontherocks.com/2021/03/desert-storm-at-30-aerospace-power-and-the-u-s-military/

17. At the same time, in 1986, the Goldwater-Nichols Department of Defense Reorganization Act was passed, which significantly modified the services' procurement policies and imposed the figure of the Chairman of the Joint Chiefs of Staff as a link between the political authorities and the Joint Chiefs of Staff.

18. E. A. Cohen, "The Mystique of US Air Power", *Foreign Affairs*, January-February 1994, p.109-124.

19. A. F. Krepinevich, "Cavalry to Computers: The Patterns of Military Revolutions", *The National Interest*, n°37, Fall 1994, p.30-42; E. A. Cohen, "A Revolution in Military Affairs", *Foreign Affairs*, March-April 1996, p.37-54.

Thanks to the integration of New Information and Communication Technologies (NICT) in the American arsenal, it was now possible to deploy a multitude of sensors on the battlefield to collect, process and distribute data to headquarters, troops and firing platforms through a networked architecture. This Network-Centric Warfare was revolutionizing the way armies fought. The proverbial fog of war was expected to largely dissipate, revealing enemy targets that would be systematically destroyed by precision fire from a distance. Some senior military authorities estimated that such operations could extend over a 200-mile-by-200-mile box[20], significantly increasing the area over which operations would be conducted compared to the Airland Battle. The new American battlespace was defined less by the characteristics of the opponent's system than by the available volume of American assets. The war would be transformed into a sort of gigantic naval battle game, where one side would have a clear view of the placement of the opposing assets. The enemy's command posts would be hit to paralyze them, and their equipment would be destroyed to render them useless. The enemy could no longer retaliate effectively, and friendly troops could infiltrate between the wrecks of enemy trucks, tanks and guns to conquer the objective.

The U.S. military had to rethink its organization within this new framework. They needed to forego their "verticality" in order to better distribute the information that those in the field require. Information must no longer be owned by a leader who jealously guards it to underline his or her authority. Moreover, formal concerns about grade, status or hierarchical "ownership" of the kill chain platforms need to lose importance. It is better to have simple, available effectors, possibly robots, but in sufficient numbers to be able to flood the battlefield and seized every opportunity that arises, than to have a few highly sophisticated machines. It also does not matter if it says Army, Navy or Air Force on the side of the robot, so long as the desired effect is achieved. Network and flow take precedence over hierarchy and ownership. What matters is that all the components of the network form a "system of systems", capable of exchanging data and operating in unison.

The agenda is now clear. The U.S. military needed to gradually move out of the industrial age and into the digital information age. If this conversion was undertaken with vigor, the U.S. military would have the opportunity to maintain the control and operational superiority it demonstrated in the Gulf in 1991. They would be able to dominate the enemy on a vast battlefield where distinctions between services tend to become secondary.

20. B. Tertrais, « Faut-il croire à la révolution dans les affaires militaires ? », *Politique étrangère*, n°3/1998, p. 617.

While the G. H. W. Bush and Clinton administrations sought to significantly reduce the defense budget in order to reap the dividends of peace, while the Pentagon preserved its funding by obtaining a directive to be able to conduct and win two regional conflicts simultaneously, the wave of the RMA shattered administrative and financial preconceived assumptions. The theses of Marshall and Krepinevich were discussed, then gradually accepted. In July 1996, General J. Shalikashvili, Chairman of the Joint Chiefs of Staff, published the Joint Vision 2010[21]. This doctrinal text was to become the reference for the American armed forces at the operational level. It laid out the main lines of the RMA. It clearly indicated that the use of NICTs must allow for Dominant Battlespace Awareness, i.e., an interactive image providing precise assessments of friendly and enemy operations. Long-range precision strikes, combined with a wide range of platforms, will significantly increase lethality on the battlefield. Within this framework, U.S. armed forces must be prepared to dominate in the area of maneuvers to enable precision strikes while protecting American forces, assets and logistics.

Donald Rumsfeld, appointed Secretary of Defense in the first G. W. Bush administration, was one of the most ardent defenders of RMA. He intended to bring this "revolution" to fruition by initiating the process of "Transformation" of the American armed forces. He took advantage of the September 11, 2001 attacks to strongly encourage the Army to accelerate the transformation by adopting a new generation of modular combat units that were to be robust, yet light enough to be transported quickly by air. He also strongly encouraged military leaders to think like business leaders. They had to invest in new technologies related to information warfare, space-based weapons and UAVs. Weapons of precision were to be promoted, as opposed to deploying large numbers of soldiers on the ground[22].

The conquest of Iraq in 2003 provided an opportunity for American forces to test the relevance of these new concepts. They invaded and reached the capital in a three-week *blitzkrieg*. They progressed steadily, even if a pause was allowed for logistics reasons. The Iraqi cities and pockets of resistance were deliberately left aside in order to reach Baghdad as quickly as possible, dethrone Saddam Hussein and seize power in the vacuum. This campaign was a triumph, but it is difficult to draw any final conclusions. It pitted the world's superpower against a country weakened by an embargo that had been in place for more than 10 years. However, the verdict fell quickly. The transformation was buried under the Iraqi sands as disastrous American governance fueled a popular uprising, *jihad* and a civil war between Sunni

21. Gen. J. M. Shalikashvili, USA, Chairman of the Joint Chiefs of Staff, *Joint Vision 2010*. Washington, DC, Office of the Chairman, July 1996.
22. P. C. Light, "Rumsfeld's Revolution at Defense", *The Brookings Institution Policy Brief* No. 142, July 2005.

and Shia factions. Washington wavered on the course to take, as the insurgency gained momentum, U.S. casualties mounted, and the War on Terror entered a stalemate[23].

Uncomfortable echos of the Vietnam syndrome were looming. General Petraeus saved the day by suggesting with others in 2006 to surge reinforcements to better control the country. His ideas were attractive, and he obtained the command of American forces in Iraq. He succeeded, rallying the moderate Sunni tribes, and engaging extra soldiers against the insurgents to defeat them and win the hearts and minds of the population. COIN (or counterinsurgency) trumped the other grand military designs. As the new Secretary of Defense R. Gates repeatedly stated that energy and resources must be mobilized to win actual irregular conflicts rather than the potential wars of the future[24]. As long as the Army and Marines are fighting insurgents on a daily basis, they will take priority. The Air Force, Navy and RMA could wait.

China enters the scene

The arrival of the Obama administration prompted a shift in the main focus of American policy. Eager to put an end to the American adventure in the Middle East and Central Asia, which had been ruinous in terms of American lives and disastrous in terms of finances and international image, President Obama was above all preoccupied by the irresistible rise of China. Secretary of State H. Clinton confirmed this orientation by writing in 2011[25] that the Asia-Pacific region was considered to be the geographic area where the future of the world's geopolitical balance would be played out. Potential competitors such as China, were able to increase their capabilities or global influence by taking advantage of the relative absence of the United States as it attempted to rebuild an unlikely stable state in the Middle East. Those days were over. The center of gravity of foreign policy was now pivoting to Asia.

One of the first problems raised by this competition between Beijing and Washington was the risk of erosion of American control over the commons. The commons are areas or spaces that do not belong to anyone in particular,

23. See for example D. Filkins, *The Forever War*. New-York, Knopf, 2008; T. E. Ricks, *Fiasco: The American Military Adventure in Iraq*. London, Penguin Group USA, 2006.

24. A. Gray, "US must Focus on Iraq, not on Future Wars: Gates", Reuters Word News, May 13, 2008, available at https://www.reuters.com/article/us-usa-military-gates/u-s-must-focus-on-iraq-less-on-future-wars-gates-idUSN1233548020080513

25. H. Clinton, "America's Pacific Century", *Foreign Policy*, November 2011, p.56-63.

but whose use by everyone is a source of well-being and wealth. The sea, the air, space and cyberspace all meet this definition – all lie outside the artificial borders drawn up by the Nations. Access to these areas is essential for the proper functioning of globalization and the international order that the United States supports[26].

Secretary Gates was not mistaken when he declared in 2008 at the Air War College that protecting the Global Commons is part of the United States' agenda for the 21st century. Beyond the geopolitical stakes, the military aspect of controlling the Commons is fundamental. The Commons are requisitioned as soon as American forces deploy to intervene in any region of the world. They could do so without hindrance until then. In 1990 or 2003, the Americans could pour in their troops from the air or the sea without being threatened by the Iraqis.

But the Chinese could pose far more serious problems. Aware that American forces were stronger if they were to make contact, the People's Liberation Army (PLA) had a vested interest in preventing such confrontation. An acronym destined for posterity summarizes their strategy: A2/AD (Anti-Access, Area-Denial)[27]. Anti-Access refers to enemy actions that inhibit military movement into a theater of operations. They are based on long-range capabilities. Area-Denial refers to enemy activities that attempt to impede military freedom of action within a theater of operations. It is based on short-range capabilities. The idea is to prevent the enemy from approaching a contested strategic area or to severely constrain its freedom of maneuver.

A RAND study published in 2009 asserted that U.S. forces would have the greatest difficulty in resisting an invasion of Taiwan around 2015[28]. The Chinese could destroy the Taiwanese air force on the ground by raining down a hundred short-range ballistic missiles[29] on their airbases. American USAF or Marine squadrons, present in limited numbers in Japan, could be put out of action in the same way, so that China could win the air war without even fighting in the air. If aerial combat were to occur anyway, the increased sophistication of Chinese aircraft, as well as the protection offered by ground-to-air artillery assembled in layers of overlapping short-, medium-, and long-range artillery that support each other, would make the Chinese confident of ultimate victory.

26. B. Posen, "Command of the Commons", *International Security*, Summer 2003, p.5-46.

27. A. F. Krepinevich, B. Watts, R. Work, *Meeting the Anti-Access and Area-Denial Challenge*, Washington DC: CSBA, 2003, available at https://csbaonline.org/uploads/documents/2003.05.20-Anti-Access-Area-Denial-A2-AD.pdf

28. D. A. Shlapak, D. T. Orletsky, T. I. Reid, M. S. Tanner, B. Wilson, *A Question of Balance: Political Context and Military Aspects of the China-Taiwan Dispute*. Santa-Monica, RAND, 2009.

29. More precisely, between 90 and 240 missiles.

The Navy was no better off. Experts had been pointing out for years the danger posed by Chinese DF-21 missiles, with a range of over 1,500 km, to ships and aircraft carriers that come too close to Chinese shores[30]. The range of the more recent DF-26 missiles would even reach 4,000 km. Chinese cyber-attacks could disrupt American logistics. The potential battlefield would now extend over thousands of kilometers, over an area as large as an ocean. Setting the boundaries of potential conflict had become a daunting challenge and may even seem laughable in light of actions in cyberspace, which eliminate any notion of distance, or even time, in the immediacy of the effects produced.

The American military response was swift. The 2010 Quadrennial Defense Review announced that "the Air Force and Navy are jointly developing a new Air-Sea Battle (ASB) concept to defeat ... enemies equipped with anti-access and area denial capabilities"[31]. Building on the publication of "Why Air-Sea Battle"[32] by CSBA and A. Krepenevich, both armed forces were in fact developing an operational concept that was shrouded in mystery. Few elements transpired towards the public. A first official document, based on ASB and called the Joint Operational Access Concept (JOAC), was issued by the Pentagon in 2012. Another portion of ASB was declassified in 2013. A list was drawn up of thirty capabilities needed in order to have the necessary means to neutralize a protective bubble. The new American art of war was becoming clearer. U.S. forces must develop the ability to disable enemy C4ISR capabilities to disrupt attacks against friendly targets, to destroy enemy A2/AD weapons systems, before successfully confronting the armed forces they would then face. Most importantly, the possibility of attacking along several axes by mobilizing all the armed forces and initiating a complex choreography in the cyber, space and electromagnetic arenas was discussed.

Towards Multi-Domain

Victory on the battlefield, however, would not originate only from a merely conceptual point of view. In November 2014, Secretary of Defense C. Hagel noted in an address to the Reagan National Defense Forum[33], that potential adversaries of the United States were developing disruptive capa-

30. The most modern version of the Xian H6 bomber could carry this type of missile under its wings since 2019, significantly increasing its range.

31. *Quadrennial Defense Review 2010*. Washington DC, Secretary of Defense, 1 February 2010, available at https://archive.defense.gov/qdr/QDR%20as%20of%2029JAN10%201600.pdf

32. C. Hagel, "Secretary of Defense Speech, Reagan National Defense Forum Keynote", *US Department of Defense*, November 15, 2014, available at https://www.defense.gov/Newsroom/Speeches/Speech/Article/606635/

33. J. Louth, T. Taylor, "The US Third Offset Strategy: Hegemony and Dependency in the Twenty-First Century", *The RUSI Journal*, June-July 2016, p.69.

bilities over the entire spectrum of conflict. He noted that the United States was able to re-establish itself on the strategic stage in the 1970s and 1980s thanks to developments in precision reticular attacks and stealth. He then announced the launch of a Third Offset Strategy (TOS), designed to give the United States a new competitive advantage in the area of projection over the next few decades. This strategy is based on the adoption of innovative development processes, inspired by those of start-ups, and on the mastery of new technologies such as robotics, autonomous systems, miniaturization, Big Data[34]and 3D printing. Above all, artificial intelligence (AI) must make it possible to manage and usefully exploit the mass of data collected by sensors, which literally overwhelms human operators, who are only capable of exploiting a small quantity of it. TOS is obviously an extension of RMA. The Pentagon decided to apply the same recipe by identifying innovative technological solutions that could help solve tactical and operational problems.

While TOS disappeared from official discourse with the advent of the Trump administration, its spirit remains, and the focus continues to be on AI development. Yet it is Multi-Domain that has ultimately taken up the vacant space. While the National Security Strategy (NSS), released in 2015, did not address the issue, the 2017 NSS and the 2018 National Defense Strategy recognized that U.S. military superiority can no longer be taken for granted. Both documents then tout the MD approach to ensure that U.S. interests are preserved. The following narrative now dominates the thinking of the U.S. strategic community: potential adversaries understood that American strength relies in achieving military superiority in fluid environments and taking advantage of that to facilitate ground maneuvers. They therefore develop elaborate means to prevent conquest of air or sea. Since the components can no longer proceed sequentially as they did in the 1991 Gulf War, first dominating the air, exploiting the benefits of that supremacy, and then launching a land offensive under very favorable conditions, U.S. forces are considering maneuvering in a synchronized manner, both physically and cognitively, in all environments and across all scopes that form the battlefield. The enemy then faces multiple dilemmas, which can create temporary windows of opportunity that must be seized. U.S. forces can then step into the gap and regain the initiative by adapting their actions to the new environment. For example, successful air raids can be generated by taking advantage of a cyber attack that temporarily disables surface-to-air weapons. By manipulating the magnetic spectrum, enemy satellites can be momentarily blinded in parallel, facilitating the approach of friendly ships carrying troops or launching a salvo of missiles to enlarge the temporary gap.[35]

Obviously, in this new approach, the necessary degree of joint coopera-

34. The USAF adds hypersonic technologies, directed energy and quantum computing to this list.

35. P. Gros, V. Tourret, "Multi-domain synergy", FRS, *Future Conflicts Observatory*, note n°7, April 2019. The authors speak of cascading effects.

tion is a much higher bar than before. The various components of a force must no longer simply coordinate closely. Ideally, they must be integrated, if only to reduce the friction of information transfer or to fully understand the precise nature and effects of maneuvers of other components operating in a different environment or scopes. Only then can convergence be achieved, that is, the creation of simultaneous effects at the operational level, at a higher speed than that of the enemy.

While the discussions on Multi-Domain did not lead to a merger of the American services, it did allow the Army to join the doctrinal debate. It first developed the Multi-Domain Battle concept in cooperation with the Marine Corps, but the latter withdrew to produce its own body of text. The Army then published the Multi-Domain Operations (MDO) concept, which it tested in the Indo-Pacific theater, hoping to arouse the Navy's interest and develop cooperation. However, the Navy has been only moderately involved in this dialogue, believing that it has been practicing multi-domain operations naturally for decades, operating daily in all three environments. The USAF, on the other hand, was very interested in C2-related aspects. It is involved in Multi-Domain Command and Control (MDC2), seeking to develop solutions to link actors from different environments or scopes.

The dimensions of the battlefield are not really specified anymore. The Army does refer to a Multi Domain Extended Battlefield[36], but the essential lies elsewhere. It is now a question of fighting an adversary that occupies less a given volume, transformed into sources of vulnerability, than several generic systems of systems, networked together, protecting each other, which must be disarticulated by acting on their nodes and datalinks.

Today, publications around Mosaic Warfare, launched by DARPA, are expanding the initial thinking around MD. This new term refers to how elements of reduced force, consisting of various weapons systems, could be rapidly assembled or disassembled on the battlefield to produce the most appropriate kill chains for a particular situation at a given time. In particular, automated platforms could be employed to perform a large number of tasks and increase the lethal potential of the whole. The operation of these ad-hoc structures would be driven by AI and ensured by robust networks, composed of redundant nodes to ensure their survival[37].

Over the last forty years, American military experts have had to take into account the development of new technologies, accelerating the digitalization

36. C1, *FM 3-0*. Headquarters Department of the Army, Washington DC, 6 December 2017, p. 1.6 available at https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN6687_FM%203-0%20C1%20Inc%20FINAL%20WEB.pdf

37. B. Clark, D. Patt, H. Schramm, *Mosaic Warfare: Exploiting Artificial Intelligence and Autonomous Systems to implement Decision-Centric Operations*. Washington DC, CSBA, 2020.

of the battlefield. They have had to reflect on the effects of these technologies and have progressively expanded the size and scope of the battlefield, to the point of transforming it into an abstract space, reconfiguring regularly the articulation between the different forces with the overarching tendency being towards integration. It is remarkable that the complexity of the battlefield has been regularly resolved by apolitical, non-strategic principles, which focused essentially on the operative aspects. Thus, the harnessing of the new opportunities offered by technology should lead to quick, sure, and decisive victories, provided that one understands their potential and their impacts on the art of war. Principles and rules of engagement can be derived from this, based on a greater speed of decision and action in a reticular environment. In this respect, it may be relevant to speak of the quest for a Jominian[38] technological approach to characterize at least the last forty years and probably the decades to come, of American strategic thinking.

38. B. Colson, *La culture stratégique américaine: l'influence de Jomini*. Paris, Economica, 1993.

Russian and Chinese multi-domain approaches: the same aerospace battle?

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In order to understand the vision that non-Western powers may have of the "multi-domain" approach, one must first distinguish the two realities inherent in the concept.

Under the name of *MultiDomain Operations* (MDO), this concept has become *the* American doctrine for a return to high intensity warfare, attempting to compensate for the emergence of Russian and Chinese military capabilities, particularly in terms of integrated defense systems (IADS). Depending on their culture, strategy and means, the Russians and Chinese are reinterpreting this concept, which unequivocally targets their so-called anti-access strategies.

As a process of *transformation*, the multi-domain synergy revolves around two core elements. First, it furthers the theories of network-centric warfare, in which the growing information advantage from intelligent weaponry and integrated formations allows them to be configured as collaborative systems. Second, it proceeds from the entry of deep strike capabilities into the precision-strike regime. By imitation and reaction to these applications, these two

principles have also been implemented by the Russians and the Chinese, who recognize technology as a determining factor, structuring their military science and strategy[1]. The extension of the domains of war to space, cyber and electromagnetic warfare is hence at the heart of their current modernization, although they integrate them in a singular way.

We will therefore examine the main guidelines of the Chinese and Russian approaches to multi-domain warfare. To do so, we will conduct a comparative examination of the doctrinal and capability developments of Russia and China and we will look more specifically at the role assigned to their respective air forces in their operational schemes.

Russian and Chinese multi-domain operation designs as a strategy to challenge US concepts.

Russia's and China's considerations of the multi-domain approach is first of all part of the dynamics of their competition with the United States. The concept of MDO is taken up by the Russians as multi-sphere operations (*mnogosfernoy operatsii*)[2] and by the Chinese as multi or all-domain operations (多域作战, *duōyù zuòzhàn* or 全域作战, *quányù zuòzhàn*). From their perspective, this is a description of what they consider to be the latest refinement of an American operative concept that has been steadily maturing since *Desert Storm*.

For the Russians, this takes the form of a "planetary or non-contact war" by launching an integrated massive air strike or IMVU (*integrirovannyy massirovannyy vozdushnyy udar*)[3] made possible by the advent of precision guided munitions and the exploitation of the space sphere. According to their vision, this air campaign, like those carried out in ex-Yugoslavia in the 90s, would disarm Russia by annihilating or overcoming its fighting forces. The country would be decapitated following the targeting of its political-military decision-making centers, which would ultimately cause its dismemberment along ethnic and/or confessional lines.

It is indeed the specter of an "air blitzkrieg" against its western districts that continues to determine the Federation's planning[4]. The breakthrough embodied by MDOs to their way of thinking is less in the promise of a decom-

1. T. Thomas, "The Chinese Way of War: How Has It Changed?", *US Army Future and Concepts Center*, MITRE, June 2020.

2. R. McDermott, "Russian Armed Forces Test Multi-Domain Operations", *Jamestown Foundation*, 9 September 2020.

3. V. Stuchiinskiy, M.V Korollkov, "The Aviation Battle Application Justification Aviation To Disrupt An Integrated Massive Air Strike In The Enemy Multi-Sphere Operation", *Aerospace Forces Theory and practices*, n°16, 2020, pp. 29-36.

4. Lieutenant Colonel T. R. McCabe, "The Russian Perception of the NATO Aerospace Threat: Could it lead to Preemption? ", *Air & Space Journal,* Fall 2016.

partmentalization of the physical domains and the advent of collaborative combat, than in the strategic value of conventional strikes coupled with influence operations. These developments mean, according to the Russians, that it is now possible to limit – that is, decisively engage – a war in its "initial period" to a local and regional scale, below the threshold of nuclear deterrence. They announce "new generation" or "new type" wars structured as sophisticated coercive operations, taking the example of Western interventions against Libya and Syria. Therefore, the challenge for Russia is not so much to achieve joint integration, which it thinks it has solved since the Soviet era thanks to pursuit of deep operations, but to reverse the subordination relationship between its armed forces that had heretofore been to the advantage of ground forces. The Federation seems to be designing out new operational schemes by recognizing a shift in the center of gravity of conflicts towards the aerospace and information spheres, as well as the superiority of quality of fire over pure mass.

China, for its part, insists on the non-kinetic aspect of modern U.S. operations, for which the objective of annihilating opposing forces would have given way to a system-to-system confrontation (体系对抗, *tǐxì duìkàng*). The outcome of the struggle would be determined by a side's ability to generate, exploit, and protect information, which for armed forces would be a source of "integrated whole effectiveness" which would thus improve their ability to conduct precise strikes on C4ISR nodal centers and weak links in the adversary posture. Denial of information, through isolation, decapitation, or sabotage, achieved through kinetic means or influence actions, is hence the major effect of the new Chinese doctrine. It is no longer just a matter of coordinating its forces, but of unifying them in "integrated joint operations" (体化联合作战, *tǐhuà liánhé zuòzhàn*), increasing their mechanization through information enhancement[5]. Recent developments in the Chinese literature further emphasize that this modernization is likely to undergo a new stage with the implementation of "intelligentization" (智能化, *zhìnénghuà*) described by American authors as an algorithm-to-algorithm confrontation, with the incorporation of automated decision-making into the planning, conduct, and even execution of maneuvers[6] .

As a consequence, China's air forces are expected to eventually form a "strategic air force" (战略空军， *zhànlüè kōngjūn*), not only because of the nature of its potential targets as broadly defined in Western air forces, but also because of its increasing capabilities to meet national security objectives in a more offensive approach[7]. Following the largest reorganization

5. T. Fravel, *Active Defense - China's Military Strategy Since 1949.* Princeton: Princeton University Press, 2019.

6. K. McCauley, "People's Liberation Army: Army Campaign Doctrine in Transition", FMSO, 9 January 2020.

7. M. S. Chase & C. L. Garafola, "China's Search for a "Strategic Air Force," *Journal of Strategic Studies*, 2015.

of the People's Army of China (PAC) since its inception, five joint theater commands (战区) were established in 2015 in place of the former seven military regions, a unified logistics support force was established, and a new strategic support force (战略支援部队: *Zhànlüè zhīyuán bùduì*) centralized the means of collecting, processing, and transferring information, both in the space, cyber, and C4ISR fields. The Central Military Commission (CMC) has been considerably strengthened as a result, with the streamlining of the chain of command being pursued through the vertical subordination of the armed forces.

As can be seen, Russian and Chinese developments are facing a choice regarding their adaptation to the MDO that partly explains the divergence of their modernization. At first glance, Russia and China consider that it would be illusory to be able to replicate American superiority on a domain-by-domain basis in the short and medium term[8]. Russia is thus assuming a selective modernization by seeking to develop an asymmetric response[9] to the U.S. multi-domain approach, partly by relaxing its focus on the ground forces[10]. It is focusing on the search for "non-standard" innovations, capable of creating surprise and targeting the weak points of its adversary[11] in order to achieve a forceful deterrence (*silovoye sderzhivanye*)[12]. China, for its part, proceeds from a deeper syncretism by seeking to marry its practice of warfare stratagems[13] with the high technology contained within its concept of system of systems operations. Ultimately for China, the prevalence of asymmetry is considered temporary. According to Xi Jinping, the modernization stage should be completed by 2035 so that the People's Liberation Army (PLA) can assert itself as a "world-class" army by 2050, meaning that it would be in a situation of parity, if not of superiority with the United States[14].

While both powers recognize the devaluation of the principle of mass that previously underpinned their model of warfare by popular mobilization, Russia still considers Operational Art to be relevant as a matrix for jointness, while China has embraced the idea of a new revolution in military

8. D. Solen, "Chinese Views of All-Domain Operations", *China Aerospace Studies Institute*, August 2020.

9. V. V. Selivanov and Y. D Ilyin, "A Methodological Basis for Forming an Asymmetric Response in a Military- Technical Confrontation with a High-Technology Opponent", *Military Thought*, no. 2, 2019, pp. 6-7.

10. Sanctions and the economic slowdown make it difficult to modernize on "all fronts", so Russia is forced to make choices in the allocation of its military budget. Nevertheless, Russia is trying to invest in all areas of the aviation industry.

11. T. Thomas, "Russian Military Art and Advanced Weaponry", MITRE, January 7, 2020.

12. Michael Kofman, Anya Fink, Jeffrey Edmonds, "Russian Strategy for Escalation Management: Evolution of Key Concepts", NAC, April 2020.

13. *Op. cit.*, "The Chinese Way of War".

14. T. Fravel, "A 'World-Class' Military: Assessing China's Global Military Ambition", in "A World-Class Military: Assessing China's Global Military Ambitions", *Homeland Security Digital Library*, 20 June 2019.

and even civilizational affairs. Unlike the People's Republic of China, which structures its military to gain informational dominance over its adversaries, Russia seems primarily guided by the pursuit of dominance through firepower superiority, based on a vision where information would increase its deep strikes efficiency.

In order to better understand these interpretations of the MDO by Russia and China and to appreciate their consequences for their aviation, it is relevant to further detail their strategic thinking.

Russia and multi-domain: not re-inventing, but restoring deep operations through the aerospace dimension.

If the Russian strategic thought recognizes in a similar way to our "principles of military art", it constrains them to three elements or theoretical stages which were bequeathed to it by the Soviet corpus.

The interpretation of the multi-domain approach is first of all part of the study of Military Science, which focuses on identifying trends and generational breakthroughs in armed conflicts[15]. During the Soviet era, war was understood as high-intensity, industrial, and continental war. Today, by contrast, the "new kind of war" is limited, information-driven and aerospace-based. This reinforces the classical concept of the "initial period of the war" (*Nachal'nyi Period Yoiny - NPY*). The need to reach and neutralize the enemy's great depth by maneuvering ground forces has been replaced by the need to gain superiority in the exchange of accurate fire at the beginning of hostilities.

Military Science is then supported by the evaluation of the Correlation of Forces and Means (*sootnosheniye sil i sredstv* - COFM) in different theaters of operation. The COFM must define the vulnerabilities and opportunities contained in the balance of power, both at the strategic and tactical levels, and is partially automated by the adoption of mathematical models[16]. This assessment is not simply an operational indicator but is eminently strategic. For the Russians, the study of an adversary's capabilities reveals his intentions. Its main task is the search for "hidden" factors and conceptual or technological innovations capable of directly altering the COFM. The fact remains that despite technological and geopolitical changes, a lesson offered by COFM has persisted since the Soviet era: initiating the offensive makes it possible to alter an unfavorable balance of power. It is this principle that

15. M. Gareyev, "On the System of Scientific Knowledge and the Scientific Level of Command", *Krasnaya Zvezda (Red Star) Online*, May 30, 2013.

16. See T. Thomas and L. Grau. Recent operative practices, as in Syria, tend to demonstrate that there is no longer a systematic recourse to mathematical modeling, although it remains a regular exercise in their specialized literature.

inspires Russia's "active defense" posture, i.e., the integration of all means that can contribute to degrading the adversary's combat potential, including through pre-emption. In the aerospace field, its influence was demonstrated by the 2015 integration of the Air Force (VVS) and Air Defense Force (PVO) into the Aerospace Forces (VKS).

The study of military science and the assessment of the COFM finally informs Military Art, which is the choice of the form and methods of combat to be adopted in the conduct of operations. This third and final element is equivalent, in NATO terms, to the definition of Concepts of Operations (CONOPS). It is here that the multi-domain approach is afforded the most attention. Since the Soviet era, Operational Art remains the intellectual and organizational matrix of Russian forces, structuring them not in terms of domains, services or operational functions, but according to the depth of the objectives to be neutralized in the enemy's system and today, increasingly, according to the depth of the effects to be achieved. In the 1980s, Operational Art led to the creation of the "operational maneuver groups" (OMGs) which were specifically designed for land operations in a depth of 150 km. Their insertion and progress were in return ensured by the formation of an "air echelon" made up of a dedicated aviation and airmobile forces. However, with the advent of precision munitions, this process of echelonment is now carried out through their ability to form a "system" of reconnaissance and strikes to a given depth.

In contrast to a "domain", depth is not only geographical, but is above all a relationship to the combat potential and resilience of a military system, to its density and critical points. The characteristics of the targeted depth then determine the constitution of strategic theaters of operation or TVD (*Teatr voyennykh deystviy*) [17] which in turn define the main lines of effort (strategic directions of operations). The General Staff of the Armed Forces is responsible for determining the number, scope and qualification of the TVDs. Operational directions are under the authority of the military districts and not under the rule of the different services. Traditionally, Russia has only defined land-based and, to a lesser extent, sea-based TVDs, with which the commands of the other services were made to "fit". Today, it can be argued that the Syrian intervention constituted the first "aerospace theater of operations" for the Russians. The issue is whether this experience will be limited to permissive environments, as seems to be the case with the concept of "limited action strategy" (*Strategiya Ogranichennykh Deystviy*), described by Gerasimov in 2019[18], or whether its institutionalization is possible against an equally matched enemy in a high-intensity situation.

17. D. Glantz, *Soviet Military Operational Art - In Pursuit of Deep Battle*. London Routledge, 1991.

18. D. Massicot, "Anticipating a New Russian Military Doctrine in 2020: What It Might Contain and Why it Matters", *War on The Rocks*, 9 September 2020.

From the point of view of Operational Art, this last option is perfectly coherent. The operational maneuver groups (OMGs) – that is, the ground exploitation capabilities – have disappeared for the moment, and aerospace forces are today the only Russian forces truly capable of going beyond tactical depth (100 kilometers) and remaining there, unlike ballistic strikes.

As such, the creation of the VKS in 2015 was accompanied by the recognition of a strategic aerospace direction, the SVKN (*Strategicheskoye vozdushno-kosmicheskoye napravleniye*). It combines the interdiction effects of the PVO (MiG-31 interceptors, long-range ground-to-air batteries and radars) with those of annihilation of the tactical aviation (Su-25 and helicopters), the tactical-operational aviation (Su-24M and Su-34 bombers, Su-30SM, Su-35 superiority fighters and to a lesser extent MiG-29K and MiG-29SMT) as well as the strategic aviation (Tu-95, Tu-160 and Tu-22). At first sight, this reform would make them capable of implementing, alongside electronic warfare means, the concept of "information strike system" (*Formatsionno-Udarnaya Sistema* - IUS)[19], i.e. striking in great depth (more than 500 kilometers) against critical targets of the enemy C4ISR. In support of this thesis, the Russians have broken down the SVKN into two operational schemes : the "Strategic Operation for the Destruction of Critically Important Enemy Targets" (*Strategicheskaya Operatsiya po Porazheniyu Kriticheski Vazhnykh Ob'ektov* - SOPKVO) and the defensive one",Strategic Operation for Repelling Aerospace Agression", (*Strategicheskaya Operatsiya Po Otrazhe-niyu Vozdushno-Kosmicheskogo Napadeniya Protivnika* - SOPVKN)[20] . However, it would be necessary for Russia to gain air superiority or to operate vectors with sufficient penetration quality to break through or to neutralize the enemy's SDAI. In a potential confrontation with a peer-competitor, Russia seems more pessimistic about its prospects and remains, for now, unable to go beyond the Soviet approach.

Its definition of air superiority (*Prevoskhodstvo v Vozdukhe*) remains constrained by the perception of a structurally unfavorable COFM in the aerospace sphere vis-à-vis NATO. It therefore continues to be articulated asymmetrically in a joint counter-air effort to protect the district and its operations. The integration of all means, defensive and offensive, air and ground, and now electromagnetic[21], is hence motivated by the perception of an air shortfall that must be compensated for, rather than a maneuver force that should be maximized. In this respect, the SEAD mission entrusted to the air force seems to be tactical in nature for the moment, as the Russians

19. Morozov, *Op. cit*, 2009.

20. D. Adamsky, "Moscow's Aerospace Theory of Victory: What the West is Getting Wrong", *Russian Analytical Digest*, n°259, November 30, 2020 as well as Kravchenko, Valeev, "The Preemptive Strike Advantage (Ставка Только На Удар- Ные Или Только На Оборонительные Действия Недопустима)", *Aerospace Frontiers Journal*, August 2018.

21. S. G. Chekinov, V. I. Makarov, and V. V. Kochergin, "Conquering and maintaining air supremacy - an honorable place in the development of Russian military theory and troop training", *Military Thought*, n°2, 2017.

prefer to act against anti-aircraft defenses at a safe distance, through a combined arms preparation favoring artillery and ballistic means. However, mastering a stand-in penetration capability should appear to be a prerequisite for offensive and strategic missions of the SOPKVO[22] type.

This observation seems to be confirmed by the nature of the VKS's capabilities, with the lack of a ramp-up of its C2ISR assets and the continued reliance on stand-off munitions to compensate for the lack of aircraft that can penetrate the enemy's system. In this regard, the new "fifth generation" PAK-FA fighter, the Su-57, might be called upon to assume the mission of defense and air superiority. Its ability to launch a stand-in strike at the enemy's SDAI does not seem to have been studied, and the effort is instead focused on hypersonic missiles to foil defenses, like the Kh-47M2 Kinzhal missile, adapted to be carried by the MIG-31(K) interceptor. This approach to modernization through munitions, while it has the advantage of upgrading platforms that have become too vulnerable, creates a strong dependence on the availability of the most sophisticated[23] stand-off munitions. As it stands, the development of a deeper penetration capability seems to be postponed until the deployment of the PAK-DA heavy bomber, the first prototypes of which are in production, and of long-endurance and sufficiently resilient UAVs. Russia seems to be stepping up its efforts in this area with the deployment of the *Altius* UAV (10,000 kilometers), which is often compared to the *Global Hawk*, and the development of the stealthy S-70 *Okhotnik* heavy UAV, the *Wingman* of the PAK-DA and FA[24].

These shortcomings indicate that a theater of aerospace operations, while doctrinally coherent, does not yet have the means of dynamic strikes in great depth to be operational. The VKS are proving to be a force that still prefers to operate within their "bastion", sheltered by its land based SDAI for which its aircraft were designed. The recognition of greater autonomy for the air force, suggested by the creation of a strategic aerospace direction, comes up against the lack of formalization of a TVD of its own. However, the responsibility for joint integration, which until now has been assigned to the ground forces, could evolve, and become more non-linear locally, due to the progress made by the joint networking of automated C2s up to the tactical levels from the national defense management center, the NTsUO (*Natsionalnogo Tsentra Upravleniya Oboronoy*).

22. Major M. Fiszer and J. Gruszczynski, "Crimson SEAD. An insider's view of suppression-of-enemy-air-defense weapons and doctrine, soviet-style", *Journal of Electronic Defense*, January 2003.

23. J. Bosbotinis, "Fire for Effect: Russia's Growing Long Range Strike Capabilities", *Wavell Room*, September 5, 2018.

24. R. McDermott, "Moscow's Military Modernization Sets Agenda For UAV Development", *Eurasia Daily Monitor*, vol 18, n°19, Jamestown Foundation, 3 February 2021.

China and multi-domain: a systemic organization that struggles to materialize the strategic contribution of its air forces.

While operational doctrine texts, such as "combat regulations", are not available in open source, two other types of documents attract attention: the ten White Papers of "China's National Defense" and, above all, the nine "strategic directives" (*zhanlue fangzhen*) that are often mentioned during speeches within the CMC. These do not directly refer to CONOPS but rather to force development plans. Since they were first issued in 1949, these guidelines have been built around the concept of "active defense", which is remarkably similar to the Russian concept, although it traditionally places more emphasis on the attrition of the enemy. Although the concept remains, the content has undergone significant change since the 1993 directive to "win local wars on its periphery, characterized by high technology". This directive describes the two core tenets of Chinese military strategy and modernization: strengthening the army through information technology and streamlining its organization through the implementation of an integrated joint operations capability. The 2004 directive "under informatized conditions" and the 2014 directive "winning informatized local wars" represent adjustments and updates in this regard. The two objectives of 1993 are perfectly summarized by the 2015 White Paper's maxim: Information dominance, precision strike against strategic points, integrated operations (*xinxi zhudao, jingda yaohai, lianhe zhisheng)*. This White Paper differs from its predecessors by referring for the first time to space and cyber as the "new strategic heights", and encourages the PMA to shift from its continental vision to embrace its growing external interests[25]. This direction is reinforced by the 2019 White Paper, which states that the mechanization of the armed forces is to be completed by 2020, and that the target for full modernization is no longer 2050, but 2035. This modernization effort through a "systems of systems" approach can be nonetheless ascertained in their joint exercises and in their military science literature dealing with the concept of "operational force generation systems" (作战 力量体系, *Zuòzhàn lìliàng tǐxì*)[26] .

The Chinese vision is to be able to deploy forces specifically aggregated for a given campaign or mission, whose integration is ensured by their modularity and by their unification within a joint command architecture[27]. Since 2017, units are in fact structured according to their ability to bring together "operational elements", close in spirit to the American *Warfighting Functions*: C2, reconnaissance and intelligence, informational confrontation

25. The first mention of space as a strategic height, however, was in the 2006 edition of National Defense University's "The Science of Military Campaigns."

26. K. McCauley, "System of Systems Operational Capability: Key Supporting Concepts For Future Joint Operations", Jamestown Foundation*, China Brief*, vol. 12, n°19, October 5, 2012.

27. K. McCauley, "People's liberation Army: Army Campaign Doctrine in Transition", *FMSO*, January 9, 2020.

capability, maneuver, protection, support. A tactical formation is thus an "operational system" bringing together several units and at least two services, called upon in turn to form, with other formations of the same rank, a campaign formation, understood as an "operational system of systems" (OPSYS) and characterized by its ability to conduct an operation independently[28]. Five of these systems are known today: anti-air, anti-landing, joint strike, blockade and information warfare[29]. They should be activated and assembled in wartime according to the type of campaign chosen.

China recognizes the validity of the MD approach in the sense of a multiplication and a diversification of the domains of warfare. It understands the need for *multidimensional* formations, considering that the freedom of maneuver in the three tangible domains (land, sea, air) is increasingly conditioned by the control of space as well as the electromagnetic spectrum and cyberspace[30]. Considering these last two elements as the main expressions of informational warfare, China's ambition is to bring them together in a single "network-centric electronic warfare" CONOPS to combine attack vectors, from kinetic strikes against sensors to intrusion into the computer systems of opposing C4ISRs[31] .

However, this vision of a fluid and adaptive integration remains largely hampered for the moment by multiple difficulties experienced notably by its aviation.

First, the formation of OPSYSs continues to be structured along service lines that favor ground forces[32]. Second, the lack of combat experience is combined with overly predictable joint exercises[33]. More generally, the "system-of-systems" integration model raises the question of the scope of operations considered and the real goal of joint integration, between political control and operational effectiveness. If the model seems adapted to conduct very specific campaigns on well-identified objectives in a limited time, its unified architecture seems above all designed to allow micro-management by the CMC. The approach, consistent with the perspective of limited local wars, ultimately raises the question of the existence of a true Chinese Operationnal Art and the possibility of broader integration in the event of a higher intensity war.

28. K. McCauley, "System of Systems Operational Capability: Key Supporting Concepts For Future Joint Operations", Jamestown Foundation, *China Brief*, vol 12, n°19, October 5, 2019.

29. J. Engstrom, *Systems Confrontations and System Destruction Warfare*. Santa Monica, RAND, 2018.

30. "Identifying the Starting Point for Military Readiness" (定准军事斗争准备基点), *Study Times,* July 8, 2015.

31. *Op. cit*, Dean Cheng, 2019.

32. J. Wuthnow, "A Brave New World for Chinese Joint Operations", *Journal of Strategic Studies*, 2017.

33. J. Allen, K. Allen, "The PLA Air Force's Four Key Training Brand", *CASI*, May 31, 2018.

These cross-cutting issues thus found particular resonance in the modernization of the Chinese Air Force (FAAPL). As the first service to put forward, in 2004, the notion of an "integrated air and space" (*Kōng tiān yītǐ*) so as to conduct "simultaneous defensive and offensive operations[34]", the air force was no longer restricted to the sole mission of territorial defense and support[35] . According to the 2013 "*Science of Military Strategy*", FAAPL was on its way to building an integrated anti-aircraft, anti-ballistic, and aerospace defense system. However, space-based reconnaissance assets eluded their control with the creation of the Strategic Support Force in 2016. This loss of the new "strategic heights" goes hand in hand with a doctrinal ambiguity that U.S. analysts interpret as a stagnation of the service[36]. Indeed, China does not recognize an equivalent to the concept of "air superiority", which it translates *in extenso* to refer to the missions of Western aviation[37].

The 2015 reform further created a still unresolved problem of integration. Airborne divisions structured around types of aircraft have certainly been eliminated and have been replaced by brigades attached to "bases" within a command theater, as was the case in the Russian 2008 reform. This model, however, makes inter-service coordination of forces more complex, as it cannot be handled directly between staff of the same rank. A FAAPL commander must report directly to theater command to operate jointly with naval or army elements within the same task force.

Finally, although progress is significant, China, like Russia, is still too poorly equipped with airborne or space-based ISR assets to achieve the dynamic targeting it envisions in its system-to-system confrontation[38].

To further its "strategic mission", the FAAPL has therefore focused on its potential contribution to the "comprehensive military deterrence posture" (整体军事威慑态势, *Zhěngtǐ jūnshì wēishè tàishì*), which encompasses, among other things, conventional and nuclear[39] action. This ambition leads it to invest today in the naval domain in order to secure its importance and its funds in the face of the Chinese navy's aviation branch and missile launcher forces, which conversely propose to ensure "sea superiority through land

34. K. W. Allen, B. S. Mulvaney, S. Char, "Ongoing Organizational Reforms of The People's liberation Army Air Force", *Journal of Strategic Studies,* vol. 44, n°2, 2021.
35. "Xu Qiliang: China must create the concept of aerospace superiority" (许其亮：中国空军必须树立空天安全观), *People's Liberation Army Daily*, November 2009.
36. I. B. McCaslin and A. S. Erickson, "Selling a Maritime Air Force: The PLAAF's Campaign for a Bigger Maritime Role", *CASI*, April 2019.
37. CASI, "Command of the air", October 2020.
38. P. Wood, R. Cliff, "Chinese Airborne C4ISR", *CASI*, November 2020.
39. M. Chase, A. Chan, China's Evolving Approach to "Integrated Strategic Deterrence". Santa Monica, RAND, 2016.

superiority"[40]. FAAPL's efforts appear to be more successful in this area. It is incorporating the naval dimension into its exercises and has succeeded in establishing air defense identification zones in disputed areas, such as over the East China Sea in 2013. It announces its ambition to be able to operate "throughout the country's strategic space", patrolling increasingly around Taiwan and within combat distance of the U.S base in Guam.

Conclusion.

Russia and China are now seeking to emulate the underlying principles of American power in order to better oppose them. The multi-domain approach is part of this dual relationship with Western innovations. Both countries want to take advantage of network centric warfare and provide their deep strike capabilities with a high degree of precision, and so they are moving towards cross-domain synergy however asymmetrical.

For both models, the role of aviation appears pivotal in two ways. First, it represents the main threat to their military system and encourages them to integrate their capabilities into a single information space. Secondly, it is leading them to a profound re-evaluation of the contribution of aviation to their operations. Its growing autonomy represents a departure for continental powers, which had mainly assigned it a role of support, preferring the ballistic vector.

For Russia, aviation is asserting itself as the catalyst for its preparation for "wars of a new type". While a strategic aerospace theater of operations does not yet seem likely to materialize, the advent of strategic directions under the responsibility of the VKS underscores the fact that the reform of operational schemes inherited from the Soviet era is well under way.

For China, aviation is becoming a strategic service, vital for fire support and precision strikes in system-to-system confrontation. The modernization of the FAAPL seems more difficult as it has been deprived of the exploitation of the space domain, whereas previously it had clearly been included in its 2004 strategic concept. As a result, it is seeking to gradually assert itself through its maritime contribution to the country's active defense.

40. *Op. cit*, McCaslin, Erickson, 2019.

C2 Air multi domain or the art of mastering complexity.

GDA Louis Péna

As a former Weapon System Officer, Major General Louis Péna flew the Mirage 2000D *and the* Rafale*. He was later chief of staff of the Operation* Barkane*, chief of staff of the French Command for Joint Operations in Creil, and French JFAC commander for air operations in central and western Africa. He is now the chief of staff of the Air Defense and Air Operations Command.*

Military operations are most often represented through the prism of actions on the field. These lend themselves more to the narrative because they give strength to the images. The armies are quite comfortable with this approach, which puts the combatants in the spotlight. In the shadows, however, there are other military personnel whose activity is decisive for the final outcome of the conflict: present at all levels of responsibility, the decision-makers have an essential responsibility for the conduct of military operations. It is at their level that the fate of crises, and even wars, is decided.

Military leaders operate within command structures, commonly referred to as C2s[1], which allow them to make decisions that frame the actions of combatants. These decisions are the result of formalized processes that include various factors, not only military ones. Command performance is described by the recent force employment concept as one of the nine factors of operational superiority[2]. Its credibility is essential in the French logic of engagement of forces, where the role of the President of the Republic, the head of the armed forces, is central. There can be no doubt in his mind about the effectiveness of military leaders, as General de Gaulle reminded us: "It is

1. Command and Control: to command (give orders) and control (follow) their execution.
2. The other eight being: fortitude, understanding, agility, influence, endurance, lightning, credibility, mass.

still necessary (for the military leader) to have a clear enough plan himself to support his resolve. Nothing provokes interference from above more than a lack of confidence from below[3].

More specifically, C2 Air is the focus of particular attention in the context of multi-domain thinking, as it reflects our ability to design and conduct tomorrow's operations in the ecosystem that this neologism evokes. The French air operations command structure is the result of an evolution that began 30 years ago with the first Gulf War[4], and is now a reference for Western air forces. Despite the current performance of the French C2 Air Force, the challenges ahead raise questions about the future of air operations command. The French Air Force is already working on this issue, both at the conceptual level, through the dissemination of an exploratory concept on multi-environment/multi-field and connected collaborative air combat, and at the technical level, as part of the work on FCAS (Future Combat Air System).

The result of a rich operational history: a mature and efficient contemporary Air C2

Similar to what happened at the level of the joint forces, the chain of command for operations within the Air Force underwent a real transformation after the 1991 Gulf War. Until then, the armed forces, and in particular the Air Force, were very much focused on the protection of the homeland, but this conflict made it clear that progress had to be made in order to command operations that could involve them thousands of kilometers away from France. In this respect, while the 1972 White Paper was that on deterrence, the 1994 White Paper was clearly on deployment and projection. Published in the aftermath of the Gulf War, twenty-two years later, it represents a turning point in the French strategic vision.

The Air Force and its operational command then shifted away from the use of conventional combat aircraft, which were largely reduced to support ground forces in the face of the Soviet divisions that were expected to pour through the Belfort gap.

The exercise of command at the time was based more on the quality and experience of the leaders than on the actual structures and processes at their disposal. Therefore, in 1994, the Air Force created the Air Defense and Air Operations Command (CDAOA), grouping together the planning and conduct of operations to protect the national airspace, and to conduct air operations. The air operations chain of command [5] subse-

3. C. De Gaulle, *Le fil de l'épée*. Paris, Plon, 1996, p. 127

4. L. Péna "Between geostrategy and technology, the evolution of the command and control of French air operations since 1991", *Revue historique des armées*, n° 301, vol. 4, 2020, p. 2-14

5. This article only deals with conventional air operations.

quently continued to perfect its operating methods, in keeping with the reality of operations. In 1999, the war in Kosovo highlighted the need for robust targeting, as their characteristics and their vulnerabilities became a necessity for the coalition. In the aftermath of this war, France created the CNC (National Center for Targeting), a joint unit under the command of an Air Force officer. Later, operations in Afghanistan underlined the need for command structures capable of managing fire support missions over a geographically vast area and for the benefit of a multitude of actors on the ground and in the air. In this respect, after Kosovo, the engagement in Afghanistan demonstrated the operational value of UAVs[6].

In 2011, as part of Operation Harmattan, the Air Force operations chain of command conducted strikes around Benghazi. Throughout this operation, it demonstrated its ability to fight with the air support systems of the French armed forces, the Navy Air Force and the French Army's Light Aviation (ALAT), as well as its ability to work within the NATO command structures. This capability was confirmed the following year when they assumed responsibility for the NATO alert by implementing the Air C2 of the Nato Response Force (NRF). When Operation Serval was launched in 2013, the French Air Force responded to the urgency of the situation by planning the strikes that stopped the rebel columns heading towards Bamako in the very early hours of the engagement, carried out by aircraft that had taken off from the French mainland. Since then, it has operated a single command center, located on Mont Verdun North of Lyon, from which all conventional air operations conducted by France are now commanded, specifically long-distance missions such as exercise Skyros, air operations in the Sahel, but also, in 2018, the Hamilton mission against Syrian infrastructures.

Over the years, the French C2 Air Force has expanded to encompass the use of all types of vectors, and the planning and conduct of missions assigned to a modern air force, using satellite-based resources. Air C2 is systematically involved in joint and even international operations, and is well versed in command methods, both the highly vertical methods of French joint command and the more horizontal methods of cooperation between various components. Its processes are fully compatible with those of the upper levels and those of our main NATO allies, since they are modeled on them. The chain of command of an army is one of the factors of operational superiority that sets it apart. Today, the French Air Force has a proven command capability, which, on a daily basis, plans and conducts operations on or from national territory, sometimes thousands of kilometers away from mainland France; "this capability makes the Air Force a major military force, without equivalent in

6. The Air Force acquired Israeli *Hunter* drones in 1995.

Western Europe".[7]

But this superiority factor is not "rust-proof" since performance is constantly being called into question by the reality of operations. Just as our Air C2 has continued to adapt since the Gulf War, it must continue to evolve to meet future challenges (changing geostrategic context, extension of conflicts to cyber and exo-atmospheric arenas, impact of new technologies, etc.). These developments will eventually form a new ecosystem that strategists will have to harness to rethink air warfare. This lies at the heart of the rationale governing the chain of command, which must conceptualize the military problem posed, place it in contemporary and future contexts, and imagine the appropriate responses, considering the levers available - whether military or not. The objective to be reached, the challenge that structures the whole approach, is therefore not the definition of the *multi-domain*, which is quite secondary[8]. The real purpose of the initiatives that the French armed forces must now implement is to identify all possible synergies between direct and indirect approaches[9] in this new ecosystem, whose effects can be applied in both tangible and intangible areas of confrontation, in order to command operations and win conflicts in the coming decades. For the French Air Force, this translates into the ability of C2 Air to command and fight in the era of FCAS, i.e., by 2040. Over the next 20 years, our command structure will have to adapt to the requirements of operations in a multi-domain operational environment, in an uncertain geostrategic context and with increasingly high-performance technological resources.

The vision of the French Air and Space Force

Like all Western armed forces, the national French armed forces are already examining this issue. In keeping with French military culture, the Air Force's approach is initially conceptual and not based solely on technological promises. As a technological army, born of the industrial revolution, the Air Force knows the risks of blindly relying on the temptations of technology. In parallel with work on FCAS, it has published an exploratory concept on "Connected Air Combat"[10], which includes the Global Air Combat System (GACS) and the *Rafale F4*, which will ensure the transition to FCAS.

Concerning multiple domains, the Air Force and Space Force use the distinction between environments and fields as outlined in the Force Employment Concept published in December 2020. There are the five classical environments – land, air, sea, space and cyberspace – the first four of which

7. M. Forget, *L'armée de l'Air face à ses épreuves*. Paris, Economica, 2020, p.11

8. The expression "multi-domain" is only a semantic facility: we must be careful not to become lost in complex discussions that lose sight of the crux of the matter: how to command operations in the future?

9. Termed hard power and soft power.

10. Document #00501068/ARM/EMAA/SCPA/BPLANS/NP dated April 2020.

are subject to physical laws (Newtonian, Archimedean, Keplerian, to name but a few). To these five environments are added two others, the information and electromagnetic fields. In the French conception of the subject, the multi-domain approach thus encompasses seven spaces for maneuvers and confrontation, five of which are also environments.

At first glance, it may seem difficult to distinguish between the concepts of environments and fields. The main characteristic common to all five environments is that they have a permanent command structure that has been established or is being developed. These midfield C2s are thus able to give orders, carry out actions and generate effects[11]. A multi-domain C2 must be able to find the best synergy between these effects, obtained in one or more of the seven domains of confrontation, in order to dominate the adversary. On the other hand, the levers of action constituted by information or the electromagnetic spectrum are not used by a dedicated command structure; there is no information or electromagnetic spectrum command like the CDAOA or COMCYBER for example. However, they are fully integrated into the planning of staff working on these environments, and into the planning work of operational or strategic level command structures.

The number of combinations of possible modes of action increases as the number of areas of confrontation is extended. In the not so distant past, one fought on land, in the air or on the sea with combinations of actions coming from these three environments, to which can however be added the manipulation of public opinions through propaganda. More recently, these traditional environments have refined their modes of action by using products from space (images, telecommunications, etc.), by mastering more and more the electromagnetic spectrum (electronic warfare, detection, stealth, laser, etc.) and by investing in the field of perceptions[12]. From now on, the multi-domain approach offers staff officers the prospect of imagining new modes of action, more difficult to counter by the adversary, because they can produce a wider range of effects in a greater number of domains. If, traditionally, a C2 seeks to pose more problems to the enemy than it can solve, multi-domain fits perfectly into this perspective. Multi-environment/multi-field combat is announced as that of controlled complexity, which we seek to impose on the adversary without suffering it in return. Imagining the most disruptive modes of action is one thing, having the means to implement them is another. The SCAF promises to be formidable in this respect, with the New Generation Weapon System (NGWS). Comprised of a New Generation Fighter (NGF), Remote Carrier (RC) unmanned air vehicles and an Air Combat Cloud (ACC), it offers a wide range of possibilities. RCs in particular combine consumable vectors, which can be used in massive

11. In terms of planning, actions generate effects that cause a change of state in the opponent.
12. For example, through psychological actions.

numbers and/or in swarms, and UAVs that are true NGF team members (the loyal wingman concept) with valuable capabilities (reconnaissance, offensive jamming, etc.). The scope of application of these capabilities is immense and flexible. In this respect, FCAS, with its first-entry capability, brings complexity to the heart of the adversary's system.

The modes of action developed by a command structure are expressed mainly through targeting. At the strategic level, it may be a matter of defining the best option (direct or indirect) for imposing one's will on the adversary in all or several areas of confrontation. At the operational level, targeting can be translated into an optimal synchronization of effects obtained through physical destruction and psychological actions. At the tactical level, it can be expressed by the destruction of certain parts of a complex system, such as a communications system, for example. It is undoubtedly in the targeting process that the prospects offered by the extension of the fields of conflict and technological developments will provide the most decisive operational gains. In the context of a multi-domain C2, this know-how must be mastered and used at all levels of command. This requires the implementation of a single targeting process, common to all levels, guaranteeing a coherent joint approach and facilitating interoperability.

The multi-domain dimension is not the prerogative of the strategic or operational levels of command, since it is the C2s of the environments, confronted with the reality of the adversary's systems, that will detect and exploit opportunities in and through the seven defined domains. However, acting in this ecosystem does not seem compatible with an approach that would be satisfied with juxtaposing environment solutions. Thus, thinking about multi-domain must give C2 environments a joint dimension that they have too little of today. Much progress has been made in recent years in the joint design of operations. Recent engagements – Hamilton, Barkhane – leave little doubt about the need to pool the know-how and capabilities of each of our armies. But this integration must be taken further, in particular by standardizing working methods. The use of a common grammar is necessary to facilitate exchanges between armies, between levels of command, but also with our allies. The bases of this common language exist; they are practiced and taught by the French operational referent, the French Command for Joint Operations They are generally known to the armed forces, but are used in different ways. This method is sufficiently flexible to envisage its application in a multi-domain environment. It natively integrates the principles of the global approach, which considers a crisis through perspectives other than the sole military prism, and integrates by nature all the levers available to respond to the problem to be resolved. This methodology, inspired by NATO's, applied by the French Air and Space Agency, offers the best basis for developing processes adapted to the multi-domain environment, where,

for example, simulation, serious gaming and artificial intelligence can constitute interesting auxiliaries.

Beyond the method, all national armies are moving towards greater digitization of their combat tools. In its "Connect@Aero" concept, the French Air Force is developing the idea of a cloud that will enable the pooling of useful information for all its vectors. The Air Force is considering interoperability and interfacing its future tool with those of other armies and its allies. Interoperability is essential to the joint multi-domain approach. This takes on its full meaning in the search for a shared, joint-level vision of the multi-domain operational situation, which would be permanent. The Air Force advocates the permanence of the multi-domain model. It is not a matter of "doing multi-domain" at the start of a campaign or in the context of a major engagement, and then returning to a traditional form of command afterwards, when the advantage is gained or during "rustic-type" engagements. The essence of tomorrow's C2 is not going hybrid, high intensity or counter-terrorism; it is all of these. It must be able to deal with any type of threat by evolving in, and with the help of, the seven confrontation domains.

The multi-domain approach must preserve the flexibility of adapting C2 to the changing status of a crisis, and even to the type of crisis itself. We can therefore imagine a joint[13] *master cloud*, which can be adapted to different situations, in the *form* of *theater or contingency clouds*[14], based on the needs of clouds of different armies, as required. The basic idea is to be able to have a permanent assessment of a multi-domain situation. Technology offers us the possibilities to meet this ambition, to permanently "scan" the battlefield in all domains. The capacity to process information rapidly and massively, as promised by artificial intelligence and quantum computing, leads us to believe that real-time management of the multi-domain space is no longer really science fiction; having an operational vision of moment-by-moment and permanent interests is now accessible.

As can be seen, thinking about the multi-domain approach is leading to changes in the traditional scope of an service C2. The most significant of these changes concerns its ability to handle effects, whereas until now a tactical C2 was more restricted to actions.

The future principles of command

The French Air and Space Force is also considering revamping their own command principles. The command of French operations is centralized at the strategic level and induces an essentially vertical flow of information[15],

13. Even interdepartmental.
14. Which must therefore be made impervious to any intrusion.
15. The term "information" has a very broad meaning here: information, orders, transmission of working documents, etc.

between the strategic, operational and tactical levels, both "top-down" and "bottom-up". The multi-domain approach leads us to reflect on how to adapt current command relationships. The synergy of the effects obtained in (or thanks to) one or more of the seven confrontation domains raises the question of the exercise of command at the level of the armed forces. Relationships between environmental commands, on the one hand, and with the joint level, on the other, undoubtedly deserve to be adapted and the environmental culture also needs to be better shared. Tomorrow's decision-maker will be imbued with the characteristics and capabilities of the different environments. They will therefore need to have followed a path that enables them to master the multi-domain spectrum.

At the same time, the complexity of the action of the armed forces in all areas of confrontation will lead, according to needs, to more subordination to the lower echelons, in particular tactical. Some operational concepts and decision-making will be shifted closer to the battlefield, contributing to a more horizontal chain of command. The digitization of the battlefield, the connectivity of tactical units regardless of the service to which they belong, the implementation of informational clouds and the robustness of transmissions will promote the global understanding of tactical units, a better awareness of the multi-domain operational environment. Thus, from a pyramid architecture, the chain of command and control of operations will evolve towards an architecture with a very broad and meshed base, similar to a spider's web.

Airmen believe that the development of greater subsidiarity is a doctrinal opportunity to be more effective in decision-making by giving the tactical effector the means to make decisions that structure the course of operations-decisions traditionally made by higher echelons. The principles that have until now set the pace for the functioning of an Air Command structure are the centralization of command (a single leader, regardless of the origin of the air assets deployed[16], and centralized design) and control[17] (monitoring the execution of orders and evaluating results). The execution of orders by combat units remains decentralized at their level. This mode of operation has proven its worth in guaranteeing concentration, selectivity of effort and economy of means.

However, it can be cumbersome, and the issues described above – specifically the permanent updating of the multi-domain operational situation – militate in favor of making it evolve towards greater subsidiarity. There are two essential conditions for achieving this distribution. The first is the train-

16. As was the case, for example, during the first Gulf War.
17. Not to be understood in the sense of air traffic control performed by controllers in control towers.

ing of decision-makers at the tactical level. Today, they are far removed from central-level thinking, focused on considerations of tactical expertise, and rarely have a detailed understanding of general air maneuvers. In order to broaden their contribution to the air campaign, they should be familiarized as soon as possible with the functioning of a multi-domain air operations command structure and with the methodology mentioned above, which, as we recall, still must be adapted. This theoretical approach will allow them to consider the mission in which they are going to be engaged with a more complete viewpoint than they have today: not only through the technical-tactical prism, but with the awareness that their decisions could have a structuring impact on the operation in progress, whereby they would become, as it were, "strategic lieutenant colonels". To ensure the relevance of their decisions, the theoretical approach must be made concrete throughout the operation itself, through close exchanges amongst the staff, grouped around the head of the multi-domain C2 Air Command, and these tactical-level decision-makers. They must be constantly informed of the component commander's intention so that their decisions are naturally in line with their leader's vision.

The second condition is technological. It is necessary for the tactical decision-maker to have access to useful top-down information at the best moment to make a decision. At the tactical level, information management is decisive, given the direct contact with the adversary and the very short decision times in the cockpit of an aircraft. Only useful elements must therefore reach him, in an orderly and timely way. Connectivity between the different actors (fixed, in-flight, manned or unmanned), artificial intelligence developed as a decision aid and data management as imagined for FCAS must enable the transfer of responsibility. The connectivity between all the air vectors in the first circle (i.e. in contact with the adversary), those in support (second circle) and the air command chain on the ground, makes this very significant change in current command principles technologically possible.

The problem of information management also arises in the upward direction, from the effectors to the component commander. We have seen that the ability to have a permanent multi-domain situation assessment gives a real operational advantage. In order to give the commander of an operation the ability to make decisions, this assessment must be complemented by an evaluation of the effectiveness of the operations in progress. The evaluation function is generally the weak link in command structures. It is difficult, subjective, and yet essential to allow the military leader to orient the operation and make any necessary corrections. The multi-domain nature of the problem makes it even more complex: while there are effects that are fairly simple to measure (the production capacity of a power plant, whether or not adversary radio transmissions are being pursued), there are others for which measures of effectiveness or performance are more difficult. This is generally

the case for actions having effects on perceptions and intangible fields and more particularly for cyber actions or actions in the information sphere.

The problem of evaluation also arises within a C2 environment. For an air force, there are currently three levels of reporting: the first during the action, transmitted by radio by the crews; the second just after the action, transmitted to the ground, generally by intelligence officers; and the last, the most exhaustive, by the staff services. It is with this evaluation that the head of the air component will be able to make decisions for the continuation of operations[18]. Just as was mentioned for subsidiarity in decision-making, the same principles - training of "strategic lieutenant-colonels", technological innovation - make it possible to envisage enriching the initial reports of combat units. Part of the analysis work that was previously done by the component staff must be taken on by the first tactical echelons in order to save time.

The joint collaborative approach mentioned, the review of command relationships outside and within the air component, raise the question of information sharing and "decompartmentalization". Whether it is used in the long term, for planning purposes for example, or in the very short term, intelligence remains the fuel for operations. Without quality fuel, the best engine cannot deliver the expected power. The enrichment of raw information by all the actors in the intelligence sphere according to a timeframe adapted to the needs of operations (medium term, long term, or instantaneous), and the dissemination of the intelligence thus obtained to decision-makers and effectors, are decisive capabilities for a multi-domain chain of command. The tools that enable the efficient processing of a large mass of information are being developed with the help of artificial intelligence and are already proving their worth. The speed of analysis, attribution and transmission remains a challenge. This last point is also related to the security of the transmission. Operational security in the transmission of intelligence or orders is essential to maintain the advantage. It is also a technological challenge in which the control of the electromagnetic spectrum is essential; the developments in progress and the progress made by laser communication, which allows the transfer of large masses of data very quickly (of the order of 2 gigabits per second) while being extremely difficult to jam, are likely to reinforce the protection of our data.

Finally, mastering time in all its dimensions is one of the challenges of multi-domain C2 Air. It must take the long term view in monitoring, planning and evaluating effects in the field of perception. On the other hand, the ability to react quickly to seize any opportunity will depend on the ability to master the instantaneous or the very short term. This is only possible if the assessment of the multi-domain situation is ongoing, requiring constant

18. This is the orientation phase of the OODA (Observation, Orientation, Decision, Action) loop.

monitoring. Time management is also expressed by C2 Air's ability to reproduce work processes systematically and rigorously, an ability that is inseparable from operational efficiency. Finally, time management is expressed through the circulation of information and elements useful for carrying out missions at all levels of responsibility at a frequency and tempo adapted to the individual needs.

The French Air and Space Force is fully aware of the geostrategic, doctrinal and technological challenges that will characterize the next twenty years. The conceptual work carried out for the evolution of its operations command structure and the progress of FCAS project enable it to identify future requirements. In an innovative approach, it envisages a C2 Air Force capable of mastering all the dimensions of time with renewed command principles. While the centralization of design is maintained to guarantee the overall coherence of air action, structuring decisions can be envisaged and distributed at the tactical level. Technological advances allow for improved evaluation of air maneuvers and the circulation of data (information, intelligence, situation assessment) is favored by the use of an information cloud connected to that of other armies and the joint level. The design of disruptive modes of action in all areas of confrontation and the connected collaborative approach will confront the adversary with an operational complexity that will deny him any initiative.

Air operations and Space

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As soon as it came to power, the Nazi regime studied the possibility of acquiring a capacity to strike the American territory, no doubt rightly sensing that its existence could at some point depend on a military confrontation with the United States. It was with this in mind that the Austrian engineer Eugen Sänger developed the *Silbervogel* (Silverbird) "Rocket Bomber" in Peenemünde in 1936. Designed to be propelled from Germany to low orbits by rocket engines, then gliding to American territory by bouncing off the upper layers of the atmosphere, this rocket bomber was then to be capable of dropping four tons of bombs on the United States before landing on a runway located somewhere in the Pacific, on territory held by the Japanese ally. In 1942, as the Nazis were beginning to lose their grip on the war, the Silverbird program was abandoned in favor of technically less ambitious projects, including the V2 rocket, the first object sent into outer space by man and the first ballistic missile. On September 8, 1944, six Parisians were the first victims of this new weapon, which opened a new era in the history of armed conflicts. This look back at a dark page of our history shows that the idea of extending the scope of military air strikes beyond the atmosphere to include aerospace operations is by no means a new idea. It also shows that, in a way, the ballistic missile option was initially presented as a fallback solution to that of the Silverbird Rocket Bomber, an aircraft whose planned mission trajectory involved flying both through and above the atmosphere. Thus, at the time, the ballistic missile was perceived to be a second-best solution by airmen, a sort of pilotless aircraft, while ground forces saw it as an extraordinary "super-artillery".

With the collapse of the *Third Reich*, the engineers who had developed the most advanced aeronautical and astronautical programs for the Nazis emigrated to the Allied countries where, suddenly imbued with newly acquired "virtue", they became the initiators of an unprecedented move towards "space conquest". However, the primary purpose of the research efforts then deployed was far from the ideal of exploration that this name suggests. On the basis of the V2, it was in fact a question of acquiring as quickly as possible, in the context of the emerging Cold War, a nuclear weapon with intercontinental range. The ballistic missiles gave rise to civilian versions used to launch crews and satellites into space for both civilian and military applications. Thus, space capabilities were developed to support military operations, mainly in the fields of intelligence and telecommunications, the indispensable nature of which is now recognized by all.

For seventy-five years, the general pattern has been that of two distinct military operational domains – air and space – involving specific concepts and doctrines of use, for which common strategic principles are applied in different ways due to their respective physical singularities. Nevertheless, it is important to recognize the possibility of combined implementation of these environments, whether collaboratively or, on the contrary, in an offensive posture. The bridge between these two "worlds" is embodied by the space plane, which the state of the art of military technology still limits to a marginal role at this stage. Thus, Air and Space strategy coexist today, while the existence of an aerospace strategy still appears uncertain.

A third dimension of a strongly heterogeneous nature: the air and space environments are contiguous yet fundamentally different in their nature as well as in the operational potentials they offer.

The air and space environments are contiguous and apparently of the same nature, the first being the necessary point of passage to reach the second. This is clearly a very different situation from that which differentiates the terrestrial and maritime environments. In considering the air and space environments, the first difficulty is the absence of a clear and legally established boundary between them. In a way, there is a grey zone in which the regulatory logic applicable to the air domain is blurred and replaced by another regulatory logic, which is less clearly defined and thus more permissive. No international agreement has ever been reached on the boundaries of space. Some countries have opted for an altitude arbitrarily fixed at 100 kilometers above sea level. This is the case, for example, of Australia and Denmark. Some argue that the line, known as von Karman's line, from which flight becomes impossible, around 80 kilometers above sea level, is more relevant, while others prefer to retain the minimum altitude at which it is possible to remain in orbit, around 125 kilometers. Confronted with these divergences, the international community has remained ambiguous, and no one knows

today where space begins. In fact, this situation has become acceptable, and at this stage it does not constitute an obstacle to activities in space, nor a cause of legal disputes. The future, however, will see a considerable increase in space activities, whether commercial, governmental or scientific, and the boundaries of space may have to be further defined as the stakes of all kinds of endeavors become both more important and disputed.

Although there is no commonly accepted definition of the boundary between air and space environments, many differences in their physical characteristics allow us to clearly differentiate them: chemical composition, temperature, conditions under which the law of universal gravity is exercised, intensity of cosmic rays, conditions of wave propagation or the observed electromagnetic field are all fundamental differences distinguishing the air and space environments. For military operations, the most discriminating element is undoubtedly the move from a Newtonian to a Keplerian reasoning when a mobile device moves from air to space. An orbital system is subject to Kepler's laws and not to aerodynamics, it does not "fly" but rotates around the Earth in a movement that is similar to a never-ending fall. Changing the plane of its orbit is extremely energy consuming and rendezvousing with another orbital system is possible in a given plane that is known at launch but is otherwise very difficult to achieve. The maneuverability and flexibility of a satellite are thus far from being comparable to an aircraft.

Another very differentiating factor between air and space environments is the recognition of the principle of national sovereignty in their respective air zones, whereas outer space completely disregards this principle. Admittedly, the sovereign national airspaces only represent about a quarter of the surface of the globe, yet they are the unavoidable points of passage for any air activity which, by definition, begins and ends on an airbase located on sovereign territory[1]. Aircraft stationing rights, flyover authorizations, compliance with specific operating regulations and landing fees are some of the restrictions imposed on aviation activities by sovereign states. On the other hand, space-based activities are largely unrestricted, allowing, for example, to legally and discreetly bring any point on the globe within the range of a satellite sensors.

Airpower also has the characteristic of being transient by nature. The vectors that airpower uses have the characteristic limitation of not being able to stay in the air for more than a few hours, or in certain cases, a few dozen hours. New high-flight devices, called "pseudo-satellites", enjoy days-long or months-long operating autonomy, and are harbingers of a new era. However, such devices are largely experimental at this stage, and do not yet allow air warfare to break with the limits of transience. On the contrary, the laws

1. Airborne operations conducted from a naval platform cruising on the high seas are not subject to this rule, provided they are confined to this environment. However, this represents an infinitesimal quantity of worldwide airborne activity.

of space mechanics enable a spacecraft to conduct missions for several years without interruption as shown by the *International Space Station* which has been in orbit for more than 20 years and our *Syracuse III* military telecommunications satellites which have been fulfilling their mission for some 15 years.

Nevertheless, the air and space environments have common characteristics that make them unique as compared to other operational environments.

Airborne vectors and orbital platforms evolve in three dimensional environments, whereas ships and land-based vehicles are limited to largely "flat" maneuvers on the surface of their environments.[2] Access to "high points" offers airborne weaponry and space systems unquestionable strategic advantages that free them from the environmental discontinuities observed on the surface of the Earth. They thus have the potential for direct action in all *Three Spheres of War* described by the British strategist John Frederick Charles Fuller: the physical sphere, where fighting capacity resides; the mental sphere, where war is conceived and planned; and the moral sphere, where the capacity to resist the effects of war stands. It must be noted that naval and land-based vectors cannot claim such easy access to these last two principles, as they must generally first go through a confrontation in the physical sphere to reach them. With this ability to carry out military action into the three spheres of warfare, i.e., into the very heart of the enemy, airpower and space systems offer those who have them a considerable strategic advantage over an adversary who does not.

Moreover, air and space environments have the common singularity of not hosting any form of life in a permanent way[3] and of requiring that any object or living organism found there must be set into motion. These environments are also transparent, even if they are not all transparent in the same way, for example regarding electromagnetic waves propagation. The result of these two characteristics is that these two environments are first and foremost places of transit, of flow. The air environment is in fact an important area of transit of goods and people, whereas, similar to cyberspace, the space environment is a place of reception and transmission of digital data, which have become both the fuel and the product of space activities. Our daily lives, as well as many public policies, such as defense and national security, are closely dependent on the ever-increasing number of applications based on the use of space-based data. This situation makes space infrastructures of vital importance to our societies.

2. Submarines also operate in the vertical plane but remain very close to the surface of the sea, their maximum working depth not exceeding a few hundred meters. In addition, they are not able to maneuver in the third dimension with agility.

3. Except for a limited number of astronaut crews, especially those being involved in the *International Space Station*.

Finally, access to the third dimension is very demanding in technical terms and in terms of the skills required. The air and space environments are very selective, since they can only be accessed through a small number of highly qualified professionals, unlike the land and maritime environments, where everyone is able to act. The world's air traffic thus mobilizes only a little less than one and a half million professionals, a third of whom are pilots. It is this small population that has the capacity to operate in the air and not the vast majority of people who are just consumers of the services offered. Even for leisure purposes, access to airspace remains very much restricted, as most human beings do not have the financial resources or the technical skills to fly. The same observations apply, with even more relevance, to outer space which is certainly a shared space, but a very elite shared space. In fact, less than half of all countries are present in outer space, even if they all benefit from space services. Only three percent of them have autonomy of action in space, i.e., the ability to design, produce, launch and operate orbital platforms on a regular basis. As for the countries that can be considered true military space powers, by endowing their defense policies with a coherent space component based on autonomous capabilities for space surveillance, launch, satellite services of all kinds and actions in space, they represent only a little more than one percent of all countries.

Air strategy vs space strategy, two strategies for two environments with distinct characteristics and which are very differently concerned by military affairs.

In his book *Introduction à la stratégie (Introduction to Strategy)*, André Beaufre doubtless puts forward one of the most convincing definition of strategy. He sees it as *"the art of the dialectic of wills using force to resolve their conflict"*. Beaufre also rightly recognizes that *"if strategy is one in both purpose and method, in its application, it is necessarily subdivided into specialized strategies valid only for a particular field of conflict. This is because it must take into account material data, and the characteristics of the material data specific to each field of the conflict produce a different system of consequences in each of the fields; naval strategy, for example, has always been different from land strategy, etc.*[4].". In a few lines, Beaufre clearly states that even though the major strategic principles – freedom of action, economy of means and concentration of efforts, surprise, security – have a universal dimension that makes them relevant to any operational environment, they cannot be applied uniformly from one operational environment to another. The differences between air and space environments, and their consequences on the modes of operation of aircraft and spacecraft, are such that they require a distinction between air and space strategies, while being careful not to unwisely merge them into a single "aerospace strategy", which is sometimes evoked without justification. In this respect,

4. A. Beaufre, *Introduction à la stratégie*. Paris, Fayard, 1963.

the same reasoning leads to the dismissal of the concepts of an "air-land strategy" or an "air-sea strategy", while recognizing that air, land and naval strategies combine their effects during a joint engagement.

As regards the air and space environments, it is very clear that the main principles of military strategy cannot be taken into account in the same way. First of all, freedom of action is subject to much greater technical and financial constraints in space operations than those confronting air power. Space operations are also subject to the limitations of Keplerian movements of orbital platforms and are far less agile than aircraft.

The notion of massive actions is then hardly conceivable in space. Satellites for military use are few, and there is – at least at this stage – no firepower capability in orbit. It is therefore difficult to advocate, with the same force as in airpower, the principles of economy of means and concentration of efforts. Even with the observed increase in the number of orbital systems for military use and the possible appearance of kinetic actions in space, a discriminating effect of scale remains obvious as compared to air domain.

Another great strategic principle, that of surprise, must be viewed in comparison with the quasi-absolute predictability of orbital movements and the transparency of exo-atmospheric space. As for security, one cannot identify combat zones and "rear" zones in space where it would be possible to take cover to preserve or regroup combat potential. To summarize, air strategy and space strategy certainly share the same DNA, that of relating to physical environments structured in three dimensions, but their application responds to such different requirements that it is appropriate to make clear distinctions between them.

However, as indicated above, air and space environments share strong intrinsic characteristics that distinguish them from other operational environments (three-dimensional space, absence of life, need to be in motion, and selective access). For this reason, and because the former is the necessary place of passage to access the latter, strong interactions between air and space strategies exist and are bound to develop. These are strong arguments in favor of making Air Forces responsible for implementing these two strategies, without confusing them. Moreover, airpower increasingly relies on space capabilities to achieve its objectives.

Airpower "boosted" by orbital systems

A simple effort of imagination is enough to realize that there would be no significant military operations if satellites were to fail. Without them, there would be no long-endurance UAVs, no cruise missiles, no all-weather precision strikes, no long-range communications, no accurate weather forecasts; without them, the very precise and widespread means of navigation would

disappear and the C4ISR means[5] would be very degraded. Without them, an army would more or less regress to its operational level at the end of the Second World War. Without them, everything that makes the Western armed forces superior would disappear.

The example of Operation *Hamilton* conducted in 2018 by the American, British and French forces against the Syrian regime is particularly illustrative in this regard[6]. It highlights what military air operations owe today to space systems. The decision to commit to the operation *Hamilton* was partly decided on the basis of space intelligence, planned thanks to it, conducted via space telecommunications, and the results could be assessed thanks to satellite images. The execution was based on weather forecasts from satellite observation, on navigation data provided by the military GPS system, and also on digital terrain models developed from space data, which were essential for the hundred or so cruise missiles fired to reach their targets with great precision. *Hamilton* has demonstrated that space-based data are currently underpinning airborne military operations. And what was observed in this high-profile operation is also observed in more "rustic" joint operations, such as those conducted in the Sahel-Saharan strip where MALE[7] UAVs are able to provide considerable operational added value thanks to satellite transmissions.

The so-called "New Space" program, which has led to a proliferation of military and civilian projects for low-earth orbit satellite constellations, will also very quickly benefit airpower. On the military side, the movement that is underway consists of adding tactical systems to strategic space systems. The most ambitious projects aim to set up constellations providing permanent coverage over a theater and capable of communicating with a substantial number of weapons systems, in particular to transmit target coordinates in real time. With more complete and less dated intelligence, military air vectors will be better directed and better coordinated and therefore much more effective. In the civilian sector, there are countless projects for low-orbit satellite constellations to ensure better connectivity. In the United States, where connections between these new systems and military air platforms are being tested, a new form of airpower is taking shape, offering permanent, resilient and globally extended connectivity to all its actors.

However virtuous they may be in terms of operational efficiency, these developments make the implementation of air strategy by the most modern forces increasingly dependent on space systems. The situation is tantamount

5. C4ISR: Computerized Command, Control, Communications, Intelligence, Surveillance, Reconnaissance.

6. Operation *Hamilton* destroyed a Syrian research center and chemical weapons production facilities in April 2018 through air strikes by cruise missiles fired from air and naval platforms. One hundred and five cruise missiles, including twelve French and British, were fired.

7. MALE: Medium Altitude Long Endurance.

to a kind of space addiction. Vulnerabilities are emerging that deserve to be taken into consideration. Otherwise, certain countries could expose themselves to the risk of a "space Pearl Harbor", to use the expression of the Rumsfeld Commission which, in 2001, published a report assessing the US national security space management and organization. In this case, the commission pointed out the risk for the United States of being the victim of an unexpected and very disabling attack. Twenty years later, no one will dispute that this risk is shared by countries other than the United States.

The forays of airpower beyond the limits of the atmosphere herald the coming advent of aerospace power.

On 13 September 1985, a US Air Force *F-15* fighter destroyed an end-of-life scientific satellite placed in orbit at an altitude of 525 kilometers by means of a missile. This historic first demonstrated the feasibility of a kinetic action initiated in the atmosphere by a conventional air vector and producing effects in space. Air power thus demonstrated its capacity to significantly widen its field of intervention. However, this experiment did not lead to any operational development and, to this day, no other country has committed to this approach.

More than the ability to destroy a satellite from an airborne vector by means of a missile, which has very deleterious effects on space operations by producing large amounts of debris, this test above all demonstrated the ability of an aircraft to send objects into low Earth orbit that can carry out a mission that may target other orbital systems, or that can simply transit before returning to the ground. The major aeronautical nations have all studied these options and have more or less mature military programs in this field.

In France, for example, the launch of small satellites (up to 150/200 kg) to low earth orbits by a *Rafale* fighter (*Aldebaran* project) or by a drone (*Altaïr* project) has been studied. In the United States, the same approach has been taken in the *ALASA*[8] project to provide an airborne launch capability for a microsatellite by an *F-15*. The military interest of these formulas lies in the autonomy of action, since they make it possible to free oneself from a launch service, usually civilian, and in the time frame constraints that are concomitant. This strengthens the overall resilience of their space systems. The U.S. Space Force is following with interest ongoing developments in this area and has contracted *Aevum*[9] to demonstrate a 24-hour satellite orbit capability in 2021 (*Mission Aslon 45*). While the trend is towards a reduction in satellite mass and the development of low-orbit constellations, there is renewed in-

8. *ALASA: Airborne Launch Assist Space Access.*

9. *Aevum* proposes an autonomous launch system capable of placing 100 kg in sun-synchronous orbit at 500 km, combining a *RavnX* drone (25-ton class) and an autonomous launch vehicle. The system is described as extremely flexible (operable anywhere in the world from a conventional runway) and very responsive (3 hours between consecutive launches).

terest in airborne launches for the military. However, the technical difficulties and financial requirements associated with airborne launch should not be underestimated, at a time when the size of combat aircraft fleets is constantly being reduced and such valuable resources must be reserved primarily for their traditional missions.

The interest of the military seems to be even greater for aeroballistic missiles, which are ballistic missiles, part of whose trajectory leaves the atmosphere, and which can be equipped with a hypersonic boost-glide head, fired or dropped from a combat or transport aircraft. This interest is not new, since at the end of the 1950s, the US Air Force carried out experimental firings of nuclear-capable ballistic missiles from its strategic bombers (*Bold Orion* missiles by *B-47* and *High Virgo* by *B-58*) with measured success. More recently, in 1974, a *Minuteman* nuclear ballistic missile, normally fired from a buried silo, was dropped from a *C-5 Galaxy* cargo plane before igniting its thrusters and completing its intended trajectory. Today, in several countries, aeroballistic missile projects have reached an operational status or will reach it soon. This is notably the case in Russia, where President Putin has presented as operational since 2017 the *Kinzhal* missile, an airborne version of the *Iskander* fired by a *Mig 31* fighter, and in the United States, where the US Air Force has announced that its *B-1B* and *B-52* bombers, and even the *F-15* fighter, will be able to carry *AGM-183A* missiles with a warhead consisting of a hypersonic glider as of 2023. As for China, which remains discreet about this type of development, everything leads one to believe that it now has a new version of its *H-6* bomber capable of firing a ballistic missile which, according to some observers, would be a variant of the *DF-21* "carrier killer" missile.

However, physically reaching a target located in a particular environment from another environment with a weapon remains quite common. Air-to-ground strikes, ground-to-air defense, and attacks from the sea have been part of military modes of action since the early days of military aviation. However, apart from missiles with a change of environment (ballistic or cruise missiles fired from a submarine or naval platform), for which this phase is very specific, armed delivery systems generally maneuver in a single environment. Aeroballistic missiles herald a new era in which combat vectors, piloted or not, will conduct missions including atmospheric flight phases and exo-atmospheric trajectories[10]. The concept of aerospace power will then take on its full meaning, with its main advantages being reach and lightning speed. It will then become relevant to speak of the existence of a truly "aerospace" strategy. As for submarine warfare, which is the respon-

10. The US Air Force already conducts secret long-duration missions in low-Earth orbit using the *X-37B* spaceplane, a kind of mini-space shuttle with a cargo bay and great agility in orbit. A Chinese aircraft of the same type was also tested in 2020. In France, *Dassault Aviation* is also conducting studies on a spaceplane concept (the *Verha* project, which *stands for Hypersonic Reusable Air launched Vehicle (VéHicule Hypersonique RéUtilisable AéRoporté)*.

sibility of naval forces for obvious and indisputable reasons of operational coherence, the implementation of this new strategy can only be the responsibility of air forces, which have become aerospace forces.

At this stage, military practice implements two distinct strategies for the air and space environments. While the implementation of the former is universally the responsibility of Air Forces, several models exist for the latter. The United States and Russia have created autonomous space forces alongside land, air and naval forces. In other countries, joint staffs or air force staffs are entrusted with the responsibility for implementing a country's space strategy.

In the relatively near future, military space planes should reach an operational status and give substance to a true aerospace strategy, the responsibility for which can only belong to air forces. In a more distant future, as soon as technology allows it, there is no doubt that man will take the field of military affairs beyond circum-terrestrial space, convinced as Lyndon B. Johnson was in 1958 "*that there is something that surpasses any weapon. It is the ultimate position, the position that offers the possibility of a total control of the Earth and that is somewhere in space"*.

It will then be appropriate to consider the existence of a true Space Force alongside the "armies of the Earth".

Evolution of the strategies of use of space for military purposes

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The strategies of military use of space have largely structured space activity since the beginnings of space exploration. The context of the 1950s in which these activities appeared was first that of the confrontation between the American and Soviet blocks. The new focus on space was initially rooted in the race for military and strategic supremacy. Paradoxically, this agenda has for a long time determined what space is about, with the primary objective of mutual surveillance, which was ultimately to benefit the stability of the strategic balance.

This era of stability seems to be in question today, with the symbolic turning point on January 11, 2007, the date of China's first anti-satellite test, which *ipso facto* became a new major player in the military landscape of space. This event can be seen as a novelty that has destabilized the initial balance. The numerous reactions throughout the world denouncing this Chinese decision and its consequences have manifested the fear of seeing space fall into a new and more dangerous era, being open to direct or indirect military confrontations in orbit. But above all, this event confirmed the transformation of the military uses of space that has taken place over the last thirty years. Space-based systems have gradually become part of the defense systems used directly in operations and they will henceforth constitute a target of choice during future conflicts. This is also what the January 11, 2007 test was all about.

Since that date, space activity itself has undergone profound and rapid upheaval. The context is marked by an accelerated industrialization, which has in turn led to a proliferation of objects in orbit and the entry of new players, whether they are new space-going countries or new private players in the process of deploying infrastructures. The very conditions of security in space have been transformed. As users of space, the armed forces are in the front line and will have to adapt to these transformations both to limit the risks to their capabilities and to make the best use of their new environment in order to make it a real lever for their action. For the military, this ability to operate in space is unprecedented. Forged by the years of the Cold War, military space programs have long been marked by the incremental improvement of observation programs in the broad sense (in the optical or electromagnetic domains in particular) but relatively few direct military uses, whether on Earth or in space. It is true that the first ASAT activities took place in the 1960s and 1970s (in particular the Soviet campaigns of 1968-1972 and 1976-1982), but the effort made in this field never led to the launch of real large-scale space or counter-space weapons programs.

This is not to say that space was of little interest to the political powers of the time. The analysis of this past effort shows indeed the persistence of public investment with as a constant a military sector that has remained particularly active for the two great powers. On the contrary, the best-established link between the space sector and governmental activity concerned the military sector. This link has been historically dominant with a very early investment by the United States and the Soviet Union in space activities, designed to meet the new needs arising from the advent of nuclear weapons in the 1950s. In the United States, this is even the main factor explaining the considerable budgets that were invested, year after year, in the military space sector until today[1]

In fact, the connection between space and military uses has remained very solid over the decades. A cursory analysis of this evolving connection shows how much stronger it has grown. The initial objectives were not abandoned, but new ones were added, leading to the emergence of new uses of space today. This classification of the different types of military uses of space leads to an interpretation in successive “layers”. This explains the constantly renewed dynamism in the defense world.

1. Today, the United States alone accounts for approximately 50% of global public investment. Despite estimates clouded by the secret nature of certain programs, it can be estimated that they devote nearly 60% of this budget to their military activities.

“Strategic” space: The historical “space-nuclear” link

The military activity, although not the most spectacular component of the space effort, has nevertheless been one of the most constant, if not one of the most important, since the beginning. This was particularly the case in the United States and in the Soviet Union where space activity was directly born out of the rise in nuclear arsenals. It is because in the ten years between 1945 and 1955, the United States and the Soviet Union were able to develop nuclear warheads capable of equipping future ballistic missiles that the political powers of both countries saw the interest in using space.

This relationship between “space” and “nuclear” was not only based on the filiation between the technologies necessary for the development of ballistic missiles and those that would lead to space launchers. It also derived from the need (felt very quickly and formalized in 1955 in the United States on the basis of reports published as early as 1946) to have permanent and invulnerable means of surveillance and possibly of targeting opposing missiles. While airborne means were soon to come up against their limitations in this field[2], space-based means of reconnaissance, warning and targeting became a priority, given the developments in offensive assets. The doctrine of mutual assured deterrence (MAD) has led to the perception that these assets[3] are a sort of life insurance and would thus contribute to making space a mutually recognized sanctuary.

This relationship between space and nuclear weapons has always made the space-based capabilities a means to make better use of nuclear ballistic weapons, not to replace them. As a consequence, and as American historical documents show, programs aiming at weaponizing space, very regularly proposed since the beginning, have had only a limited acceptance by successive political and military powers. A simple political calculation suggested that the strategic cost of space weapons in orbit greatly exceeded their benefit. In the context of mutual deterrence, it was better to accept the reciprocal use of observation satellites to assess the state of the enemy’s arsenal, than to run the risk of another confrontation that could endanger these mutual observation capabilities. The very guarantee of nuclear balance implied the possibility of “seeing” the adversary’s capabilities and verifying the adherence of the parties to the common rules of arms control. Threatening the existence of these means was therefore not in line with these strategic objectives. In the first place, the dissuasive character of a satellite interception did not seem to have been demonstrated: the “*development of a U.S. anti-satellite interceptor,*

2. Gary Powers' U-2 spy plane was shot down by Soviet air defence in 1960. In August 1960, the first satellite photographs were transmitted to the American authorities..

3. The secret use of which will be hidden behind the expression "national technical means" used by the disarmament treaties.

while technically feasible", indicated Brent Scowcroft, Gerald Ford's national security adviser, in 1976, "*will not contribute to the survivability of U.S. space assets. Other types of U.S. responses are available to deter the Soviets from offensive actions in space.*"[4] On the other hand, it was recognized that any "*preparation for satellite interception would be contrary to the spirit if not the letter of the SALT protection of "national technical means*"[5] with the prospect that stimulating "*satellite interception (would not be in the interest of the United States) since we are more dependent on intelligence from space sources and would have much to lose*"[6]. At the same time, as early as 1960, confidence in the effectiveness of ballistic missiles in delivering their nuclear payloads disqualified from the outset complicated and costly projects aimed at placing missiles in orbit. In the end, everything seemed to dissuade the use of space as a new field of maneuver.

This historical link persists and remains the basis of the military space activities of the world's main nuclear powers, with the continuous development of efficient space techniques for acquiring information on nuclear arsenals and delivery systems. It is also worth noting the particular dynamic R&D efforts made on certain types of sensors (infrared, hyperspectral, etc.), which have benefited from the revival of efforts to develop anti-missile defenses, particularly in the United States. China also appears to be increasing its efforts in this direction, with a recent test of an anti-missile weapon. The publicity that has been given to China is certainly also intended to demonstrate to the world the country's ability to design complex packages for detection, tracking and ballistic interception. As such, it seems legitimate to consider the space developments linked to the Anti-Ballistic Missile (ABM) as a continuation of the "historical" link between space and nuclear in new and very related fields, which we will see with other current military activities.

Space becomes a "force multiplier"

The end of the Cold War brought about a first upheaval for military space, with the addition of a new type of link between space activities and military activity. In the aftermath of a series of regional conflicts inaugurated by the

4. Memorandum from the President's Assistant for National Security Affaires (Scowcroft) to President Ford, 26 April 1976, published in 2009 : W. B. McAllister, *Foreign Relations of the United States, 1969-1976*, Volume E-3, Documents on Global Issues, 1973-1976, Washington D.C., United States Government Printing Office, December 2009.

5. Strategic Armaments Limitation Talks, a treaty signed in 1972 between Richard Nixon and Leonid Brezhnev.

6. Memorandum from the National Security Advisor (Scowcroft) to President Gerald Ford, 24 July 1976, published in 2009 : William B. McAllister, *Foreign Relations of the United States, 1969-1976*, Volume E-3, Documents on Global Issues, 1973-1976, Washington D. C., United States Government Printing Office, December 2009. Discussions were nevertheless beginning to point to the potentially obsolete nature of this position and a decision was finally taken in 1977 to launch an underwater interceptor programme. The test was successful in 1985 but did not lead to any further action.

Gulf War, followed by the Kosovo War, and then by conflicts that occurred more recently in the Middle East, space capabilities were recognized to have gradually contributed to the shaping of the military balance of power in the field. Space is decisive for ensuring superiority in terms of intelligence, but also for conducting complex operations at a distance, when they involve, for example, the use of drones or precision-guided munitions. In this sense, they are frequently combined with the use of air strategy, since they would, according to their promoters, extend its effectiveness by eventually giving rise to the birth of a new "paradigm" in the "art of war". More broadly, the priority military objective, which appeared after the Gulf War and was then confirmed in the Balkans, consisted in setting up new methods of gathering information. This choice reflects the changes in the world of intelligence, which must deal with military objects that are often difficult to identify, because they are mobile and different from Soviet ballistic weapons. The idea of adapting American space assets, which had been prepared for decades to monitor the Soviet adversary, to cater to these new needs gradually took hold. The effort had to be focused on the quality and the pervasiveness of the available means of information gathering, through the progress made in the field of sensors and the progressive implementation of complete space systems intended either for ballistic surveillance or for more traditional observation. Military observation satellites now needed to be both capable of very high precision and flexible enough to monitor large areas. This new emphasis on space in the conduct of military operations has led to an effort to adapt the defense capabilities to new strategic conditions. There has been much deliberation along these lines, particularly in the United States, where the space effort has literally been fueled by the broader effort to overhaul the military capabilities, which began in the 1990s.

This was a founding period, sowing the seeds of the transformations whose effects we see today. From a general point of view, the space sector was perceived as the linchpin of future military architectures, around which forces and their employment should be organized. In line with the sometimes-fantasized idea of a "revolution in military affairs"[7], information from space must be available for use directly at the lowest level of the battlefield, right down to the soldier, who will have to have the most efficient personal communication equipment. One of the many consequences of this new approach must be emphasized, as it now represents a foundational component of the efforts undertaken. The generalization of an architectural or "system of systems" vision, as it is often referred to at the beginning of the two thousands, makes the use of non-military or commercial resources more and more acceptable (apart from the most sensitive programs, such as high precision observation or technical electronic surveillance, for example). Tele-

7. Revolution in Military Affairs, or RMA as it was known at the time.

communications are particularly concerned here, with the multiplication of agreements signed between the ministries of defense and the major operators, which today continue to meet a large part of military needs in this field. This movement has since increased and the appearance of new commercial capabilities, which are increasingly powerful, has only accelerated this trend (whether for telecommunications, Earth observation or signal interception).

A new security dimension emerging

Of course, here again, technical performance does not explain everything, and the broadening of the military use of space resources, as just described, should be seen in relation to a feeling of vulnerability that was even greater in the early 2000s. The perception of new threats implied taking into account terrorist attacks in the various theaters of operations, in the Middle East for example, and a more secure paradigm overall, which was widely promoted in the aftermath of the attacks of 11 September 2001. The change would be rapid in the United States. At the time of the attacks, many observers had highlighted the need for the country to reform so as to better understand these new threats and better ensure the security of the homeland against terrorism[8]. It became essential to streamline and harmonize the means to detect and anticipate hostile actions in military theaters or in the homeland. Omniscience, omnipresence, omnipotence, such are the key words of the defense and security strategy set up by the United States. From a strictly military point of view, the increasingly massive use of space technologies for Earth observation, telecommunications or support for navigation, location and synchronization in the conduct of military operations has first of all led to an increased presence of these techniques at the heart of weapon systems. The guidance of munitions or cruise missiles by GPS satellites is without doubt the most spectacular example of this during these years. The extensive use of GPS-guided JDAM (Joint Direct Attack Munitions) in Afghanistan, Iraq and Syria attests to the importance of space in military equipment policies[9].

The existence of smaller satellites with lower performance, but now available in large numbers, naturally completes this system. Networked, these resources are progressively forming a true space architecture, which must itself interact with other airborne or ground-based information gathering resources. The path is now marked out. The words of Fred Kennedy, the first director of the Space Development Agency (SDA), the agency created

8. One can recall the official report on the attacks of September 11, 2001, *Final Report of the National Commission on Terrorist Attacks Upon the United States*, see https://govinfo.library.unt.edu/911/report/911Report_Exec.htm and the comments it generated at the time.

9. See for example, J. R. Hoehn, S. D. Ryder, *Precision-Guided Munitions: Background and Issues for Congress*, Congressional Research Service, R45996, June 26, 2020, available at https://www.everycrsreport.com/files/2020-06-26_R45996_c107c14859584666078c83063a19f1156c3bc0df.pdf

in March 2019 to prepare for the future uses of space, are worth quoting as they summarize this school of thought, which is now very present in American decision-making circles: "*I have an architecture in mind and it's comprehensive. It's not just one mission area. It's the whole thing.*" It's about looking at the entire satellite offering: "*I'll take those satellites. I'll put payloads on them. I'll fly them. And I hope to tunnel through their networks to get data to the tactical edge, to soldiers, sailors, airmen, marines.*" According to him, we must think in layers: for example, a first capability will have to consist of a "*tracking layer that will go after hypersonic weapons* (...) *(and) we believe that a proliferated LEO layer is the right way to go about it.* (...) *The question is, can we build the payload at cadence.*" In short, "*That is not the exquisite mindset. That's the commodity mindset. I put it up, I see if it works and then I try something again. That encourages innovation. That's happening on the commercial side and is not happening on the national security side. I need to ride that wave.* (...) *This is the time to stand up something like an SDA to take advantage of that synergy with the commercial sector*"[10]. Of course, this vision is still relatively forward-looking and these announcements have not really been followed up. However, these debates show how space technologies have gained a central status in the very definition of weapon systems and the defense system as a whole. The use of expanded logistics for a large number of space systems of various origins is now clearly stated: "*We need a logistics infrastructure that that's not exclusive to the military to civil space or commercial space but a logistics architecture*", as a Pentagon official in charge of space innovation hammered out recently ...[11]

This position obviously corresponds to the analyses of the evolution of the threat mentioned above. But it is also based on the ubiquity and the performances that these new spatial ensembles theoretically allow. The supposed permanence and versatility of a network of multiple sensors of diverse origin refer to the effort made to obtain a better "knowledge" of the security and defense environment. The emphasis is now less on the destination of the platforms than on their capacity to be integrated into a variable geometry system, responding to military needs as they arise. It is worth noting the propensity of the current space industry, and in particular that of the new entrants on the applications market, to play precisely this logistical support card. The well-known projects of mega-constellations in low Earth orbit for telecommunications, and even the efforts made by some commercial operators to set up Earth observation architectures using many low-cost satellites, also bet on a cost/benefit ratio that will encourage the public authorities to consider them as a complement to their resources.

10. S. Erwin , *SpaceNews*, 8, April 2019, available at https://spacenews.com/exclusive-interview-with-the-space-development-agencys-fred-kennedy-how-we-do-things-in-space-has-to-change/

11. S. Erwin , *SpaceNews*, 10 February 2021, available at https://spacenews.com/dod-grapples-with-how-to-bring-in-new-space-technology-to-military-systems/

Whatever the success of this double bet, it is not without consequences on the current dynamics of military efforts on the organization and content of current programs. The prospect of a growing dependence of the military on military space assets, but also on less protected civilian or commercial assets, has for several years rekindled fears of assets being targeted during conflicts. For more than ten years, this perception has been largely reinforced with the return of anti-satellite experiments, which have given rise to a new phase of military developments in space.

The "control" area?

Historically, the international space community has never been able to agree on the measures to be implemented to build true collective security in orbit. The diversity of national space capabilities as well as the plurality of political and military interests have prevented the emergence of true international agreements on the militarization of space. Moreover, the emergence of a new era, which is characterized by the multiplication of anti-satellite systems and their showcasing, deeply divides the international community. For more than 10 years, the major space powers have openly tested ways of inspecting and intervening in opposing satellites, or even destroying them. Unannounced maneuvers are not uncommon[12] and have contributed to further tension with respect to orbiting assets. France itself has taken note of these developments with the publication of a new "defense space strategy" in the fall of 2019[13]. Already in 2008, the authors of the White Paper on Defense and National Security, reiterated that "France, like all its partners in the European Union, is opposed to space becoming a new battlefield. Our country does not plan to acquire weaponry for use in space and will continue its diplomatic efforts for the non-militarization of space."[14] The 2019 French strategy does not go back on this commitment in principle, but it clarifies its intention to find the means necessary for the "active defense" of national satellites. This evolution is another example of the changes that have taken place in a decade, with the balance of power undeniably tense, in an environment that is itself undergoing transformation.

The importance of space for the security or even the economic activity of the great powers now imposes a logic of its own. A new defense posture has been established in recent years, insisting on the protection of objects in orbit and more broadly on the need to control the risks and threats weighing

12. As recently indicated by Florence Parly, Minister of the Armed Forces, by denouncing on several occasions the "visits" of the Russian satellite *Loutch-Olymp* near French telecommunication satellites.

13. Available at https://www.defense.gouv.fr/actualites/articles/florence-parly-devoile-la-strategie-spatiale-francaise-de-defense

14. White Paper on Defense and National Security, p.143 available at http://archives.livreblancdefenseetsecurite.gouv.fr/2008/information/les_dossiers_actualites_19/livre_blanc_sur_defense_875/index.html.

on these objects. This general theme of Space Control is the latest addition to the various military uses of space. Space becomes an environment in itself, in which one imagines acting, maneuvering, defending oneself, etc. The United States has been by far the quickest to discuss these issues, probably because it quickly felt the most affected. More than half (56%) of the functional satellites in orbit at the end of 2020 were American, while Chinese and Russian satellites accounted for just over 12% and 5% of the orbital population respectively[15]. Of course, the unique position of the United States is also linked to the recent activity of companies, such as Space X, which now launch several dozen commercial satellites per shot, with unprecedented frequency (sometimes every 2 weeks)[16]. However, the United States is the leading military player in space, with 212 satellites dedicated to defense, a figure which is more than 20% higher than the total fleet of Russian satellites, both civilian and military.

As a sign of the pivotal nature of this period, the American government decided in the late 1990s that space was a "vital national interest". This update came in the form of an important policy directive signed by the Secretary of Defense in July 1999, which replaced the previous space policy document, which was dated in 1987 and bore the stamp of the Cold War and the Reagan years. This new directive aimed to lay the foundations of the American approach to the new millennium. It called for space to be considered as "a medium like the land, sea, and air within which military activities will be conducted to achieve U.S. national security objectives. The ability to access and utilize space is a vital national interest because many of the activities conducted in the medium are critical to U.S. national security end enoconomic well-being"[17]. Accordingly, "purposeful interference with U.S. space systems will be viewed as an infringement on our sovereign rights" leading the United States to "take all appropriate self-defense measures," for "deterring, warning, and if necessary defending against enemy attack" and for "ensuring that hostile forces cannot prevent the United States' use of space," and for "countering, if necessary, space systems or services for hostile purposes"[18].

15. According to the tally from data collected by the non-governmental group *Union of Concerned Scientists.*

16. The ongoing deployment of Space X's megaconstellation of communications satellites is obviously a major contributor to these numbers. Of the 1061 satellites launched in 2020, 961 were communications satellites. See analysis by keen observer Jonathan MacDowell, Jonathan Space Report, available at https://www.planet4589.org/space/papers/space20.pdf. March 2021 alone saw more satellites launched than in all of 2016 (360, of which 240 belonged to Space X).

17. Memorandum from the Secretary of Defense, July 9, 1999, pp. 1-4. This document accompanied the new DoD Space Policy Directive #3100-10 "*Defense Department Space Policy*" (document available at https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-891j-space-policy-seminar-spring-2003/readings/dodspacepol.pdf).

18. *Op. cit.*

This text is still relevant today. It explains the first budgetary and program orientations taken under the presidency of George W. Bush, strongly amplified under the Obama administration and continued by Donald Trump. Even before any technical dimension, it reflected a new political, diplomatic, economic, industrial and military posture, which has been confirmed over the years. The destruction of one of its own satellites by China during a test in January 2007 certainly seemed to vindicate this approach. For the American government, it confirmed the validity of the heading it had been taking for several years and proved that other countries seemed to be pursuing the same approach. Several episodes in the following years confirmed the increase of risks (for example the episode of the collision between an American Iridium satellite and a Russian *Cosmos* satellite), but also the increase in threats for the American side (Chinese experiments of maneuvers in low Earth orbit in the years 2013 and 2014, or more recently the numerous repeated Russian exercises in orbit) or for the Russian and Chinese sides (American programs of "inspector satellites" in geostationary orbit[19], regularly criticized by these two powers).

In this context, the major space powers now seem to be getting organized in a similar way, i.e., mainly along three tracks:

The implementation of space surveillance which provides for the use of ground- and space-based sensors for improved identification of orbital devices. At this stage, it is necessary to decide on the type of objects to be observed, and then to focus efforts on the monitoring activities that are deemed insufficiently investigated. This aspect implies the consolidation or simultaneous development of ground observation capabilities (optical or radar), the use of existing space resources (use of observation satellites) for the inspection of low Earth orbits, and to develop capabilities for the inspection of geostationary objects. In the United States, it is the notion of "space situational awareness" (SSA) that is rapidly gaining ground. It is above all a question of "operationalizing" the very concept of space surveillance. The aim of SSA is to characterize as completely as possible the space environment and the objects that circulate within it, but also to establish a "map" of the orbital environment (LEO, MEO, GEO), in order to prepare for possible "counter-space" actions[20]. In the operational context, the SSA intervenes at different stages in the "counter-space" action: its mission is to detect and

19. Geosynchronous Space Situational Awareness Program. For an annually updated description of all these programs, please refer to the annual report "*Global Counter Space Capabilities*" of the *Secure World Foundation*, an independent American research center, available for the year 2020 at https://swfound.org/media/206970/swf_counterspace2020_electronic_final.pdf.

20. See in particular the first document on these subjects published by the US Air Force in 2004, which already announces the programs in progress today: Counterspace Operations, Air Force Doctrine Document 2-2.1, August 2004, available at https://fas.org/irp/doddir/usaf/afdd2_2-1.pdf. It is regularly updated.

alert during "space events"[21] ("Find, Fix and Track"), then to locate the threat ("Target and Engage") and finally to evaluate the damage ("Assess"). This convergence of surveillance and environmental knowledge with operations now seems to be the hallmark of modern space doctrines.

- Passive protection of satellites, by establishing a list of protection techniques by type of system, in particular by electronic shielding of civilian and military satellites[22]. Research on electronic components that are more resistant to electromagnetic interference, whatever the origin, or on platforms capable of withstanding the impact of space debris in orbit, all support this strictly defensive posture. More broadly, it is a matter of protecting satellites against any source of failure or accident, whether intentional or not. Platforms with maneuvering and mobility capabilities can also be put in place, which can also be implemented for the related ground segments. The recovery of possible damages can also be ensured by two techniques: redundancy, to replace any element of the information chain, whether it is in space or on the ground, and repair, which requires the implementation of a highly responsive means of space transport, capable of serving all the orbits involved and ensuring the service necessary for repairs or replacements.[23]
- Finally, to acquire direct intervention capabilities in space or on the ground, which has motivated experimental activities in the field of missiles, anti-satellite satellites or high-powered lasers (ground- or space-based) to blind, disable or even destroy enemy satellites. Attacks on space and ground "nodes" (fixed operating stations on the ground) and transmission links (satellite-ground, ground-ground)[24] are preferred. There are various methods, ranging from "killer satellites" to ground assaults of ground control stations by specially trained troops, including "electronic warfare" with computer attacks or satellite jamming. In current doctrines, such capabilities have a warlike function, *i.e.* they go beyond merely banning the enemy from using space-based means to attack. They imply the temporary or definitive annihilation of its assets in order to assert from the outset a "space superiority" in a conflict.

This picture, apart from a few details, now seems to portray the kinds of initiatives undertaken by the principal space powers. Whether they take the form of experiments conducted by the major space powers (for example,

21. "Space events" include *"orbital maneuvers, anticipated and unanticipated launches, atmospheric reentries, laser emissions, solar bursts, and conflicting electromagnetic emissions." (Ibid., p.20.)*

22. In the same sense, one can notice the interest shown for the passive "protection" that the implementation of the networks or architectures mentioned above brings to the space segment, by nature less vulnerable to attacks than individual platforms associated with unique functions.

23. Counterspace Operations*, op. cit*. pp. 26-29

24. *Op. cit.* p. 32

listed in the annual *Global Counter Space Capabilities* report mentioned above) or the concept of "active defense" mentioned in the French defense space strategy, the objective of better protection now goes hand in hand with that of better control.

What impact on collective safety in space?

This advance towards a "controlled" space remains modest. It is still essentially translated by the presentation of future programs and by the realization of incremental experiments. But it must be considered as one of the major factors in the transformation of contemporary approaches to space. It reflects the transformations which marked all space activity since the Cold War, with an undeniable acceleration these past years. The first transpositions into space of military doctrines which previously had been focused on the land, sea and air, accompany in their own way this global transformation of the space activity. In return, the emergence of circum-terrestrial space as a full-fledged defense environment contributes to changing the rules of the game. It is within this dynamic relationship that we can understand the main reason for the efforts to upgrade military postures and organizations in recent years.

Even if it reflects increasingly perceptible international tensions, this movement does not automatically herald the prospect of new conflicts in space. Space remains an environment that is difficult to control and, by its very nature, does not accommodate purely national strategies of domination or control. The actors remain profoundly interdependent and must play on cooperation and collective security. In this context, the new objectives of protection and defense make a successful international dialogue more necessary than ever. Better still, they can reestablish the foundations of a strategic dialogue that remains difficult today. Here, without doubt, the lessons of the Cold War years are worth remembering.

The space war will not happen

Guilhem Penent

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As its Giralducian-sounding title illustrates, this article is intended as a reference to the work of Thomas Rid[1]. Because war in the tradition established by Clausewitz involves the instrumental use of physical violence in the service of a political objective, Rid argues that talk of "cyberwar" in the past or present is inappropriate, and likely will remain inappropriate in the future. According to him, the notion is a misleading use of language because it obscures rather than sheds light on conflictual practices in the cyber environment: such practices act as *a substitute for open conflict* and help to keep violence below a certain "controlled" threshold – absence of human loss, in particular – and thus constitute a means of framing international relations, if not encouraging appeasement.

This reasoning could in part be reiterated concerning the space environment. While almost all of the uses of space are informational in nature, it presents, in the same way as cyber, features that "are prone to clandestine action and manipulation," in the words of the 2017 *Strategic Review*[2]. As for satellites in orbit, if they have owners and operators, they have no mothers in case of an attack as the catchphrase goes.

Clausewitz's threshold of war may seem implausible, but there has never been a shortage of doom-sayers prophesizing the inevitability of "Star Wars". If they have found in Hollywood a mental and metaphorical foundation – to the point of giving its name to the strategic defense initiative of the Reagan years – their origin goes back to the beginnings of the "conquest of space" and traditionally opposes the *space warriors,* partisans of the development of "space weapons" as soon as possible, to the *space worriers*, convinced that this would be to condemn space to a cycle of mutually assured destruction because of the advantage attributed to the offensive over

1. T. Rid, *Cyber War Will Not Take Place*. Oxford, Oxford University Press, 2013.
2. Ministry for the Armed Forces, *Defense and National Security Strategic Review*, October 2017, p. 72.

the defensive. When the latter considers that space must remain a "sanctuary", the former is based on a quest for invulnerability. Even if the arguments and agendas are different, a shared and recurrent feature of these opposing discourses remains the possibility of the outbreak of a "space war" distinct from a war on Earth – when space rather reflects the fact that it does not transcend terrestrial political dynamics. The deterministic and obsessive link that is established with the question of arsenals – even if the "weapons" mobilized in the competition between powers are not necessarily always military – is also a point shared by these two positions.

At a time when the announcements of the advent of "space forces" in the world once again invite all kinds of fantasies, the objective of our reflections is to understand what conflicts in space really represent today by describing, first of all, the conceptual and practical impasse of space weapons, then by outlining the contours of space warfare such as it is imagined in the absence, to date, of any first-hand experience and finally, by offering a more nuanced and empirically tested threefold reading of the practices of rivalry and competition, or even confrontation, between nations in space.

1/ The problem of space weapons

Space has been built and organized as a military terrain since the beginning[3]. It was born in the collective consciousness by appearing first of all as an environment through which objects transit whose vocation is not to remain in orbit. The ballistic missiles that appeared in the wake of the V-2 include an intermediate space stage, distinguishing them from space launchers. This explains why they are excluded from the scope of space law. This is even an essential point of the 1967 Outer Space Treaty, which limits the authorized uses – also called "peaceful" uses – of space: while the Moon and other celestial bodies are demilitarized, the only explicit prohibition appearing in the treaty with regard to the Earth's orbit concerns the placement of weapons of mass destruction. If this amounts to authorizing the specific use of ballistic missiles, it also authorizes a "liberal"[4] interpretation that is now generally accepted, according to which the peaceful character corresponds to a "non-aggressive" activity and not to a "non-military" activity.

3. This reading, now well documented, may seem counterintuitive. Indeed, the European experience is original in that it was structured around the scientific exploration of space, seen as both a unifying factor and a badge of identity. Even today, the Defense aspect of space appears to be the neglected part of European space cooperation. Other major space programs, starting with the United States, follow a different approach, mainly oriented by military needs. If the "space race" and then the "race to the Moon" are perceived by the general public as the focus of twentieth-century space efforts, they actually conceal the efforts undertaken in a secret but continuous manner to develop the military uses of space. See, for example, W. A. McDougall, *The Heavens and the Earth. A Political History of the Space Age.* Baltimore, Johns Hopkins University Press, 1985, and P. B. Stares, *The militarization of space. U.S. Policy, 1945-84.* New York, Cornell University Press, 1985.

4. Ministry for the Armed Forces, *Space Defence Strategy*, 2019, p. 15.

Space is thus also a place for the placement of objects used for military purposes. In the aftermath of *Sputnik* in 1957, the usefulness for the United States of having means capable of monitoring adversary activities from orbit was all the more accepted since it had already been under discussion for ten years. Indeed, the "preliminary design of an experimental world-circling spaceship ", which was also the name of the report produced under the aegis of the future RAND Corporation, had been the subject of work since 1946, through secret programs. The reason this study is so fascinating, is that it already describes the whole range of satellite applications which, by helping in decision-making and in the prevention of strategic surprise, will allow "the nuclear balance of power to function"[5]. In doing so, it prefigures the "tactical and operational" functions that have become central to the planning and conduct of operations in the theater of conflict (observation, electromagnetic eavesdropping, targeting, combat damage assessment, navigation, communications, meteorology, etc.). Thus, the military uses of space are ambivalent: on the one hand, military space appears to be the guarantor of strategic stability as an essential tool for reducing the risks of misunderstandings when under the threat of the ultimate "surprise attack"; on the other hand, it is also a factor in the enhancement of forces, contributing to capability to project conventional military power (but at the risk of making satellites prime targets).

This hypothesis, also anticipated by the RAND report, accounts for a third and final use. It is no longer a question of speaking of "militarization" *stricto sensu*, which refers to the strategic intelligence and support systems for ground operations described above, but of "*space weaponization*", i.e. the deployment of "weapons" that can reach land-, air-, sea- or space-based targets. Even if we focus on a narrow definition (by nature), the field to be examined is very broad and of unequal importance, maturity and feasibility: it can contain systems specifically designed to hit targets on Earth from orbit, from space to space or Earth to space. The list is even longer in the case of "weapons by destination", which any object in orbit may be implemented for, given the duality of technologies, the laws of space mechanics and the intrinsic fragility of satellites: for example, missile defense systems used for anti-satellite purposes (ASAT) or in-orbit rendezvous and proximity capabilities (debris removal, refueling, etc.). More broadly, it is the question of intent that must be highlighted: space surveillance methods can help improve transparency and trust, but they can also hide a "*dormant*" capability (such as an inspection satellite), it being understood that they are an essential prerequisite for conducting effective defensive and offensive operations. On the other hand, depending on whether the result intended is reversible

5. X. Pasco, "L'espace et les approches américaines de la sécurité nationale", *L'Information géographique*, Vol. 74, n°2, 2010, p. 87.

(temporary) or irreversible (permanent), partial (producing only disruption) or complete (entailing full destruction), or ease of detection and attribution, the number of systems to be included under this heading can be reduced (by excluding, for example, certain modes of action relating to electronic warfare, laser blinding or cyber-attacks).

In addition to the difficulty of defining what a space weapon is, the instrumental and symbolic motivations behind the development of certain capabilities are often intertwined. This observation is reinforced by the fact that the technical and operational advantages appear in the most blatant cases to be difficult to discern and, in any case, not very competitive compared with more traditional and more effective alternatives. Finally, the confusion is often maintained and exploited by the actors themselves to justify their activities and denounce those of their rivals. Space-to-Earth weapons, which are a matter of hypothesis if not fantasy, continue to be a source of concern for a number of countries, often more out of a desire to follow the arguments put forward by Moscow and Beijing, than out of real understanding. As for the United States, while they denounce the fact that Russia and China "have weaponized space"[6], they also maintain at the same time that it is impossible to define precisely what a space weapon is.

2/ From space war to "Star Wars"

Despite this complexity, the tendency is too often to see the militarization and weaponization of space from an "all or nothing" perspective. What we refer to in this article as "Star Wars" is part and parcel of this binary logic and refers to a set of suggestive rhetoric and images, more or less deliberate and asserted, but which have become omnipresent in thinking about conflicts in space. Summarized simply, and even if the content may vary, "Star Wars" is structured around the idea that the absence to date of any apparent direct experience of a conflict beginning in space (or extending into this environment) is counter-intuitive, constitutes an anomaly, and therefore cannot be durable.

In the most sophisticated models, the theory may be both deterministic -- where space is inevitably destined to become a war zone – and which reveals a certain technological fetishism – "space weapons" are the first step in this direction. The risk of creating a self-fulfilling prophecy is real. Given the difficulty of grasping what space in general is in concrete terms, "Star Wars" can also refer to a method by analogy, i.e. reasoning that functions by extrapolation and is based on historical, strategic or geopolitical references.

6. U.S. Department of Defense, *Defense Space Strategy*, June 2020, p. 1, 3.

In this perspective, a first widespread approach argues the immutability of "human nature", that is to say that the existence of weapons and war can be explained by the intrinsically bellicose character of humanity, which applies to space in the same way as to land, sea and air. More fundamentally, it is the "march of History" that is referred to: the evolution of *seapower* and more particularly of *airpower* would reveal by analogy an inexorable tendency according to which the development of human activities in space will unavoidably fall victim to. The emergence of a layer of new applications focused on controlling space, and not only using it to operate in other environments, is already proof of this. A last variant, which is experiencing a revival following the creation of the American *Space Force*, maintains that space is called upon to play the role in world trade that is currently enforced by sea and that necessarily – to paraphrase Bismarck – space weapons "will have to follow trade".

A second approach, more strategic in nature, focuses on the supposed military attractiveness of space-based weapons, especially those directed against Earth, whether associated with planetary strike or missile interception systems. Space, we hear repeatedly, is the "high ground". While it is true that it occupies, spatially speaking, the position of overhang *par excellence* – although the measure is always relative – the formula as it is generally used does not merely repeat the seductive, albeit banal, logic of the "commanding positions" dear to the art of war. Its implications are more revolutionary in that it associates space with the "ultimate position" whose occupation provides a decisive advantage, thus becoming as desirable as the possession of the "ultimate weapon".

In this, it is partly confused with a last approach, of geopolitical inspiration. Inspired by the tradition of Mackinder and Spykman, which translates into military terms as the "gravity well theory"[7], this third form of analogy is traditionally contained in two axioms: "whoever controls the Moon controls the Earth" and "whoever controls the Lagrange points L4 and L5 (where the gravity fields cancel each other out) controls the Earth-Moon system"[8]. The issue was fully revised and refined by Everett Dolman in a work with neo-conservative leanings which, although it has marked research and oriented in part the American strategic production of the 2000s, has not been followed up, which somehow questions its importance: "Who controls low-Earth Orbit controls near-Earth Space. Who controls near-Earth space dominates Terra. Who dominates Terra determines the destiny of humankind"[9].

7. That is, the idea that the notion of topography also applies to space, with notably the same phenomenon of choke point as on Earth.

8. See for example G. H. Stine, *Confrontation in Space. Wars of the Future Will Be Fought in Space*. Englewood Cliffs, Prentice-Hall Inc, 1981, p. 55-61.

9. E. C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age*. London, Routledge, 2002, p. 8.

3/ Return to Earth

Obviously, this reversal of priorities justifying "Star Wars" for its own sake, and not for its consequences on Earth where the real stakes are, is theoretically open to criticism. As a general observation on the inevitability of a conflict in space, it also appears to be of little use, even unusable, unless it is considered as an event that can occur in the short term. From this point of view, it is empirically invalidated. The obsession with space weapons obscures the restraint and caution with which states approach the issue. Although its importance is undeniably growing, the militarization of space – which must be understood as a global phenomenon and viewed along a continuum – has so far remained extraordinarily selective. While at the lower end of the spectrum, the militarization of space in the strict sense has long been known and accepted by (almost) everyone, weaponization at the other end of the spectrum has been confined to a few R&D programs, followed by occasional test campaigns, the history of which is well known: nuclear bombs in orbit, anti-satellite missiles and killer satellites. This does not mean that space is not a place of confrontation: three major realities deserve to be understood from this point of view.

The choice of under-weaponization

The first of these realities refers to what is called the *de facto* "sanctuarization" of space, a categorization that is empirically absurd and more normative than descriptive, which we prefer to replace with the more nuanced concept of "under-weaponization"[10]. In fact, this has never meant an absence of competition and is a concept that is hardly self-evident. The product of trial and error, this choice first developed in a negative way, due to a growing awareness of the undesired consequences that the unlimited use of space weapons could wreak. This learning of interdependency – "my behavior affects (and is affected by) that of others" –began with the conviction that in order to avoid a suicidal nuclear exchange, satellite espionage had to be tolerated, or even preserved from any interference. Indeed, targeting the relevant "national technical means" would have been tantamount to announcing the intention to launch a first-strike attack. This "nuclear learning", centered on the balance of power on Earth, was subsequently coupled with learning of a more space-based nature, also known as "environmental", based on the obvious unsustainability of a policy of unlimited military development in orbit (the persistent nature of the radiation created by an electromagnetic explosion at high altitude, the uncontrolled and exponential nature of the creation of long-lived debris...).

10. G. Penent, *America in orbit, or the anomaly of the under-weaponization of space since the end of the Cold War. A reflexive realism analysis.* PhD thesis, University of Bordeaux, October 2017.

This dual legacy has remained limited, however. These interactive, irregular, and iterative processes have only ever defined which tools could be used and which others should be set aside, at least temporarily. And they have not been without backtracking. For example, three ASAT tests with interception of a target, resulting in debris generation, and carried out as demonstrations of power, have followed one another since the end of the Cold War[11]. These processes have never directly led to "establishing any formal international rules to control space weapons". This failure can be explained by the fact that the actors have remained faithful to a primarily national conception of their security, convinced "that they are better off by arming, even if it means that the other side will arm, too"[12].

A more positive, potentially more enduring form of under-weaponization has nonetheless emerged. This has to do with the understanding that space is, because of its encompassing character even more than its elevated position, a primary political and normative vector. If there is a final lesson to be drawn from the history of space, it is that the raw power relationship, which is one of constraint, matters as much as the manner in which it is expressed. In other words, in space, power, in order to be effective and at the risk of provoking resistance, must go hand in hand with the search for influence, that is to say the capacity to make one's positions prevail on a basis that appears to be legitimate. It is therefore a question of formulating a discourse that is likely to be listened to and to lead others. This "hegemonic learning" – a notion which, according to Greek etymology, evokes a mixture of adherence to common values and well-understood interests – accounts for an approach to asserting and legitimizing power that is not only incompatible with the deployment of space weapons, but also makes their *raison d'être* obsolete.

Its implementation, in particular by the United States, can thus be presented as a continuation of *space dominance* by other means. The temptation to prefer short-term gains is of course never absent, and even constitutes a permanent tension, as certain episodes with European countries (from the Symphony satellite to the Galileo program) can attest. On the whole, however, a distinctive feature of the American approach lies in its unparalleled ability to organize and renew its efforts to be a structural power, that is, also a hegemonic one: there is no "leader" without "followers". The *New Space* thus appears to be the latest incarnation of an old trend. The United States, eager to adapt its space initiative to the post-Cold War era, had already decided to practice a policy of unprecedented openness (invitation of Russia to participate in the International Space Station, deregulation of Earth ob

11. With a first dramatic demonstration by China against one of its satellites in 2007, followed by a U.S. test the next year, then another by India in 2019.

12. M. M. Mutschler, *Arms Control in Space: Exploring Conditions for Preventive Arms Control*. London, Palgrave Macmillan, 2013, p. 168-169

servation and telecommunications, access to the GPS array, etc.) to better organize worldwide activity and to influence that of its allies, partners and possible competitors.

Preference for ambiguity

The second reality concerns the preference among actors for ambiguous actions that are either complex to track, detect and attribute (interpretive dilemma) or at least aimed at limiting the thresholds for possible response or open conflict (response dilemma). This propensity towards a "grey zone" ambiguity – which results in a form of impunity, allowing certain countries to deliberately maintain a blur around their activities, which could increase the risk of miscalculation – is not specific to the space environment, but is facilitated and even amplified by certain aspects. Space is indeed an inhospitable environment that subjects systems and equipment to adverse conditions, especially since it is also partly a victim of its own success, especially on certain very busy "corridors". Combined with its immensity and the impossibility of accessing the satellite *in situ*, this constraint makes it difficult to characterize with certainty the causes of any suspicious failure. In fact, it will never be possible to totally exclude the effect of the environment itself and thus to distinguish the intentional from the accidental, accidental events representing most incidents.

This is not insignificant at a time when the possibilities offered by *New Space* (miniaturization, electric propulsion, robotics...) are so great. The densification of orbits, which can lead to congestion, with for example the projects of mega-constellations of thousands of satellites, suggests an even more extensive revolution. It would be easy for an actor to more successfully conceal its intentions and actions by using discrete capabilities (camouflaged satellites or "nesting dolls"), modes of action with no visible physical damage or with delayed effects and which can target ground, communication and space segments equally well (jamming, laser blinding, cyber-attacks), or even "dual" means diverted from their primary civil, scientific or commercial use (sounding rocket, maintenance or logistics satellites).

The absence of a definition to date of what is or is not "unfriendly", "dangerous" or "irresponsible" behavior does not help to frame this evolution, which is taking root in the landscape and extending to all fields, not only military, but also diplomatic and informational – if we are to believe the "narrative wars", against a background of mutual accusations between large countries. This is all the more the case since the eventual multiplication throughout the world of powerful space surveillance systems, whether governmental or commercial, will not be the panacea we have been waiting for: although it may help to reduce uncertainties and even allow a form of "discouragement" – what the American strategist John Klein calls *space fo-*

rensics[13] – it will not, however, make the "fog of war" disappear, which is ultimately a matter of human psychology. In a space context made more complex by the increase in traffic and the evolution of technologies and practices that contribute to blurring the boundaries between civil and military, private and public, attribution, i.e. the identification of the origin, will remain more than ever a primarily political decision.

Defense bonus

In this context, the third reality is that we simply do not know when, in a conflict, the space component can intervene or influence the course of events. At most, we can say that space warfare is currently only of interest in its relationship with the Earth, and can only be thought of as a "continuation of Terran politics by other means"[14]. From this point of view, the idea of "Star Wars" is curious, even dangerous, in that it could lead to subordinating strategy to tactics. It also leads to a reductionist posture, to the detriment of a more systemic and global understanding defended in this article. Through naivety, ignorance or informational bias, it fails to consider the possibility that the triggering element of a conflict may take place in another environment than space, that victory cannot be decided on the basis of space means alone and finally that space weapons are not the fantasized strategic *quick fix*.

This is problematic because, at least on the theoretical level, there is nothing to suggest that the hypothesis of a massive and devastating surprise attack, unleashed at the very beginning of a symmetrical high-intensity conflict, in order to deprive an actor of any possibility of using its space-based surveillance and support capabilities (observation, monitoring, telecommunications), is more likely than any other, nor that it serves as the sole frame of reference for thinking about conflict in space. Often referred to as a potential "space Pearl Harbor" since the alert launched in 2001 by the Commission to Assess United States National Security Space Management and Organization - also called the Rumsfeld commission -, this scenario owes its popularity to the construction of the "Chinese threat" as being more and more serious, especially since the ASAT launch of 2007. The generalization of the politics of "plausible deniability" and of the fait accompli aimed at establishing a favorable balance of power explains why it has remained relevant. Finally, it owes its strength of mobilization to the perception of a "vulnerability dilemma", i.e. the idea that space as both a vector and a source of power is not only the Achilles' heel of American power but also a Damocles' sword.

13. J. J. Klein, *Understanding Space Strategy: The Art of War in Space*. New York, Routledge, 2019, p. 223.

14. B. E. Bowen, *War in Space: Strategy, Spacepower, Geopolitics*. Edinburgh, Edinburgh University Press, 2020, p. 3.

Another strategy, which could be qualified as "*counterspace-in-being*", does appear to be possible[15]. This strategy takes into account the fact that strategic confrontation is not only a continual interaction, a dialectic of intentions and of intelligence, but is subject to constant change. In this context, an adversary may wish to continue to benefit from the advantages provided by space and, rather than a full-scale assault at the very beginning of hostilities, will on the contrary take the gamble of waiting for the right moment, in order to consolidate a gain in the course of the conflict and possibly tip a phase of the conflict in its favor. In the meantime, it will maintain its capabilities in a latent state or will only implement them in a graduated and proportionate manner.

This hypothesis starts from the observation that the military uses of space and thus the related dependencies are widely shared, and while being the object of an asymmetrical competition, are also part of a movement towards emulation[16]. It is supported theoretically by the idea that "defensive strategy is the stronger form of warfare in space "[17]. This is also supported empirically by developments centered on *deterrence by denial*, which consists in limiting the advantages that an aggressor could obtain from an attack by convincing him that it could not succeed or that it was not worth the effort since it would not prevent the service rendered by space from continuing[18]. The most promising avenue in this perspective – the most emblematic of the efforts launched today by the United States and, in a rather predictable way, probably also by China – is the deployment of alternative and resilient space architectures known as "disaggregated" (low earth orbit constellations).

What are the implications?

If, as this article maintains, *the space war will not happen*, then the urgency seems less to prepare for it, than to manage and channel the potentially destabilizing tensions that already pervade the space environment. At the international level, this implies a deeper understanding of the risks that could be created by a gap between discourse (i.e., legitimacy) and action (i.e., constraint), which could lead on the one hand to demonstrations of force embodied in intimidation, and on the other, to a "dissuasive posture" that includes the threat of retaliation (*deterrence by punishment)* in an excessively disproportionate or unbalanced manner. At the national level, this is a question of concentrating efforts on factors that one can be certain of impacting.

15. *Ibid*. p. 228-229.

16. China is in fact today the second military space power in terms of the number of satellites in orbit.

17. J. J. Klein, *Understanding Space Strategy, op. cit.* p. 30-31

18. P. Swarts, "Loverro: defense is the best deterrent against a war in space", *Space News*, October 14, 2016.

In the face of growing threats and the announced risk of congestion – for which there are no levers of action and which come up against opposition by third parties – resiliency, which depends only on oneself and allows one to envisage the future over the long haul, is undoubtedly one of the priority areas of focus. The paradox of this point of view is that the actions seen as non-escalatory, undertaken in this direction by the major countries (constellations, responsive launch capabilities, etc.), can also contribute to the technological and strategic marginalization of France and Europe if they are too slow to mobilize the necessary resources. At a time when Brussels and Paris are displaying new ambitions, it is imperative to develop the protection and resilience of our space capabilities by taking advantage of the opportunities offered by *New Space* and preparing for future transformational developments in new space architectures.

Free discussion of Multi-Domain

To better extend the discussion on the topic of Multi-Domain, three brief perspectives are offered here, each of which develops a particular topic.

Jean-Christophe Noël draws on the history of conflicts, particularly that of the First World War, to suggest that the tactical integration demanded by the advocates of Multi-Domain should be examined in more intellectual and practical depth. Patrick Bouhet explores some of the tactical, operational, strategic and political consequences of this concept. Finally, Romain Desjars de Keranrouë proposes a reflection on the evolution of the notion of subsidiarity in Multi-Domain operations, drawing on the experience of drone crews.

From theory to practice

Jean-Christophe Noël

Let us first take a brief historical detour to the First World War. If we think about it, the challenge facing strategists at the time has much in common with the one faced by planners today. How do you break through a wall, which then consisted of a network of trenches, and today consists similarly of a network of weapons systems, in order to secure freedom to maneuver and ultimately defeat your opponent?

Commenting on the offensives conducted during the Battle of Artois in May 1915, General d'Urbal reported in his *Souvenirs et anecdotes de guerre 1914-1916* that "*a breakthrough is possible, but the moment is fleeting*". The vocabulary is certainly a bit dated, but it is strangely reminiscent of expressions used by contemporary Western strategists who refer to the use of "*windows of opportunity*" to gain access to an area and maneuver within a theater of operations.

If we stick to the Western Front, from 1915 onwards, a general had at his disposal infantry, artillery, engineering and air force squadrons to achieve this breakthrough. It is true that during each offensive, a few soldiers, more daring or luckier than their comrades who were strewn about the battlefield behind them, managed to reach the objectives set. But they almost never managed to maintain their positions and were often pushed back by enemy reinforcements.

It took the Allies three years to combine these assets in an effective manner, with the important addition of tanks. The first decisive breakthroughs were made on 18 July 1918 by French General Mangin between the Aisne and the Ourcq rivers, then again on 8 August 1918 by Australian General Monash close to Amiens.

There were many factors underlying these delays. Let us mention just a few. First, the generals had to learn to think in three dimensions. Until 1914, the conventional Western battlefield was flat and linear. The arrival of aviation offered new opportunities that had to be seized. Aviators and artillerymen had to learn to work together. They needed to adapt their methods to co-operate in real time so that enemy components likely to hinder the progress of ground troops (reinforcements and artillery) could be destroyed as quickly as possible. Some aircraft were designed to clear the way for advancing allied troops with bombs and machine-gun fire.

The different artillery units also had to coordinate their fire plans to best adjust to the reality in the field. For example, highly centralized at the beginning of the war, the planning of British fire was organized at the level of the army by the end of the conflict and execution was decentralized at the division level. Several tactics were tested, including the long-term shelling of enemy positions or violent but brief barrages. The Germans finally followed General Bruchmüller's method at the end of the war, first bombing for a limited time the enemy command post, then the artillery positions, and finally the enemy troops. A rolling barrage supported the assault troops who were ordered to break through the front. Industrial and logistical needs evolved simultaneously, requiring the emergence of new organizations behind the front lines.

We could elaborate at length on all the ingenious efforts that were made to break through the front lines. But what must be emphasized is that the mere existence of these resources was not enough. It was necessary to think deeply about how to combine them, to test solutions with often tragic results, to take into account the changes in trench networks that extended deep into the ground, to change logistics, organizations, etc. The learning curve was long and costly, both in human and financial terms.

What lessons can we draw from this today? Of course, it is difficult to examine industrial warfare and to use that as one's basis for thinking about digital warfare. But today we have assets in five dimensions and two fields. The combinations offered are therefore significantly more extensive than a hundred years ago and should thus offer concomitantly greater opportunities. Provided we know how to do it. This is where one of the decisive challenges of the coming years lies. If strategists have opened up a path, it is now a matter of exploring it and proposing solutions that work to implement it. Large-scale experiments will be necessary, which will probably lead to changes in our organizations, our ways of doing things, and our mentalities. For example, aviation support to ground offensives has led to the development of fighter aircraft. What will be the consequences of a systematic - and still potential - development of cyber capabilities for air operations? The United States is already implementing original solutions with Mosaic Warfare, based on artificial intelligence. This is a promising approach. There may be others.

Tactical, operational and strategic questions on the application of Multi-Domain integration.

Patrick Bouhet

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Multi-Domain (MD)[1] is intended as a response to the new international context, challenges and new threats to enable the United States to maintain its military advantage and, above all, the ability to take and maintain the initiative. However, many of the questions raised by MD have not yet been fully addressed, or even truly considered. Because the application of the concept could give rise to many major developments, entailing consequences that go far beyond the mere technical and tactical aspects.

The future of the armed forces

First of all, what will happen to the armed forces as institutions? Each service has been, and continues to be, shaped by a culture derived from the original medium (Land, Sea, Air, to which we can now add, at a minimum, exo-atmospheric space and cyber). Within this framework, it is the joint level that is responsible for coordinating actions and effects. However, integration, which can be considered as one of the main characteristics of the Multi-Domain, could lead to a rethinking of this division of tasks. For each actor will not only have to take into account the other fields, but also think of them in the context of understanding, planning, and then acting as a whole.

To be fully effective, this integration will probably also have to be carried out at the tactical level. This, while reinforcing integration, will undoubtedly entail adaptations in terms of officer training, organization, particularly in terms of apportionment, but also in terms of capacity development. All of these areas are mainly within the institutional remit of the armed forces.

As a result, the distribution of responsibilities and powers between the joint level and the armies, commands and services, on the one hand, and between the armies themselves, on the other, may have to be reconfigured to ensure that the general organization of the military is adapted to its use in

1. Multi-Domain is the term used by the English-speaking world to designate what the French doctrine defines as *multi-milieux/multi-champs*. The two terms are interchangeable. For France, there are five fields of confrontation (land, sea, air, space and cyber) and two fields of confrontation (electromagnetic and information). The difference between the milieu and the fields is explained by the existence of specific C2s for the former, which do not exist for the latter.

actual operations. This phenomenon has already been observed within the armed forces following the development of joint combat and the advent of increased versatility of resources.[2].

As far as the French Air and Space Force is concerned, joint integration can only question the principles implemented until now. Indeed, the centralized command from the national territory (JFAC - Joint Force Air Command located in Lyon-Mont Verdun), the organization of forces which was designed to make the most of the ability to shift efforts at both the strategic and operational levels, as well as to act over long distances and deep behind enemy lines (reach) is not necessarily adapted to the concept of Multi-Domain at its best. This would imply, for example, delegation of command and assets at a tactical level[3], as well as a speed of execution that is incompatible with the centralized drafting of an ATO[4] within 48 hours in the best of cases, or even 72 hours.

At the extreme, armies as we have known them for many centuries, may need to undergo profound changes, even if this means their disappearance as separate components[5].

Information and artificial intelligence

A second, even more general question concerns the implications for the conduct of war. Indeed, the importance given to information, to information gathering, processing and dissemination, corresponds to a desire to limit uncertainty both for one's own actions (risk of collateral damage, for example) and for those of the adversary (targets of opportunity, high value targets, etc.). This trend should be seen in parallel with the essentially technical American vision of war, which is often shared by air forces. A possible consequence of this phenomenon could be an "information dependency"

2. Notably in the sense given to this term by the army, in the context of two fundamental moments: the end of the 18th century (ref. resorting to use of divisions) and the beginning of the 19th century (Army corps). For the Navy and the Air Force, developments of this type have shattered the traditional division of roles into their respective components: the appearance of aircraft in the Navy, involving collaborative combat engaging very different types of assets (surface ships, submarines and aircraft), as well as the appearance of on-board radio and radar, and the introduction of multi-role aircraft, etc., in the Air Force.

3. This problem was, for example, solved in the 19th century, at the time of the creation of the army corps, by distributing the strictly necessary cavalry and artillery forces between the army corps and by regrouping the remainder in large cavalry and artillery reserves. However, it is necessary to have sufficient forces to carry out this distribution with the necessary number of personnel to carry out all the missions.

4. Air Tasking Order

5. This was the case for the Canadian Armed Forces between February 1, 1968 and August 16, 2011. The motivation was primarily political at that time. Between these two dates, the Royal Canadian Navy, the Canadian Army and the Royal Canadian Air Force were unified into a single service divided into "branches": the Canadian Armed Forces (Canadian Forces Reorganization Act C-243 of February 1, 1968).

that would lead not to accelerate and help the decision but to slow it down or even postpone it, while waiting for reliable information or the assurance, based on the estimate made by an artificial intelligence (AI), of a complete and risk-free success.

The use of AI also raises the question of how to take into account the paradoxes intrinsic to warfare and strategy[6]. The real danger lies in a vision that is too linear concerning operations, and essentially systemic concerning the adversary. The definition of the desired effects and the way to obtain them could then only derive from the application of a pre-established doctrine, tending to dogma[7], transcribed into algorithms that are not free of bias in the same way as the human beings may be[8].

This notion of paradox can be illustrated, moreover, in the very framework of the Mosaic Warfare concept. The concept was to hit the adversary at its nerve centers, avoiding attrition and maneuvering, while creating a highly resilient complex. But what if the adversary adopted the same concept? An almost mechanical return to attrition and maneuvering, as the original intent could no longer be achieved, by definition, as the enemy had increased its level of resilience. The paradox of Mosaic Warfare lies in its potential capacity to be its own antidote.

Finally, there remain a certain number of points that still require further reflection at all the classical "levels" of military art and science, but also at the political level.

Tactical aspects

From a tactical point of view, several strong points can be identified. The first is the enrichment of the range of applicable modes of action, thus increasing the flexibility or agility in the use of forces. As a result, this leads to an increase in the number of dilemmas for the adversary and complicates his task to the point of preventing him from responding to a tactical problem. In fact, the S-300 or S-400 systems, for example, which were designed to deal with an essentially airborne threat, could find themselves at a disadvantage

6. See on this subject the essay by E. Luttwak, *Le paradoxe de la stratégie*. Paris, Odile Jacob, 1989,

7. The temptation of dogma is a constant in military history. The offensive to excess, the moral force that had become dogmas in the French army, for example, showed their limits in 1914.

8. Algorithmic bias refers to results that are neither neutral, nor balanced, nor fair, reflecting the implicit values of the humans involved in the collection, selection, or use of these data. See, for example, the work of Helen Nissenbaum. The human being can be subject to many biases: those based on attention, judgments, reasoning, personality-related, etc. But the real question is to know which of the biases, algorithmic or human, is the most dangerous and especially the most likely to be corrected.

when faced with an attack carried out by ground forces, special forces, or cyber forces simultaneously[9]. The second is the fact that the action may no longer be conducted from the strong to the strong, in a frontal confrontation between capabilities specifically designed to oppose each other, but by circumventing the opposing power thanks to what is, in reality, a maneuver involving assets or resources of joint forces.

But weaknesses can already be perceived here. For example, such as the very strong dependence on cyber resources and on the more general use of the electromagnetic spectrum. This dependence must be considered as a vulnerability. This implies that the forces, and in particular the AAE, will have to maintain their ability to act in an impaired environment and with deteriorated capabilities.

Operational aspects

With regard to operations, the main positive aspects of the application of the concept seem to concern the pace of operations and the the enhancing of this level of war . With regard to the pace of operations, the sequencing of air operations and then land operations, as in the first Gulf War, could become much faster and more integrated. This would make operations more fluid, less predictable and more flexible in the face of changing situations and contexts. As a result, the responsibility of the operational echelon could be of capital importance in the design and conduct of operations, due to a faster observation/orientation/decision/action cycle.

However, there is a danger inherent in focusing on tactical aspects at the operational level. Indeed, Multi-Domain is also characterized by its objective to take advantage of all opportunities. The risk is that of moving from opportunity to opportunity, from target to target, losing the overall vision of the conflict and considering that victory could be the result of the sum of tactical successes. The effectiveness of this vision has been disproved in military history through many examples such as the Vietnam War. American forces did not lose any major military engagement, but the United States, and especially its Vietnamese ally, lost the war.

With regard to the Air and Space Force, the command structure may also be called into question. But more generally, it is also the positioning of the operational echelon that will have to be adapted. Until now, the operational echelon has been the primary echelon for synthesis and coordination of joint forces, to the point that it is sometimes confused with the joint echelon. The

9. This is exactly the effect that was obtained at the end of the 17th century and the beginning of the 20th century by the development of inter-army combat. The latter made it possible to put an end to a certain tactical blockage due to a linear combat that favored only fire. On this subject: P. Bouhet, «*La coordination interarmes dans les guerres du Premier empire*», in Choc, feu, manœuvre et incertitude dans la guerre. Pully, Centre d'histoire et de prospective militaires, 2011, p. 77-91

application of the Multi-Domain concept also implies, by nature, joint integration at the tactical level. This may be an opportunity for the operational level to assert its central role in the tension between the strategic and tactical levels, which is in fact its *raison d'être*[10].

Strategic aspects

At the strategic level, the potential increase in the pace of operations is a formidable asset that can reinforce the decisive character of operations and thus drastically shorten the time required to achieve the objectives defined by the political authorities. Nevertheless, the means implemented within the framework of the Multi-Domain carry two potential dangers, which are the two sides of the coin in the development of long-distance, high-speed communication. On the one hand, there is the vulnerability of such resources. On the other, there is the temptation, of using these same resources within the lower echelons. The strategic echelon that focuses on the tactical aspects is not playing its role, as the operational, or even political, echelon would. By focusing on details, the risk is to miss the main issues, the bigger picture.

Between benefit and danger, two other questions arise: does this mark the end of domain focused strategies, if they still exist, and what about interoperability between the United States and its allies?

True joint integration implies *de facto* a certain loss of specificity for the benefit of the whole. However, will this not be to the detriment of certain areas of expertise, and therefore of the exploitation of the possibilities offered? The example that immediately comes to mind is that of considering the air force only in the light of the conceptions and horizons of the army, confining them to direct support missions for ground forces.

True integration also raises questions about command, design and control, and the application of the principles of subsidiarity and delegation. The means necessary for the application of the concept – datalinks, communications, sensors and effectors – must all work symbiotically. However, the importance of a major supplier of assets and doctrine is not without consequences on strategy, or even policy, when defining ends, ways and means. Can Allied Multi-Domain Integration guarantee the sovereignty of each of the allies, given the pace of operations and the high level of information transparency that is required?

10. See in this regard in particular: A. Svechin, *Strategy*. Minneapolis, East View Publications, 1997. Translation from Russian of the book published in the USSR in 1925 or S. Naveh, *In Pursuit of Military Excellence*. New-York, Frank Cass, 1997.

Political aspects

Finally, at the political level, all of the risks and advantages described above are accentuated, particularly those of micro-management in the face of a renewed capacity to overcome certain bottlenecks, and thus to be able to achieve objectives more quickly while retaining initiative and freedom of action. Nor should the concept lead to the belief that a "military" solution is within reach at minimal cost, which entails the danger of the enticement to engage. It is always the nature of the conflict that will be of utmost importance at the political level, not just the mere available resources, because military success does not necessarily imply victory and even, sometimes, can carry defeat within it.[11]

It thus appears that the concepts attached to the Multi-Domain correspond fully to a cultural trend in the United States armed forces that favours technical responses to tactical, and even strategic, problems[12]. This culture is further accentuated by the technophilia of Air and Space forces, which can be largely explained by the characteristics of their respective environments[13]. But the question of adaptation to other strategic cultures, and more particularly to French specificities, remains open, because the way of conceiving and conducting war is a very significant factor of identity.

Certain dispositions can lead to considering war essentially only in its tactical aspects. Strategic and political victory is then considered attainable after a series of tactical successes. This is, *de facto,* at least a partial negation of the reasoning that led to the definition, for example, of the foundations of operative thinking.

Military history, over the long term, and experience, must underlie the reflections and work of the armed forces, in particular by calling for prudence. It is not a question of being pusillanimous, technophobic or overly conservative; quite the contrary. It is not about considering a single solution as the only viable or conceivable one. It is about not locking oneself into certainties that have not been established before the court of reality and the field. Finally, it is a matter of not considering an evolution, even a major one, of an essentially technical nature, as a revolution in the nature of war itself.

11. This is the case, for example, of the consequences of the submarine warfare conducted by Germany during the First World War. It is essentially a military result that is sought. However, the tactical successes, more or less important, were sufficient to discredit the central powers and to push the United States into the war (torpedoing of the Lusitania on 7 May 1915).

12. See on this subject: V. Desportes, *Le piège américain*. Paris, Economica, 2011, in particular pp. 141-145 or B. Colson, *La culture stratégique américaine,* Paris, Economica, 1993.

13. P. Facon, *Précis de stratégie aérienne*. Paris. CESA - CEMS Air

Multi-domain or all-domain C2 and operations concepts and their French Mult-Domain integration counterpart should be considered, therefore, as one of the best possible solutions, not as a "magic bullet" or "panacea" to deal with all threats and modes of action of a potential adversary.

Moreover, by focusing on essentially technical questions and specific issues (A2/AD for example), the real danger would be to lose the overall understanding of the phenomenon of war. This understanding is necessary to limit the risk of war.

Subsidiarity in the context of Multi-Domain

Romain Desjars de Keranrouë

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Subsidiarity: the word is spoken, but is it really understood and applied? Chantal Delsol, in her essay on this subject, doubts it: "*the concept of subsidiarity conceals, for the educated opinion, a vague connotation of freedom and autonomy. It is also used to justify the empowerment of actors at all levels of social life. But very generally the principle is known neither in its content, nor in its form.*" [14]

Yet as defined in the concept of the use of force, and as well in its application as a doctrine, it is linked to Command and Initiative:

"*The centralization of command attains its full efficiency if it is coupled with subsidiarity. The principle of subsidiarity aims at granting each level of command the freedom of action essential for the proper execution of the mission entrusted to it. The subordinate is encouraged to take the greatest initiative, while respecting the spirit of the mission. This is what is meant by* Mission Command [15]." [16]

"*Leadership performance is based on initiative, which is deeply rooted in the French military tradition. The initiative that must be granted to each level is the consequence of the principle of* subsidiarity*, according to which the responsibility for an action falls to the competent entity closest to the elements directly involved in the action or being the best able to grasp its complexity or sensitivity.*" [17]

These two definitions being stated, the concrete confrontation of these mere principles, with the reality of current military operations, raises questions. Whether in Afghanistan, Libya or Mali, the combatant's initiative has

14. C. Millon-Delsol, *Le principe de subsidiarité*, Paris, Presses Universitaires de France, 1993, p. 123.

15. A command concept whose origins are mainly attributed to Helmut von Moltke and embodied by the Auftragstaktik. The aim was to encourage initiative on the part of subordinates in order to compensate for the lack of connection with the centralized command level during confrontations with the enemy. On the other hand, it requires a high level of training of the cadres so that everyone is aware of the overall maneuver and is involved in it.

16. Force Employment Doctrine, DIA-01(A)_DEF (2014), No. 128/DEF/CICDE/NP of June 12, 2014.

17. Force Employment Concept, 2020.

been curtailed in recent years by the systematic centralization of essential decisions concerning targeting, intelligence analysis and authorization to fire, thus disempowering a whole generation of forces in combat. This centralization is a consequence of our operational superiority, combined with a scarcity of assets, which sometimes makes these assets "strategic". This practice would probably no longer be possible if higher intensity conflicts were to occur, calling this operational superiority into question.

However, when faced with high intensity conflicts, in Multi-Domain operations where the importance of C2 will be reinforced, and where the information flow to be processed will be increasingly significant, we will need to think about the definition of subsidiarity, how it is to be applied, and the way to teach how it works. Such an approach would seem essential to bring about the cultural changes necessary for effective implementation.

An attempt at definition

Subsidiarity is often considered in the Air and Space Force (AAE) as viewed through the prism of direct exchanges and sharing at the same level, even if hierarchy remains present (between the COMJFAC – Air Component Commander – and an aircrew for example). However, this aspect would warrant further exploration.

It is not necessary to decide whether the relationship between actors should be horizontal. As mentioned in the definitions above, the principle of subsidiarity is indeed a sharing of decision and responsibility between the person in authority and the subordinate's freedom of action. It is therefore a question of responsibility and initiative given to subordinate levels, within limits set by the higher level, and not a simple sharing between actors of the same level, that needs to be resolved.

On the other hand, interference and micro-management, or the "crushing" of levels, expressions often used in operations to describe a retreat from subsidiarity, reflect the intrusion of authority into a field of competence normally dedicated to a subordinate level. For example, it is not uncommon to receive a call from COMANFOR or an aide in the cockpit of a Reaper drone, a few moments before opening fire, urging them to fire more quickly. This is a far cry from the "*eyes on, hands off*" approach mentioned by General Stanley McChrystal in his book *Team of teams*[18].

A second approach within the AAE does outline a sharing of competencies: the integration of effects. A recently published document states that "*the force employment concept takes an agile approach to building a C2*

18. D. S. McChrystal, *Team of teams*. New-York, Portfolio Penguin, 2015.

Multi-Domain by opening the door to greater subsidiarity. The integration of effects *can be defined by the strategic echelon, or be the purview of the operational echelon, or be assigned to a tactical component.*" [19] This approach is based on the air component, seen as a structure. However, the principle of subsidiarity is not only based on processes and tools, but also on people, because "*it implies a philosophy and an anthropology*"[20], that of the freedom of action granted by an authority.

According to Chantal Delsol, the proper application of the principle of subsidiarity is based on:

- "*trust in the ability of the actors and in their concern for the general interest, trust also given to individual decision*

- *the intuition according to which the authority is not the natural holder of the absolute authority as to the qualification and the achievement of the general interest*

- *the will for autonomy and initiative of the actors* [...], *which supposes that they have not been previously* [...] *infantilized* [...]." [21]

Finally, it is important not to confuse delegation and subsidiarity, which are two distinct and complementary principles. "*Delegation consists of entrusting a mission or an activity to a member of one's staff, giving him or her the power to act, but continuing to assume responsibility for the final result.*[22]" Behind the word delegation, there is therefore regular reporting and supervision of the action carried out, so autonomy is not total. Subsidiarity enters into a logic where "*The subordinate in principle has the power to decide on everything except for what falls under the authority of the higher level*".[23]The foundation of subsidiarity is that there is support, help from the authority that is at the service of the subordinate, yet all of this without interference. We are moving from a "*report from*" logic to a "*support to*" logic. The question arises as to whether subsidiarity can really be transposed to the military world, where regular reporting remains the soldier's first duty and where the higher echelons tend to keep a very close eye on the implementation of their decisions.

19. Multi-Domain operations, the Air Force and Space Vision, Exploratory Concept CEAAE-2021/01_OM2MC (2021), p. 17.
20. C. Millon-Delsol, *op. cit.* p. 76.
21. *Ibid*, p. 37.
22. Eric Delavallée, Delegation and/or subsidiarity, Management issues, Eric Delavallée's blog, November 30, 2011, https://www.questions-de-management.com/delegation-etou-subsidiarite/
23. *Ibid.*

Yet, the integration of *effects*, desired for Multi-Domain operations up to the tactical level, implies that "*Integration is now needed at the tactical level of war*"[24], and would thus require the application of the three points developed below.

Confidence in the capacity of the actors

Accelerating the pace of engagements and decision-making in the face of massive flows of information is a response to constraint defined by the French vision as "*more limited opportunities for action*"[25] in future operations. This need is expressed in two ways: one is through the acceleration of flows, better connectivity, in a word through technology, which is often omnipresent in the discussion. The other need, often overlooked, refers to greater subsidiarity in analysis and decision-making, i.e., to the trust placed in subordinate levels, born of the intuition that the accelerated pace will no longer permit the higher authority to micro-manage everything. "*Such a capacity for analysis requires that the aircrews have an exhaustive knowledge and understanding of the expectations of all the missions programmed and the objectives of the chief. This involvement of effectors, which constitutes a very significant evolution in our operating principles and command relationships between the levels of planning and execution, represents a first level of decentralization* ».[26]

It is therefore essential not to remain at the component command level when expressing subsidiarity, but to go down to the aircrew level.

From this point forward, reliance on the expertise of actors in the field, who are open to factors that foster understanding, and having extensive knowledge of their environment, is a way to develop subsidiarity. This makes maneuvering more fluid and speeds up the OODA loop

Intuition that the authority is not always the most competent

Developed from actual feedback from current operations, the publication of an Intelligence Doctrine for the AAE in 2018 (*DAA 2.0, Renseignement d'intérêt Air*) has paved the way for full subsidiarity in real-time intelligence analysis, providing new opportunities. A Level 1 intelligence unit (considered to be a tactical level), deployed in the field (drone detachment, ISR Light aircraft, or C-160G), can provide correlated and merged level 2 real-time intelligence analysis (i.e., normally devolved to the operational level) in a limited scale of time and space, provided that this higher level has exhaustively pro-

24. Introducing the Integrated operating concept, UK Ministry of defence, p. 10.
25. Multi-Domain operations, the Air Force and space vision, p. 11.
26. L. Pena, "Multidomain Command and Control (MDC2): an opportunity to renovate our C2", DSI Special Issue No. 147, "Air Warfare and Multidomain Operations, May-June 2020.

vided it with both the information at its disposal (decompartmentalization of intelligence, including SIGINT, subsidiarity of COP[27] sharing, etc.) and the commander's intentions etc. This sharing of information is a real demonstration of trust, granted by the operational level to certain intelligence units working at the tactical level, and a major advance in a very compartmentalized world. Combined with the acceleration of the pace of operations, this new organization is producing promising results, in line with the principle of "*increased subsidiarity in the chain of validation and dissemination of intelligence*" [28]. One of the avenues for progress is therefore to have this intelligence organization recognized at the joint forces level, and then at NATO level, in order to follow as closely as possible, the pace of operations in real time, which requires ever faster synchronization and integration of effects.

Contemporary operations illustrate the increased synchronization between different components. For example, Command frequently avails itself of intelligence to inform proposed operations. Intel-led operations demonstrate this accelerated pace, whereby the effects produced by several components are seamlessly blended. Today, in the Sahel, the synchronization of detection, followed by classification of the enemy, targeting, then intervention/neutralization, all involve intelligence flows, UAVs, combat aircraft, helicopters and commandos in a practical version of Mission Command. It is the aircrews who are in a position to carry out these missions, even though they are joint. All that remains would be to give them the responsibility of targeting and opening fire in order to be fully integrated into such Multi-Domain operations, while at the same time accepting for one component to entrust resources to the command of another. The example of a Reaper crew is quite telling: it can exercise Mission Command at the beginning of a fire action by commanding land component helicopters, an ATL2 and other fighters, and then switch to supporting an air-land operation once the commandos have landed on the ground, all within a time scale of an hour.

Willingness to be autonomous and take initiative: how to train for Mission Command?

Conferring subsidiarity to those whose role is to implement the platforms and weapons, can only be successful if staff are identified who can break down the barriers between environments and fields. Cross-referencing information flows, gaining perspective and hindsight, even within a detachment deployed in the field, will require a more global understanding of the role to be played in the joint maneuver and solid knowledge, extended to other environments and fields. "*Fully cognizant of the Air Force leader's intentions*[29]*, he will make decisions that save a great deal of time*".[30]

27. Common Operational Picture
28. Multi-Domain operations, the vision of the AAE, p. 20.
29. Here, this would be the COMJFAC.
30. L. Pena, *art. cit.*

Thus, "*nothing will be done without a deep cultural transformation* [...]. *This cultural change will only be possible as a result of strong leadership at the highest level of the hierarchy and the training of officers pre-selected and fast-tracked early enough in their educational process*".[31]

The challenge is therefore twofold: both to train tactical actors, so that they are able to see beyond a limited role in which they may sometimes be trapped, and to cultivate a sense of distance and perspective in decision-makers, to force them to see beyond the tactical level that reassures them, and to think about the next move. De Gaulle said nothing more in his book *Towards a Professional Army* when he described the inevitable mechanization of armies: "Leaders of all ranks will have to judge and decide with an extreme promptness that will preclude seeking advice and delay. In a matter of moments, they will have to assess the circumstances, make their decisions and issue their orders".

For example, during Operation Barkhane, the deputy general of operations, deputy to COMANFOR, called on the drone detachment to provide intelligence on enemy developments over time. This trust had the effect of broadening the detachment's understanding of joint maneuvers in order to be able to provide an assessment of the situation that was useful at the operational level. This initiative, quite unique, was an opportunity to gain perspective and hindsight, which would be worth extending to other detachments because it has an educational value and develops a sense of operations oriented towards the Multi-Domain.

Also, if it is necessary to focus on the training of managers at the tactical level, it is important not to forget those who will delegate and share the decision, responsibility and competence. Indeed, this sharing of competences and responsibilities can still be improved in the face of a French culture of centralization, reinforced by the reduction in our resources[32]. Also, we must educate future leaders (both operational and strategic) to establish a kind of "*forward imbalance*" that leads them to have the impression of decentralizing too much, of sharing the decision too much. Once in this position, the leader will then be able to consider that he or she has placed the cursor correctly, i.e., to be "*able to dynamically distribute more functions and responsibilities and do so as close to the action as possible to ensure the continuity of operations*".[33]

31. D. Pappalardo, "Bringing tangibility to the concept of multi-domain warfare: to buzz or not to buzz", DSI Special Issue No. 70, "US Air Force: The Fist of America," February-March 2020.
32. Thus, since the number of fighters deployed in the Sahel is small, the slightest adjustment in format is by nature quasi-strategic.
33. D. Pappalardo, *art. cit.*

Finally, as one American military officer stated, "the *Air Force needs to empower commanders and operators at the lowest levels. Regrettably, the Air Force does not practice or exercise the type of command at the squadron or wing level that will allow forces to succeed in a future fight.*" [34]

The need for training at the line echelons, such as the squadron and wing, must become a major focus of effort. Giving them the initiative, even if it means disrupting the traditional ATO cycle ("What JFAC HQ currently does in its 'control' function – ensuring the ATO runs smoothly, making theater-wide decisions – could be decentralized"35), would allow both the identification and selection of future Multi-Domain leaders and the restoration of the principle of subsidiarity to a concrete place in operations.

Two fundamental aspects of the principle of subsidiarity can therefore be further improved: verticality, which concerns the sharing of responsibility and competence between an authority and a subordinate entity, and its embodiment, the part of subsidiarity that affects not the structures but the people, especially the crews.

Verticality and the embodiment of subsidiarity overturn the current conception of C2, the famous dogma of "*centralized command, decentralized execution*". For junior officers, it will be a matter of making Mission Command their own in order to adapt their conduct to events and thus apply General Lagarde's beautiful formula: "*initiative is the most accomplished form of discipline*" by going further than task execution. For the senior officers and generals in charge of C2, it will be time to move towards a decentralization of command, towards an "*off balance leaning forward*", where "*the art of leadership will be to know how to relinquish the baton, so as not to disturb the orchestra.*"[36]

34. N. Tsougas, "Is the USAF Effectively Embracing the Challenge of Executing Multi-Domain Operations?", *OTH Over the Horizon Blog,* February 19, 2020,available at https://othjournal.com/2019/02/20/is-the-usaf-effectively-embracing-the-challenge-of-executing-multi-domain-operations/

35. L. Pena, *art. cit.*

36. Herbert von Karajan

VARIA

RETEX - 44 days over Nagorno-Karabakh

Pierre Grasser, PhD in history of international relations.

Thanks to Mrs. Blanche Lambert (production of maps).
This article was written from open sources.

At the time, Nagorno-Karabakh is an integral part of the Socialist Republic of Azerbaijan under the USSR. This situation wavered in 1988, when the National Assembly of Nagorno-Karabakh proclaims the independence of the region, where a majority of Armenians live. Anxious to regain control, Azerbaijan sends troops to the region. The clashes between the inhabitants of Nagorno-Karabakh, supported by Armenia, and the Azeris increase. The disputes turn in favor of the Armenian party and are suspended by a cease-fire in 1994.

Baku has always contested the fairness of this agreement. Repeated skirmishes occur in the 2000s. Impoverished and with a declining population, Armenia thinks it can compensate for its military weaknesses by focusing on the training of its soldiers. However, the clashes in 2016 reveal a shift in the balance of power. Aided by oil revenues, Baku makes use of its diplomatic ties to obtain new stand-off weapons. The fighting resumes on 27 September 2020. The intensity of the conflict, its technical and operational specifics and the lessons learned in aviation are worth an assessment, which follows.

Armenia, Azerbaijan and Nagorno-Karabakh, until 27 September 2020

I - Two armies, two visions of high intensity combat

A) Armenia, a modernization barely begun

Criticized after the conflict, the Armenian forces have some assets in September 2020.

(RR) Armenian Su-30SM, armed with 4 R-73 air-to-air missiles (short range) and 4 R-27ER (medium range), Erebuni airport, date unknown.

Contoversy over the air component. Maintaining a combat-ready air force is an expensive choice, one that not all former socialist bloc nations can make. Armenia's operational fleet consists of eight Su-25 tactical bombers and seven L-39 trainers, as well as six Mi-24 attack helicopters and two transport helicopters. An ambitious leap in capability is attempted with the purchase of four Russian Su-30SM multi-role fighters, to be delivered in December 2019, which becomes controversial due partly to the cost. There is little data on the level of training in the air force. Aircraft did not leave Armenian territory and did not participate in any major exercises with Russia.

Obsolete surface-to-air defense. Although powerful in terms of quantity, the Armenian ground-air component are nonetheless apportioned into two commands:

- The air force deploys six S-300PS and S-300PT/SA-10 surface-to-air batteries with a range of about 75 km against aircraft. Four batteries of S-125/SA-3, with a range of 23 km and capable of dealing with medium-sized drones, rounded out the system.
- Ground forces provide the backbone of the anti-aircraft defense of Nagorno-Karabakh. They implement two Kub/SA-6 batteries (range : 24 km) and one Krug/SA-4 (50 km). This outdated equipment hardly poses a threat to drones. In addition, some forty short-range (9 km) Osa/SA-8 systems are distributed along the front line. Four Tor M2/SA-15C surface-to-air systems are delivered by Russia in December 2019. Their range against drones is about 9 km, with a higher hit probability than the SA-8. This parameter, combined with its high cost, makes the Tor a priority target.

A ground component with Soviet roots. The Armenians' main asset is their non-guided conventional artillery. Hundreds of 122 mm and 152 mm guns are reinforced by multiple rocket launchers. There is a deep strike capability, with *Tochka*/SS-21 (120 km) and *Elbrus*/*Scud* (300 km) systems. Several *Iskander*-E complexes are also acquired in 2016. These implement the 9M723E theater ballistic missile, with precise inertial guidance and a range of just under 300 km. The motorized forces have mostly T-72B tanks and BMP-2 armored personnel carriers. About 40,000 men[1] are appointed to the defense army of Nagorno-Karabakh, but they lack field experience.

C4I capabilities[2] below requirements. Armenia is equipped with efficient Russian *Repell* jamming units. However, no modern electronic reconnaissance means are present, despite a favorable geographical situation for intercepting transmissions from Azerbaijan.

B) For Azerbaijan, calculated investments in multiple areas.

In the face of the Karabakh army and the Armenian army, Azerbaijan proposes a rather different military strategy. Despite a defense budget twice as high as that of Armenia (1.4 billion dollars[3] in 2018 against 670 million [4]), choices have indeed been made.

An Air Force focused on tactical support. The Azeri air force has two main missions. The first is to ensure the protection of Baku, using 13 MiG-29 fighters, dating from the Soviet era and never modernized[5]. A second component is to intervene on the front line. Here they are better prepared: 19 Su-25 assault bombers, upgraded in 2019 (laser-guided bombs, jamming pods). In addition to these aircraft, there are 24 Mi-35M3s, 21 Mi-24s and 60 Mi-17s, helicopters dedicated to providing fire support, evacuating the wounded, or dropping off troops at hard-to-reach points.

Surface-to-air defense: capabilities outside the front line. Azerbaijan belongs to the restricted club of powers with IADS[6]. The country has multi-layered, coherent and centralized air defense (with its fighters), an-

1. D. Verkhoturov, " The Second Karabakh ", *Agentsvo Polititcheski Novosteï*, 16 November 2020, https://www.apn.ru/index.php?newsid=38869&fbclid=IwAR0jo3nuT29FVbCOOa-JEyEs2Z8bbw5WT8QwwoqRejDf5WzQPqqyHrOoeJ50.

2. C4I: Command, Control, Communications, Computers and Intelligence

3. "Azerbaijan, Government Defense Spending", *Countryeconomy.com*, March 22, 2021, https://fr.countryeconomy.com/gouvernement/depenses/defense/azerbaidjan.

4. "Armenian Defense Spending", *Macrotrends.net*, March 22, 2021, https://www.macrotrends.net/countries/ARM/armenia/military-spending-defense-budget

5. A new navigation system is installed, at the Ukrainian factory of Lvov, on these aircraft during an upgrade in 2007.

6. IADS : Integrated Air Defense System

ti-aircraft defense (with surface-to-air systems) and radar-based multi-layered surveillance capabilities. Two batteries of S300PMU2/SA-20-B are purchased from Russia in 2007. A belt of five S-125/SA-3 surface-to-air batteries also surrounds Nagorno-Karabakh. This does not however ensure denial of access to the enclave. Its purpose is to prevent Armenia from using its aircraft outside its borders. Lastly, Baku purchases three batteries of *Buk* M1-2/SA-11 systems from Belarus, as well as six batteries of *Barak-8* from Israel. These medium- and long-range weapons are credible for countering Armenian ballistic projectiles in their final trajectory.

Some well-equipped land forces. When seen in proportion to its population, Baku's effort to arm its 118,000-strong army is substantial. Some units have cutting-edge equipment, while most have more conventional solutions. The case of armored vehicles illustrates this, since 100 modern T-90S tanks and 12 recent *Khrizantema-S* tank hunters are acquired from Russia. These MBT are alongside 250 T-72s from the Soviet period, which have been slightly renovated. The infantry has hardly been given priority for individual equipment. In contrast, 100 Spike anti-tank missiles are obtained in 2012 from Israel. Although it has little ammunition to arm them with, Azerbaijan has these long-range strike capabilities:

Model	Manufacturer/origin	Number	Year of acquisition	Range (km)
LORA[7]	IAI/Israel	50 missiles	2018	400
Polonez[8]	Belarus and China	10 launch vehicles	2018	200
EXTRA	IMI/Israel	50 missiles	2008	130
T-300[9]	Roketsan/Turkey	9 launch vehicles	2016	120
SMERCH[10]	Bought in Ukraine	12 launch vehicles	2008	90

7. S. Roblin, "Cluster Munitions and Missiles Rain Down on Armenian and Azeri Cities", October 7, 2020, https://www.forbes.com/sites/sebastienroblin/2020/10/07/rockets-cluster-munitions-and-missiles-rain-down-on-armenian-and-azerbaijani-civilians/?sh=66009a7142c2

8. A. Helehayeu, "Polonez rockets arrive in Azerbaijan", Belsat, September 28, 2018, https://naviny.belsat.eu/en/news/belarusian-polonez-systems-arrive-in-azerbaijan/

9. R. Shirinov, "Turkey delivers T-300 rockets to Azerbaijan", Azernews, September 21, 2016, https://www.azernews.az/nation/102564.html

10. "Azerbaijan – Cluster munition ban policy", The monitor, October 30, 2020, http://www.the-monitor.org/en-gb/reports/2020/azerbaijan/cluster-munition-ban-policy.aspx

Suicide UAVs and C4I, the decisive Azeri assets. Faced with Armenian surface-to-air means, Azerbaijan very early on choose to use unmanned equipment: 15 *Hermes 900* reconnaissance drones, *Harops*, *Harpys*, *Orbiters* and *Skystrikers*. Finally, several *Bayraktar* TB2 UAVs, whose radar signature is particularly discreet, are present on Azeri soil in September 2020. They can carry out reconnaissance or attack missions, using missiles with a 9 km range. In addition to the UAVs, the Azeri C4I has been reinforced with R-934 jamming station from Belarus, and especially Israeli EL/M-2084 counter-battery radars. Equipped with active electronic scanning antennas, this equipment is used to locate large-caliber enemy fire.

II - The victory of Baku, after an initial hesitation

Between Yerevan and Baku, the outcome of the 2020 clashes for control of Nagorno-Karabakh is decided in a few days. However, the Azeri ground forces make mistakes and sometimes give the impression of fumbling. It is thanks to its elaborate air offensive, planned in advance, that the Azeri army turns the conflict around.

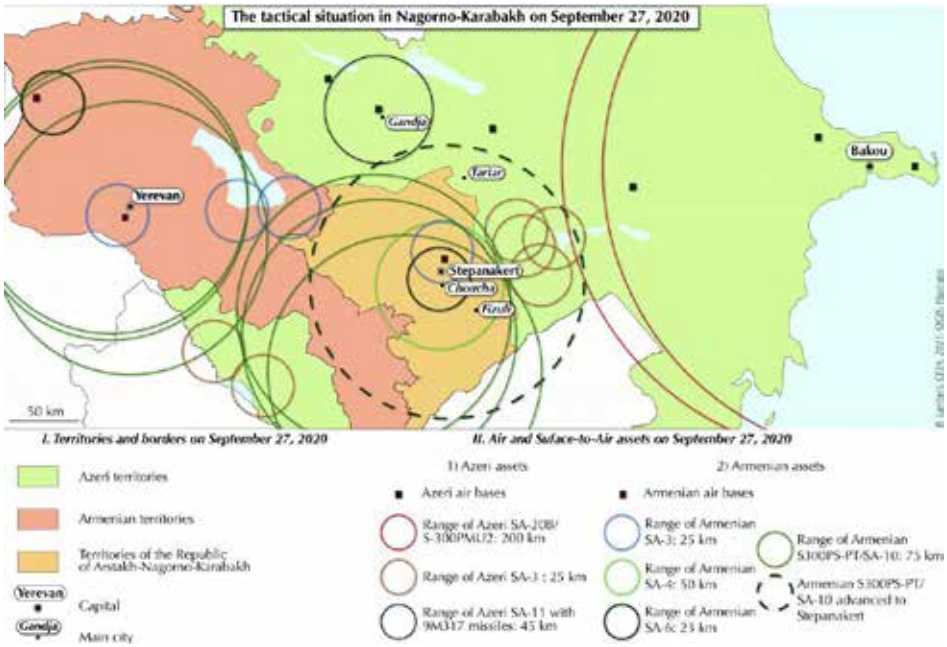
A) Some doubts, for two days, about the outcome of the conflict

Summer 2020: implementation of the Azeri plan and Yerevan's wait-and-see attitude

The final preparations of the two factions for the conflict are not fully known. The available information suggests that the Azeri army is fairly well prepared. The schedule of equipment acquisitions, as well as the training schedule, attest to this. Six F-16 fighters, as well as an unspecified number of *Bayraktar* TB2 drones, arrive from Turkey in July 2020 as part of a joint exercise. They did not return to Turkey at the end of the exercise.

Azerbaijani publications have recently revealed that some Su-25 pilots had been training since 2019 in techniques of approaching and neutralizing short-range surface-to-air systems. The process makes it possible to definitively destroy surface-to-air systems and save expensive drones, which Baku does not have in such large numbers. As to ground forces, conscripts are recalled to active duty in July.

Although Armenia has a reputation for being more open than Azerbaijan, it gives little information about its preparations. In response to a spike in tension in the spring of 2020, it organizes a large-scale artillery exercise in May and installs a long-range S-300PS surface-to-air battery in Nagorno-Karabakh during the summer, but does not mobilize until September 27.



48 hours of Azeri trial and error

Three separate assaults are carried out simultaneously by Azerbaijan in the early days of the conflict. One in the north is a ruse to divert the adversary. A second, messy one, is an attempt to take the shortest route to the enclave's capital. The third attack, to the south, is the real focus of the operation.

(RR) The Armenian Su-25, destroyed by collision, carried two R-60M/AA-8 air-to-air missiles,

NORTH FLANK: trapping Armenian forces. The Karabakh Self-Defense Forces have set up a chain of concrete strongholds in the northeast corner of Nagorno-Karabakh. When the Azeri assault begins at 6 a.m. on 27 September, Armenian forces in the area are taken by surprise, and one stronghold fell quickly in the morning, followed by another in the afternoon. The Armenian forces suffer losses when they send reinforcements in unprotected trucks. They are attacked by a wave of Azeri suicide drones and scattered. This attack, especially the air assault, destabilized the Armenians. Faced with the presumed urgency of the situation, the Armenian air force is called in support. In order to avoid the Azeri long and medium range air-defense-systems, the crews flew at low altitude. An Armenian Su-25 crashed into the ground on 29 September, killing its pilot. Overestimating the Azeri offensive, the Armenians

withdrew from the area. However, the attackers did not advance any further. This maneuver of deception is successful beyond Baku's expectations. The deployment of new-generation air munitions is decisive.

EASTERN FLANK: the Azerbaijani defeat. For Baku, conducting an offensive from the eastern flank is the option that offers the shortest approach to Stepanakert (36 km). The examination of videos from the Armenian border network on 27 September shows that an imposing Azerbaijani mechanized column - 14 BMP armored vehicles and 3 T-72 tanks – is heading towards the village of Karakhanbeyli, which blocked the road to the capital of Karabakh. The assault has no air support and the defenders hold on. By 3 October, 5 BMPs have been burned, as well as 2 T-72s. For the attackers, this failure raises questions: they engaged a powerful contingent, without air support, in a defended sector. In any event, this demonstrates the high level of performance of the Armenian forces when fighting in the absence of a concomitant attack from the air.

SOUTH FLANK: Baku's main strike. Despite the fact that the distance to reach Stepanakert is the longest, an attack with two pincers is launched on September 27, 2020 on the southeast flank. The northern strike targets the abandoned village of Horaditz, 8 km south of Fizuli. It has artillery support and is covered by a *Bayraktar* TB2 drone. The assault of the Azeri column is quickly immobilized by mines and anti-tank missiles. No help comes from the air, since the *Bayraktar* operators give priority to the destruction of three *Strela-10*/*SA-13* surface-to-air systems, 8 km further north. Air-land coordination could obviously be improved.

Simultaneously, a second attack is launched below, following the Arax valley. Baku prematurely announces the "liberation" of the border village of Nuyger on 27 September. The claim is premature, as the line has still not moved on the 29th. Worse, 10 light armored vehicles - BMP-2 and BTR-82 – are abandoned in a minefield. Azerbaijan redoubled its efforts to wipe out the defenses. Bayraktar drones neutralize the artillery. At least six 122 mm guns and five BM-21 rocket launcher vehicles are destroyed. A suicide drone is also engaged, against an Armenian T-72 at Nuyger, on 27 September. Finally, Azeri *Mi-35M3* helicopters make a rare appearance. The Azeris fire their rockets in the direction of Nuyger, where resistance continues on 6 October. On the ground, powerful Dana self-propelled guns and TOS self-propelled rocket launchers support the offensive. The infantry launches at least one Spike long-range anti-tank missile. Azerbaijan releases

the video of the shot, which strangely enough is aimed at a BMP-2 of its own forces. The main Armenian lines in the Arax valley give way between 3 and 4 October, after two days of engagements.

B) Azerbaijan prevails with its modern capabilities

On the battlefield: the victory of attack drones?

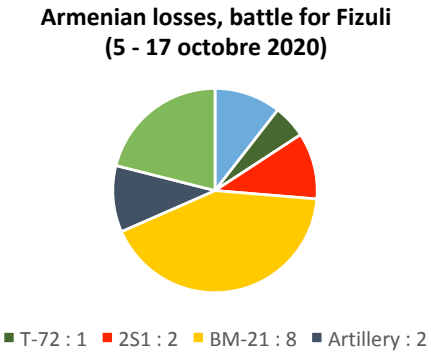
Azerbaijian efforts are then directed at south Karabakh. Troops follow two routes. First along the Arax valley, to retake control of the border with Iran. In addition to the border pockets in Nuyger, the Azerbaijani encounter resistance in Jebrail, mid-valley. One of the Azerbaijani Su-25s is destroyed by surface-to-air fire on 4 October. The ground fighting destroys two Armenian T-72 tanks and Jebraïl falls on 17 October.

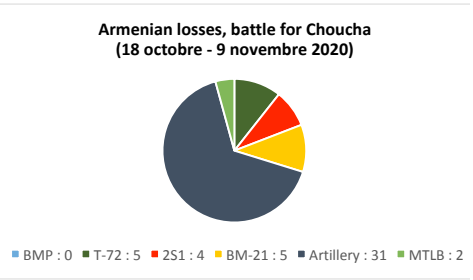
The second focus of Azerbaijani efforts extends northwards, towards Stepanakert. Several fortified towns block access, including Fizuli, whose suburbs are reached on 5 October. The stiff resistance encountered there immobilizes the attackers, who have little support when they reach the city. In fact, the airspace of southern Karabakh is still protected by a 2K12/SA-6 surface-to-air battery and by an S-300PT/SA-10, south of Stepanakert. They are neutralized between 6 and 8 October by Harop suicide drones. Before this date, the expensive Hermes and Bayraktar TB2 UAVs seem to be absent from central Karabakh. This temporary absence of air threat is exploited by Armenia. They gather their forces on the eastern flank of Karabakh in preparation for a counterattack. The aim is to cut off the supply routes of the attacking expeditionary force in the Arax valley. However, despite its audacity, the operation is a fiasco. The Horaditz positions are abandoned on 10 October, freeing the route to Fizuli for Azerbaijan.

In contact with the attacking troops, the defensive strongholds around Fizuli are solid. However, Azerbaijan takes advantage of the virtual disappearance of the surface-to-air threat to engage its drones. The city falls on 17 October. The new Azerbaijani objective then becomes the capture of Shusha, another firmly held foothold. A Bayraktar drone is destroyed there on 18 October, probably by a mobile surface-to-air system that has survived the previous attacks. The effectiveness of the other Bayraktars engaged should not be eclipsed by this event. Here again, the bombardments of the defensive positions are made possible by the lack of anti-drone defense. Gradually stripped of its defenses, Choucha falls on 9 November.

The fall of Shusha leads the Armenian government to lose hope, and it begins talks with Russia and Azerbaijan. A cease-fire is concluded on the evening of 9 November. In return for the cessation of hostilities, Yerevan

agrees to give up two thirds of Karabakh. The territories remaining under the authority of the Republic of Karabakh are demilitarized, while a Russian peacekeeping force is deployed.





Strikes beyond the frontline, pursuing the Azeri advantage by other means

FOR ARMENIA, A COUNTER-PRODUCTIVE USE OF LONG-RANGE SURFACE-TO-SURFACE WEAPONS

Yerevan has three categories of long-range attack systems, which it commits chronologically in the following order: first, a heavy multiple unguided rocket launcher (BM-30 *Smerch*), then tactical ballistic missile systems (*Iskander-E* and *Tochka*) and the powerful but obsolete *Elbrus* (*Scud*) missiles. These weapons are increasingly used as the situation on the front deteriorates.

- Multiple rocket launchers are the first weapons used by Armenia in its long-range strikes on 27 September, targeting the cities of Barda and Tartar. Despite the knowledge of the locations of the Azeri forces, the means of attack are unguided munitions, unsuitable for strikes in urban areas.
- More precise, theater ballistic missiles take over from rocket launchers. Chronologically, the *Tochka* is used first. Several groups of enemy troops are located by the Armenians and targeted[7]. Regarding the *Iskander-E*, at least two 9M723 missiles are launched in the direction of Shusha on 9 November 2020, just after its capture by the Azeris. Yerevan favors tactical use of these expensive munitions.
- The *Scud-B* missile, due to its combat record, constitutes the *last resort* of the Armenian arsenal. In total, four strikes are carried out towards Ganja, from 4 to 17 October. The impact zones are sometimes more

7. Images from an Armenian X55 drone, released on October 21, show 15 Azeri Dana self-propelled guns, 5 km south of Fizuli.

than six kilometers away from the air installations, which the Karabakh Minister of Defense claimed to have targeted. However, these strikes prompt the departure of Turkish F-16s. The results are mixed, given the political damage caused by these attacks on Armenia's image.

1) Concerning the Azeri stand-off armaments: a succession of battle achievements.

Azerbaijan's use of *stand-off* weapons contrasts with Armenia's. First, targeting work has been seriously prepared. Moreover, the Azeri arsenal is varied, capable of striking a wide range of targets. Finally, the known engagements of these weapons are effective. The destruction of the nerve center of Armenian hardware is achieved.

The destruction of Armenia's short-range surface-to-air defenses: Azerbaijan's main weapons for attacking Armenian forces are attack drones: which are not invulnerable. Short-range surface-to-air systems are the main threat. The destruction of these assets is a prerequisite for other actions. Azerbaijan employs two techniques to this end. The first is to attack sites already identified before the war, such as SA-8s near the border in the early days of the conflict. Secondly, in order to push their defenses into the open, Azerbaijan

(RR) Armenian aerial photo of Dana guns of Azeri forces, at Marjan, 5 km south of Fizuli.

(RR) Shusha, November 9, 2020: shot of the submunitions disperser of a 9M723 missile, launched by Iskander.

(RR) The serial number of the missile. Two munitions of this type are found, to the east and west of downtown Choucha.

uses some decoys. Former An-2 transport biplanes, remotely controlled, flew over the interior of Armenian lines. The surface-to-air systems deployed in Karabakh opened fire, revealing their own position and attracting strikes in return. It is not known how tracking is achieved, since Azerbaijan is not known to possess the required electronic equipment. The Baku forces are at least able to make use of their EL/M-2084 MMR counter-artillery sensors, which can locate the launching position of a missile.

At the end of the conflict, Armenian forces engage only a small number of surface-to-air systems, which could no longer cover each other. In addition, they are redeployed from one area to another, which require them to travel in a transport configuration during which they are vulnerable. A modern *Tor*/*SA-15* is neutralized in this way. Long observed by a TB-2 drone, it is attacked while sheltering in a house west of Stepanakert, around 9 November.

Destruction of Armenian medium- and long-range surface-to-air batteries: Armenia's S-300PT/PS are old variants of the S-300P family. However, even with a limited range of 75 km, their many electronic scanning radar arrays offer solid chances of a hit. They are prime targets for Azerbaijan to gain control of the skies for its tactical UAVs.

- The S-300PS site in Stepanakert allow them gain full control of the sky of Karabakh, but also part of its Azerbaijani approaches (see map). To neutralize the site, on 9 October[8], the attacking forces choose *Harop* suicide drones. The site is completely knocked out, and some specialized operators lose their lives.

(All RR) An Armenian Tor-M2/SA-15c, deployed in the Khodjanvend sector, east of Stepanakert.

- The S-300PS battery in Kakhnut, 18 km west of Karabakh, is targeted on 15 October by several *Harop* suicide drones. The site remains technically operational after these attacks, which only hit unmanned equipment.
- The Goris battery is located 24 km from Karabakh, and 49 km from Stepanakert. The system is destroyed by *Harop* drones, but human loss is probably limited.
- A detached battery at Syunik is attacked around 17 October. In order to carry out its strike, Azerbaijan implements a *Bayraktar* TB2 drone, probably not carrying ammunition to reduce its radar signature. It is used to guide an artillery strike, carried out by long-range guided rockets, to film it[9]. The damage and human toll are still unknown, but the hits cover the entire surface of the surface-to-air site.

All fixed surface-to-air systems covering Karabakh are out of service as of 19 October. With the exception of the S-300PT/PS at Syunik (hit by a long-range rocket), the Azeri *modus operandi* remains the same. It is based on the use of a small number of *Harop* suicide drones. This equipment, prac-

8. D. Mihailova, "Harop attacks on S-300PS positions in the Stepanakert region", Diana Mikhailova blog, October 12, 2020, https://diana-mihailova.livejournal.com/5569650.html

9. "Azerbaijan destroys Armenian equipment", Azerbaijan Ministry of Defense Youtube channel, October 17, 2020, https://www.youtube.com/watch?v=T_yX7xLJNes

tically absent from the front line, is favored for the approach and attack of sensitive targets. Their low radar signatures, combined with a low altitude flight profile, make them difficult to detect. For Armenia, a lack of readiness seems to persist, even after several days of conflict. No camouflage is observed on the images, and the batteries are left unprotected, without any bastion walls.

Neutralization of Armenian long-range ground-to-ground assets Yerevan's attacks on Azeri cities arouse international disapproval. Therefore, Baku hardly needs justification to carry out reprisals. The first are directed against the R-300/Scud-B ballistic systems, but Azerbaijan has to wait until it has neutralized the Armenian surface-to-air defense. Baku announces on 13 October the destruction of a *Scud-B*, south of Lake Sevan, deployed in open terrain. Then, the Armenian BM-30 *Smerch* multiple rocket launchers are also hit with precision. The BM-30 crews still seem to pay little attention to the air threat: their dispersal area for firing is close (3 km) to their base (Srkhavend, south of Karabakh).

(RR): Circled in blue, a Harop suicide drone will hit a 5P85 launcher, from the S-300PS site in Kakhnut, October 15, 2020.

RR: Syunik's S-300PS battery, filmed by Bayraktar drone, around 17 October 2020.

- **Strike against the Karabakh Defense Minister.** Minister Jalal Harutyunian is driving around the Khodjanvend area in an all-terrain vehicle on 26 October. He joins a line of Armenian military trucks, which he passes at high speed. The behavior of this car, usually reserved for the authorities, catches the *eye of a Bayraktar* drone operator, who is following the cargo convoy. A strike is launched, after which two figures, including J. Harutyunian, extract themselves from the burning carcass. The video shows how the choice to hit the ministerial vehicle is fortuitous and at the initiative of the Azeri operator.

Summary: Started on 27 September 2020, the Nagorno-Karabakh conflict can be described as a medium-intensity conflict as far as air warfare is concerned. For Azerbaijan, it is a decisive victory, but a costly one, as 2783 of its soldiers have fallen and many weapons are lost. On the Armenian

side, the resulting damage to equipment seems significant, but must be put into perspective. It is old weaponry, which Russia has in large quantities in storage facilities. They can be replaced. The human toll, on the other hand, is estimated at 8,000 soldiers killed[10], which is considerable for a country of this size, whose birth rate is stagnant at 1.3 children per woman. The backbone of the Armenian army is durably weakened.

Azeri President Aliyev's victory speech on December 1st 2020, is modest. The success of the Azeri armed forces is however indisputable. But Azerbaijan is the aggressor here and could not prolong the hostilities without the risk of sanctions. Moreover, its arsenal, effective in open terrain, would have shown its limits as the front moved closer to urban areas, while ammunition stocks are being depleted. The display of a certain restraint is therefore the most suitable posture to adopt.

(RR) The UAZ car of the Karabakh Minister of Defense, after being targeted by a Bayraktar drone.

III - A CONFLICT THAT IS A PRECURSOR TO THE NEW MODERN COMMITMENTS

A) A modern way of waging war

- **Exaggeration of « winners »**

The Nagorno-Karabakh conflict has seen intense attempts to influence both sides, as in most contemporary conflicts.

Azeri President Iham Aliyev's speech on December 1, 2020, is delivered in a well-prepared setting, with a military parade and presentation of captured equipment. Statements concerning the number of Armenian losses are made[11] and are generally accurate. The aim of this communication, directed towards foreign countries, is twofold. There is the question of proving the Azeri victory to the world by showing the assets taken from the enemy, but also of fostering good relations with countries having supplied the weapons, by recalling the effectiveness of their equipment.

The strategy is different for Armenia. From the beginning of the conflict, declarations seek to galvanize the population, while in the meantime the front is giving way. Their credibility deteriorates over time. It even col-

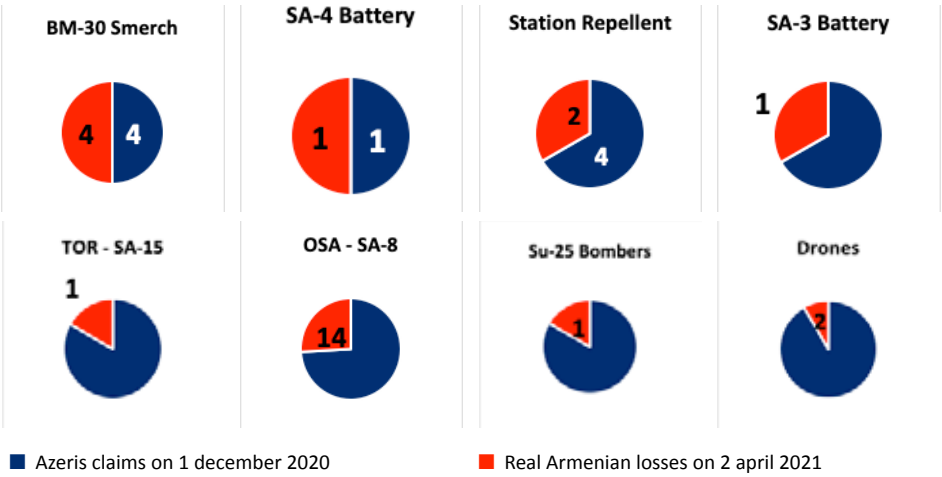
10. D. Verkhoturov, *op. cit.*
11. I. Aliyev, "Address to the Nation", Presidency of Azerbaijan, December 1, 2020, https://en.president.az/articles/48205

lapses with the publication of the list presented below, on October 20[12] [13]. The site *lostarmour.com*, highlights the exaggerations based on freely available information. The effect of the Armenian communications is ultimately the opposite of what is intended.

• Collateral damage and civilian casualties

Unsurprisingly, the conflict resulted in civilian casualties in both countries. The warring parties have levelled the same accusations of war crimes at each other. However, it seems that Azerbaijan is also winning the war of opinion.

On the evening of 27 September 2020, the first day of the war, the two sides blame each other for strikes against non-combatants. On the Armenian side, two civilians are killed in Nagorno-Karabakh and a civilian transport bus is hit by a drone strike 20 km inside the Armenian border. Azerbaijan announced, on the same time, the death of 17 citizens as a result of attacks on the city of Tartar . The announcements follow one another for more than a month, during which both sides in the fight tend to exaggerate the number of their missing.

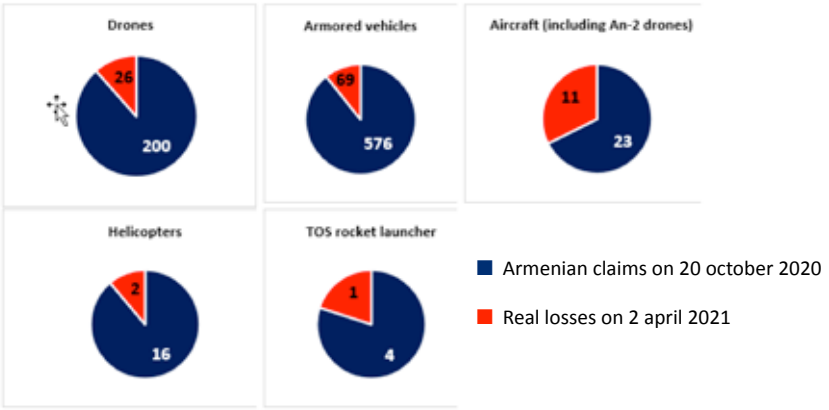


On the side of Baku, 100 non-military victims are mentioned. The Nagorno-Karabakh authorities announce 63. For its part, Amnesty International identifies 79 Azeri civilians and 11 Armenians who died in the strikes.

Even if Yerevan is the only side to evacuate its population from the war zones, the work on influence carried out by Azerbaijan is effective. The spectator will remember above all the pinpoint precision of the impact of the

12. The number of lost aircraft includes a piloted Su-25 and 10 Antonov An-2 drones.
13. "Loss Update", 1 - News, October 20, 2020, https://www.1lurer.am/en/2020/10/20/Enemy-losses-Update/340567

Azeri *stand-off* ammunition. To explain this result, Russian defense analysts mention the audience of Armenian and Russian pseudo-accounts on social networks, *a priori* managed by Azeri circles to discredit Yerevan[14]. By amplifying the faults of its opponent, Baku managed to hide its own.



- **The lack of adaptation of the Armenian military during the conflict**

During the 44 days of combat, Armenian infantrymen appeared to remain in compact groups, with little regard for the air threat. Moreover, although trained, the surface-to-air operators appeared to be out of touch with their environment. Azeri radio-controlled An-2 aircraft flew over the Armenian camp twice in eight-day intervals to lure the Armenian surface-to-air defense. Their ruse worked both times. Is this a sign of a lack of learning on the part of the Armenian soldiers, or a failure to transmit instructions?

Failures can perhaps come from Command or intelligence services. Command echelons may have been neutralized by targeted strikes or by jamming communications. Although data is lacking on this subject, the Azeri R-934 jamming stations – dedicated to the disruption of radio exchanges – are probably active. A structural failure of the Armenian aeronautical intelligence services is also possible. Probably with limited human resources, it could have been overwhelmed and thereby unable to properly inform all echelons of the forces.

B) Lessons on air warfare

The shelling suffered by the Armenian forces is accomplished with new weaponry. In the long run, the security of infantrymen and ground bases could be more precarious in the face of these new perils from the air. No military power today is capable of saturating its front line with multi-laye-

14."Some Lessons on the Nagorno-Karabakh War", CAST-BMPD, February 2, 2021, https://bmpd.livejournal.com/4249202.html#cutid1

red surface-to-air systems. The answers to these challenges are organized around two themes: what is the place of combat aircraft in this new framework and how can surface-to-air defense be redesigned?

(RR) The various wrecks of Azeri Harop drones have an antipersonnel charge

With the increased use of drones, some countries are actually questioning the value of maintaining manned combat aircraft. The debates in Mexico, Switzerland, Bulgaria, and even Armenia over the purchase of Su-30SM fighters, before the war, illustrate this well. In fact, it seems that the analysis of the Karabakh confrontations pleads for a better division of labor between types of air asset. The more powerful and versatile fighter aircraft have a higher agility or survivability than drones due to their performance. In addition, they have a much heavier strike force, thanks to the more powerful and varied ammunition they carry. In this respect, aircraft remain irreplaceable in the context of high-intensity air conflicts, which is not the case in the Karabakh war. While drones excelled in gradually damaging Yerevan's military assets, they could not hold off a rapid breakthrough. The Azeris needed more than six weeks to take 50 km of lines held by Armenia.

However, the presence of fighter aircraft will not prevent us from rethinking the surface-to-air architecture. Certainly, fighter aircraft can play a significant role in the fight against drones. The combination of electronic scanning radar and modern air-to-air missiles offers real opportunities for interceptors against this type of target. Two limitations must be emphasized, however. The cost of each air-to-air weapon is very high, so that it will soon become ruinous to systematically counter inexpensive drones using sophisticated missiles. In addition, the weak signatures returned by gliding bombs and other suicide drones can complicate the success of interception.

In any case, the problem is much more extensive than this. It is likely, for example, that Azerbaijan, like many Western powers, would have been hard-pressed to respond to attacks by drones and guided rockets, since solutions are so lacking. The best existing equipment today is Russian – SA-22/*Pantsir* and SA-15/Tor – or Chinese, with the HQ17. Their munitions are remotely controlled and cheap, since the electronics involve only a handful of servo-controls, a proximity fuse and a few receivers.

Although a medium-range surface-to-air segment based on Western missiles featuring effective active self-guiding and high maneuverability does exist, it is only supplemented by very short-range surface-to-air missiles (about 3.5 km) of the *Stinger* or *Mistral* type. In fact, there is a capability gap

between very short-range and medium-range systems, which can be exploited by a whole family of UAVs, currently in service or under development. In Europe in general, and in France in particular, there are still opportunities to revive short-range surface-to-air systems. These systems require radars, a control interface and infrared optics to operate. Domestic manufacturers know how to produce such units. However, there are constraints. The needs are urgent and the operational culture of Western air forces does not always encourage this type of solution.

The need is there, and the market exists, which could limit the cost of developing such systems. Many countries would undoubtedly like to buy French or European equipment for geopolitical reasons, and avoid depending on Russian or Chinese arms dealers.

Finally, beyond the choices made to combat drones in the sky, this conflict has once again highlighted the importance of air superiority in achieving victory on the battlefield. The Azeri forces advance is successful when they are able to exploit the third dimension and bomb the Armenian forces that faced them. Had the Armenians been able to compete for control of the skies and deny it to Azeri forces, the outcome of the conflict would likely have been different.

Reflections on the ethics of air warfare

Lieutenant-Colonel Florian Morilhat

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By its very nature, the military is intimately affected by ethical questioning. The gravity of the issues at stake and the inevitable consequences of decisions often taken in a hurry impose a reflection from the policy-maker and the military commander down to the ordinary soldier. As proof that this subject is being taken into account at the highest level in France, the Minister of the Armed Forces, Florence Parly, launched the creation of a Defense Ethics Committee on January 10, 2020, reminding us that "*ethics is at the very foundation of the military's raison d'être*"[1]. After the life and health sciences in 1983 and digital technology in 2019, it is now Defense that has a specific forum to address today the questions that France will no longer have time to ask tomorrow.

The minister had set two mandates for the year 2020. The first was on "the super soldier" and the opinion of the Defense Ethics Committee, submitted to the Minister in September, was published in early December 2020. On this occasion, Florence Parly mentioned the unprecedented questions that new technologies inevitably raise. In the same vein, the second study entrusted to the committee concerned "autonomy in lethal weapon systems". Its conclusions have still not been made public at the time of writing, which is no doubt proof of the sensitivity of this subject.

However, the direction chosen by France and its strategic competitors in the autonomization of their weapon systems will determine the future of armed conflicts, particularly in the third dimension. The combination of the shrinking space-time framework of military confrontations, resulting from

1. F. Parly, *Launch of the Defense Ethics Committee* [Speech], Paris, January 10, 2020.

factors as varied as hyper-velocity or the military use of space, for example, and the information overload induced by the digital revolution, will undoubtedly give a major operational advantage, if not a decisive one, to the military structure that will have succeeded in autonomizing its aerial weapon systems in a controlled manner.

So why continue to think about these questions if the outcome seems to be a foregone conclusion? Precisely because these concepts, however difficult and complex, do not only concern the experts who handle them. Beyond the engineers who design them or the military personnel who will implement them, future weapons systems will engage society as a whole by calling into question its fundamental values. More broadly, this questioning is part of the inexorable dilemma facing any political system: how to guarantee its survival without denying its principles? In a liberal democracy, the maintenance of operational superiority cannot be considered at the pure and simple expense of respect for human life, which is by definition at the top of its scale of values. In this respect, without presuming the orientations that will be retained or even proposed, France, to its credit, refuses at least not to question itself.

On the subject of empowering lethal weapons systems, the choice is first to accept whether or not to free oneself from a final human control before any lethal action. To take the most extreme example, will long distance UAV's be able to open fire on a target designated by a facial recognition system, which would take over during an ephemeral time window, without a human operator authorizing the shot or even validating the target? In fact, the French government has already declared to renounce the use of Autonomous Lethal Weapon Systems (ALWS), at least to fully autonomous systems. On April 5, 2019, on the Saclay campus, the Minister of the Armed Forces stated bluntly that "*France refuses to entrust the decision of life or death to a machine that would act in a fully autonomous way and escape any human control. Whatever the degree of automation, or even autonomy of our current and future weapons systems, they will remain subordinate to human command*"[2]. So what room to maneuver is left ? Quite simply, to decide exactly how much autonomy to give to lethal systems, with the aim of maximizing their operational efficiency while keeping humans at the heart of the decision-making process.

At first glance, these technical questions may seem far removed from those that air power has had to face up to now. However, the ethical questioning linked to air power has appeared since its origin, with the Italian bombing of Turkish troops in Cyrenaica in November 1911. Patrick Facon notes that at the time, this new capacity was vilified, considered as a breach of the laws of war against the military and the laws of humanity against

2. F. Parly, *Artificial Intelligence and Defense* [Speech], Saclay, April 5, 2019.

civilians[3]. The anticipatory literature of the end of the 19th century and the beginning of the 20th century fed the fear generated by a destructive potential that is difficult to define. The law was not to be of any help since only a few attempts to regulate aerial warfare were to intervene, first between the Franco-Prussian war of 1870 and the First World War, then again during the interim between the two World Wars, without any real legal scope. The trauma of the strategic bombings of the Second World War, whose peak was undoubtedly reached with the nuclear strikes on Hiroshima and Nagasaki, relaunched the question of what is acceptable or not in terms of air warfare. If, moreover, air power has been from the outset the focus of debates on the morality of military action, it is not because of reconnaissance, fighter or transport aircraft, but because of the original focus on bombing by its theorists. Even though aerial bombardment is only responsible for a minority of the victims of conflicts, contrary to conventional portrayals. Of the one hundred and ten million victims of the conflicts of the first seven decades of the twentieth century, less than two million would be due to air strikes, that is, less than 2%[4].

Beyond the numerous preconceived ideas, when one seriously tries to apprehend the ethical stakes of air warfare, one quickly notices that the traditional framework of the ethics of war does not offer sufficient precision. A specific ethics linked to the characteristics of air power seems to have to emerge. It manifests itself both through the way in which air weapons have transformed the relationship of the political decision-maker to war and through the dilemmas that their use does not fail to bring to light.

From the ethics of war to the ethics of air warfare

To better understand these notions, a few theoretical reminders are necessary. More commonly known as "ethics", from the Greek term *ethos* (way of being), moral philosophy is divided into three branches: fundamental ethics or meta-ethics (what is good and evil?), morality in itself with the domain of norms (what should we do or not do?) and all the normative ethics applied to particular domains, professional for example. Military ethics, in general, and the ethics of aerial warfare, in particular, are unquestionably applied ethics. Within normative ethics, that which prescribes and therefore judges, we distinguish three large families which all concern the military. Deontology, of Kantian inspiration, is the domain of norms, obligations and absolute prohibitions. It is a sort of code of conduct requiring the respect of universal rules of behavior, whatever the expected consequences of an action. Consequentialism, on the other hand, judges an action according to its foreseeable consequences at the time it is committed, seeking the best possible

3. P. Facon, *Le bombardement stratégique*. Monaco, Éditions du Rocher, 1996.
4. G. Elliot, *Twentieth Century Book of the Dead*. Londres, Penguin Books Ltd, 1973.

results for the community. Finally, virtue ethics, inherited from Aristotelian thought, focuses on the person and advocates the perfection of the human being as a virtuous moral agent. From the coexistence of these different families arise moral dilemmas. The antinomy between deontologism, that is to say, an ethics of conviction, and consequentialism, that is to say, an ethics of responsibility, according to the distinction made by Max Weber, leads him to consider them as "*two totally different and irreducibly opposed maxims*[5]". The difficulty lies in avoiding the temptation, too simplistic, to arbitrarily give precedence to one over the other, like Machiavelli's famous adage: "*if the fact accuses him, the result excuses him*".

Ethical questions arise when no rational path can be traced in reference to a theory. Ethics represents the intellectual and personal path that passes a decision through the sieve of its values, with a view to reaching an ultimate objective, which philosophers call the sovereign good: beatitude for Spinoza, pleasure for Epicurus or peace according to Pascal. It is therefore consubstantial with the decision and its public expression, political action, of which war is a particular case, if we are to believe Clausewitz' formula. Paradoxically perhaps, the gravity of the matter makes ethical questioning even more precious and indispensable.

So how can we overcome the apparent paradox of the ethics of war? War is actually far from being a simple, irrational and random outburst of violence. On the contrary, it is the result of a perpetual reasoning, to paraphrase André Beauffre, of a dialectic between two opposing wills. But it is precisely morality that allows us to distinguish violence, which is unjust, from force.

At the "higher" level, in the theory of international relations, the debate is lively. Some radical realists consider that morality has no place in international relations, while others believe that it is the consequences of actions that are important (this would be Weber's ethics of responsibility). The idealists, of Kantian obedience, defend an ethics of conviction by giving priority to the accomplishment of a duty over the result of actions.

On a military scale, the moral dilemma of war is exacerbated by the need to win. As Michael Walzer reminds us, the choices are "*difficult and painful*" and can be summed up as "*the dilemma between winning and fighting well*[6]." First, there is the obvious problem of reciprocity. It is tempting to refuse to impose constraints on oneself when the adversary does not restrain his action. In the war waged by liberal democracies against terrorism, we find this opposition between a deontological logic that requires democracies to fight

5. M. Weber, *Le savant et le politique*. Paris, 10x18, 2002.

6. M. Walzer, *Guerres justes et injustes : Argumentation morale avec exemples historiques*. Paris, Gallimard, Paris, 2006.

well and a consequentialist logic, according to which the end justifies the means, and which authorizes the use of terror by terrorists. Thus, in the face of the threat, can a state accept to compromise some of its most fundamental values? How, wonders Stephen Garrett about the Allied bombing of the Axis powers, can we face the challenge of the basic values of civilization without flouting these same values by trying to defend them[7]? There is a good chance that a victory obtained outside of any ethical framework would exacerbate resentments incompatible with the establishment of a lasting peace.

In any case, if war is horrible by nature, it is obvious that it would be even more horrible without ethics. Limiting the frequency and destructiveness of war seems to be in the interest of every human being and this is the goal of the famous just war theory. This normative ethics, which appeared in the West at the end of Antiquity and was built up over the centuries, has been adapted to the modern era by Michael Walzer. It divides war into three main areas: *jus ad bellum* governs the use of war, *jus in bello* governs the conduct of war and *jus post bellum* governs the transition to and return of peace[8]. For the *jus ad bellum*, which concerns the political decision-maker, the principle is simple and clearly established in international law: States must refrain from resorting to force; this is known as *jus contra bellum*[9]. As for the *jus in bello*, which concerns the military combatant, this time it is a question of limiting the suffering and horrors of war[10].

These first two aspects are theoretically independent; in reality, they are inevitably linked. If the war is just, the soldier must adopt an exemplary behavior worthy of his country and his cause; if it is unjust, he must impose it on himself to restore his country's image. The ethical scandals triggered by the behavior of some Western soldiers, even though their country is most often engaged in conflicts considered legitimate, weaken this legitimacy. National public opinion then disassociates itself from the intervention, resulting in a disaster as in Algeria or Vietnam.

Ethics and law are irremediably intertwined. Ethics precedes the law, inspires it, shapes it and the latter, in return, confronts ethics with reality, sometimes influencing it. They sometimes come into conflict, when the law is morally reprehensible, such as the deportation laws of the Vichy government; it can then be ethical to break the law. For liberal democracies, however, in the field of international relations in general, as in the particular case of armed

7. S. A. Garrett, *Ethics and Airpower in World War II: The British Bombing of German Cities*. New-York, St. Martin's Press, 1993.

8. To make matters more complex, each of these areas includes both positive law and moral norms.

9. However, three exceptions exist in international law: UNSC authorization, individual self-defense, collective self-defense (intervention by invitation).

10. The *jus post bellum* concerns air power only at the margin, so it will be deliberately neglected here.

conflicts, respect for the law (national and international) has the value of a norm, even a postulate. International humanitarian law is, in a way, the legal declension of the *jus in bello* of the just war theory. But international law does not do everything. It regulates, frames, punishes when it can. But it is precisely when it reaches its limits that ethics comes into play and the articulation between legitimacy and legality is interesting. As Marc Guillaume points out, international legality is there to frame the use of legitimate violence[11]. But in the face of a law that *"hesitates between the framing of war and its prohibition*[12]", through the modern opposition between the classical use of force and the humanitarian conception of war, the recourse to ethics takes on its full importance.

In the field that interests us here, that of air warfare, ethics is all the more important because the palliative recourse to law is not possible. Indeed, as strange as it may seem, there is no real law of aerial warfare[13]. It is rather subordinated to the law of war on land, whose principles are of general application. In positive law, only the declarations adopted at the two International Peace Conferences held in The Hague in 1899 and 1907 appear, which forbade "*the launching of projectiles and explosives from balloons or by other similar new means*[14]", and, more generally, "*the attacking or bombing, by whatever means, of towns, villages, dwellings or buildings which are not defended*"[15]. While it is interesting to mention the existence of a Manual of International Law applicable to air and missile warfare[16], drafted by a group of experts in Bern in 2009, following the example of the San Remo Manual for war at sea, it remains little known and without any real normative scope.

Moreover, the characteristics of air power, inherited from the environment in which it evolves, make it a very particular power and differentiate it from its land and naval counterparts. Its high lethality, its lightning speed, its ubiquity, as well as its technological and political dimensions, all serve to justify that we speak of the ethics of air warfare and of the strategy of air warfare. From the political leader to the crew member, in the field of *jus*

11. M. Guillaume, "Legitimacy and Legality of Military Action", *Inflexions*, n°36, 2017/3, p. 67 - 72.

12. J.-V. Holeindre, "Les deux guerres justes. L'éthique de la guerre face aux évolutions récentes de la conflictualité internationale", *Raisons politiques*, n°45, 2012/1, p. 81 - 101.

13. To deepen this subject, see for example P. Dupont, "Les opérations aériennes face au droit international", *Revue Française de Droit Aérien et Spatial*, n°292, 2019/4, p. 453 - 479.

14. *Declaration on the prohibition of the launching of projectiles and explosives from balloons or by other similar new means*, signed at The Hague on 29 July 1899.

15. Article 25 of the Annex *Regulations Respecting the Laws and Customs of War on Land* to the *Convention (IV) Respecting the Laws and Customs of War on Land*, signed at The Hague on 18 October 1907.

16. *Manual on International Law Applicable to Air and Missile Warfare,* Office for the Coordination of Humanitarian Affairs Relief https://reliefweb.int/sites/reliefweb.int/files/resources/8B2E-79FC145BFB3D492576E00021ED34-HPCR-may2009.pdf

ad bellum as in that of *jus in bello*, ethics is a guide without which air power would be an uncontrollable monster.

Air warfare in the jus ad bellum: a weapon that has transformed the way war is waged

Since its appearance, the air weapon has not escaped the judgment of the followers of the "just" war, while imposing an adaptation of this theory to the characteristics of this new form of wielding power. The traditional criteria of *jus ad bellum* (such as last resort or proportionality, for example) and *jus in bello* (such as discrimination between combatants and non-combatants or the prohibition of reprisals), naturally continue to apply. In these two aspects, however, air warfare differs from traditional warfare.

As the final step before open confrontation, air power can help contain the explosion of violence. On the one hand, history has demonstrated the possibility of using air power below the threshold of armed conflict. The American U-2 reconnaissance plane shot down on May 1st, 1960 in Soviet airspace, like the Turkish F-4 Phantom fighter shot down by the Syrian regime in 2012, have the common characteristic of not having led to the invocation of a violation of Article 2§4 of the United Nations Charter, the prohibition of the use of force. On the other hand, air power can be used in a dissuasive manner (by preventing, through the threat of force, an adversary from acting) or in a coercive manner (by seeking the cessation by this adversary of an action that he is already committing, through the limited use of force). The dissuasive effect of air power (even conventional) has been perceived and theorized since its origin. The Wright brothers, for example, thought at the very beginning of the 20th century that no government would risk starting a war, given the extent of the devastation that aircraft would soon be able to inflict on the population[17]. The immediate corollary of the power of the air weapon, envisaged from the outset, is that if a war were to be unleashed despite its dissuasive effect, air power would guarantee a rapid outcome with a relatively low loss of life. This is the cynical - but not inaccurate - paradox defended by the prophets of airpower during the inter-war period: the use of extreme means of destruction out of humanitarian concern. One moves from a deontological ethics (with the limitation of bombing at the Hague conferences) to a consequentialist ethic. As for the coercive effect of air power, we can cite the example of the one-off strikes against the Syrian regime of Bashar al-Assad, carried out following its use of chemical weapons against its population. According to the monitoring carried out by the Arms Control Association, the frequency of chemical weapons use in Syria seems to have decreased since then, without however stopping for good.

17. F. C. Kelly, "The Wright Brothers' worst brush off", *Air Force Magazine*, n°36, 1953/12, p. 38.

A political weapon *par excellence,* air power has often been used almost exclusively in recent conflicts, as witnessed by Operations Desert Storm (1991, in Iraq), Deliberate Force (1995, in Bosnia-Herzegovina), Allied Force (1999, in Kosovo), Unified Protector (2011, in Libya) or Inherent Resolve (since 2014 in Syria and Iraq). Air power today offers the prospect of military victory without causing large-scale destruction and while limiting friendly casualties. Perhaps most importantly, it allows for increased lethality through the combination of large firepower and extreme precision. Therefore, given the potential magnitude of its effects and the growing importance of the legal framework in Western democracies, it is intimately linked to the political level, which will have to directly assume the consequences. It is for this reason, among others, that the political power regularly tends to monopolize the supervision of air operations at the central level. A *Douhetian* doctrine of absolute war - which air power would allow - is not conceivable today, as it is no longer politically acceptable. The use of nuclear weapons remains a notable exception, but it is part of the supreme emergency theorized by Michaël Walzer in his modernized view of "just war" thinking.

The corollary of the political appetite for air power is undoubtedly a somewhat too easy recourse to it, which raises the question of the legitimacy of a legally questionable action. Operation Allied Force in Kosovo, traditionally considered by its advocates to be illegal but legitimate, is perhaps the best example. The use of air power also seems appropriate in the context of the particularly controversial concept of preventive self-defence. While preventive war is illegal under international law and illegitimate under just war theory (it directly contravenes the principle of proportionality), Walzer nonetheless endorses the Israeli surprise offensive of the Six-Day War as "*a clear case of legitimate anticipation"*[18]. And, as is well known, air power played a decisive role in this attack. At dawn on June 5, the air offensive destroyed three hundred Egyptian, eighty Syrian, thirty Jordanian and twelve Iraqi aircraft in less than three hours, and also neutralized nineteen air bases in Egypt and one each in Syria, Jordan and Iraq. Another morally reprehensible aspect of the air weapon is the use by some armies of extraterritorial[19] targeting. The assassination of the Iranian Major-General Qassem Soleimani on January 3, 2020, which received a great deal of media attention, casts opprobrium on armed drones, of which this is only one very specific use. However, from the point of view of the *jus ad bellum,* an analysis of the facts (*ex post*) seems to vindicate the American strategy of extreme firmness, then de-escalation, vis-à-vis Iran. The other side of the legitimacy question must

18. M. Walzer, *op. cit*.

19. It should be noted that targeted assassinations do not exclusively take the form of air strikes, as witnessed by the poisoning or attempted poisoning of Russian nationals or the spectacular assassination of Iranian physicist Mohsen Fakhrizadeh in November 2020 by remote-controlled machine gun.

be approached through the prism of *jus in bello*, and refers to Michael Walzer's famous naked soldier[20]: even if the rules of war do not prohibit killing a soldier in a car, who is not engaged in combat activity, can one legitimately strike at any time, at the very moment when the target least expects it? A realist or consequentialist perspective will see no objection to this, invoking immediately and without possible dispute, the sacrosanct principle of military necessity. Let us recall in this regard that President Trump, a few hours after the air strike in question, declared that he had acted to stop a war and not to start one.

But is air power really capable of containing the scourge of war? To the great displeasure of the prophets of strategic bombing who predicted the psychological collapse of populations, this has never really happened during the various confrontations, despite the importance of the resources engaged and the sacrifices made. Conversely, the role of air power in the resolution of conflicts is, wrongly, systematically relativized. The influence of aviation in the First World War is, for example, completely ignored, while the impact of strategic bombing in the Second World War on the conclusion of hostilities is generally denied. However, Albert Speer, Minister of Armaments of the Third Reich, went so far as to assert that strategic bombing of the Reich could have led Germany to surrender[21]. Finally, is it necessary to recall that the air weapon remains largely preferable to other solutions, even though they are considered more moral? In the case of the First Gulf War, about a thousand civilians perished during the six-week Desert Storm air campaign, while according to UNICEF and WHO, no less than one million Iraqi civilians died as a result of UN sanctions between 1990 and 2002 (55% of whom were children under the age of five[22]). That is a ratio of one to ten "in favor of" the air weapon. Not to mention that the real effectiveness of these sanctions remains highly questionable, as evidenced by the American decision to go back to war against Iraq in early 2003. It therefore seems imperative to go beyond the overly simple distinction between armed intervention and non-military measures (within the meaning of Articles 41 and 42 of the United Nations Charter), the former being more effective and, above all, less costly for the civilian population.

20. M. Walzer, *op. cit*.

21. P. Facon, *op. cit*. Adam Tooze's more recent work on the Nazi economy corroborates these assertions: A. Tooze, *The Wage of Destruction: Formation and Ruin of the Nazi Economy*. Paris, Les Belles Lettres, 2012.

22. P. S. Meilinger, "More bogus charges against Airpower", *Air Force Magazine*, n°85, 2002/10, p. 52 - 57.

Air warfare in the jus in bello: a weapon that exacerbates ethical dilemmas in the conduct of hostilities

From the outset, air power was positioned as a weapon of terror (according to Ader and Douhet, for example), even if the effects of the first bombings of civilians, on Paris and London during the First World War, were more psychological than destructive. Reviewing the atrocities of the First World War in his major work *Il dominio dell'aria*, Giulio Douhet advocated bombing opposing cities, without discrimination, to undermine the morale of the enemy and thus hasten the end of the war. Later, nuclear bombing reincarnated the terror inflicted from the sky. To date, the only atomic weapons used in wartime have been fired from an airplane, amplifying the apocalyptic image of the bomber: a single plane and a single bomb for immediate and devastating effects. This is one of the main criticisms of the air weapon: it is inherently perceived as non-discriminatory. If one believes the Prussian general and theorist Carl von Clausewitz (the people are one of the three components forming the *trinity of a state at war*[23]) or the American aviator John Warden (the population is part of the five circles that make up the adversary system[24]), the population is unquestionably one of the stakeholders in a conflict. As Grégoire Chamayou points out, as war becomes "democratized", the targeting of civilians becomes strategically relevant: "*if all citizens participate, in one way or another, in the war effort, it is absurd to target only those who handle weapons and to spare those who, through their daily work, make their use possible*"[25]. The demographic bombings of World War II resulted in the deaths of hundreds of thousands of people. Yet these operations were never prosecuted as war crimes, unlike the iconic German raid on Coventry in November 1940, for example. Here, the interference of *jus ad bellum* with *jus in bello* is striking: the non-discriminatory bombings of the Allies are legitimate, on the basis of consequentialist reasoning (for deontological reasoning at least rejects any non-discrimination, or even any act resulting in casualties), because their cause was just, whereas that of the Germans was not.

The underlying question of targeting the civilian population is really one of military necessity, which is all the more complex because this criterion is largely subjective.

It may be a matter of collateral damage, acceptable when all efforts have been made to avoid such impacts. This is the direct heritage of the "double effect" theorized by Thomas Aquinas, who considers that the moral quality

23. C. von Clausewitz, *De la guerre*. Paris, Editions de minuit, 1955.
24. J. A. Warden, *Strategic Warfare: The Enemy as a System*, unpublished manuscript, Air Command and Staff College, Maxwell AFB, Alabama, 1993.
25. G. Chamayou, *Théorie du drone*. Paris, La Fabrique, 2013

of an act that has two effects is affected by the intentional effect (the bad effect, however, must not be out of proportion to the good). In other words, "*an action is condemnable not because of its consequences in themselves, but because of the intention that presides over it*[26]", which amounts to considering that the end, in this particular case, can justify the means. A concept reinvented in the middle of the 20th Century and designating the victims among non-combatants who are affected during an act of war when they were not the object of the war, collateral damage is today provided for (and regulated) by international humanitarian law. The reduction of collateral damage is a concern that obviously does not apply only to air warfare. However, Pascal Dupont reminds us of the progress that has been made since the Second World War with the aim of reducing the collateral damage of bombing: « *whereas the precision of a bomb's drop was 1,000 meters in the 1940s, it is now between 3 and 30 meters, depending on the type of ammunition and the configuration of its use. Guided weapons, which constituted only 8 to 9 per cent of total munitions during the 1991 Gulf War, reached 70 per cent in Iraq and Afghanistan, and then 100 per cent in Libya, hence the emergence of the concept of "targeted strikes*" »[27]. In other words, to take an edifying comparison, in 1940, one thousand B-17 bombers armed with nine thousand bombs were needed to destroy a target that a single F-117 could destroy with only one of its two bombs in 1991, while reducing the radius of impact around the target from one kilometer to nearly 3 metres[28]. It is useful to specify that the estimation of collateral damage, which is one of the four pillars of targeting, is today systematic before any air strike by Western standards. The air weapon is today the most precise military instrument and therefore, in a way, the most humanitarian. This being said, the risk of collateral damage, although lowered, remains unfortunately inevitable, insofar as a malfunction of the weapon system or human error are always possible or, quite simply, because of the well-known "*fog of war"* formulated by Clausewitz.

At the opposite extreme is the nuclear strike. Michael Walzer takes a strong stance on nuclear strikes when he writes: "*Nuclear weapons shatter "just war" theory. They are the first technical innovations of mankind that we cannot fit within the bounds of our familiar moral universe*"[29]. However, this same author devotes a chapter of *Just and Unjust Wars* to what he calls "*the supreme emergency*", an extreme situation linked to the imminence and nature of a danger and which, according to him, justifies the transgression of the moral prohibitions of war. He considered that Nazism fell within this framework and that the bombing of German cities from May 1940 to the be-

26. C. Nadeau, J. Saada, *Guerre juste, guerre injuste : Histoire, théories et critiques*. Paris, PUF, 2009.
27. P. Dupont, *op. cit*.
28. Circular impact error at 50%.
29. M. Walzer, *op. cit*.

ginning of 1942 was the only solution available to the Allies to try to stem the spread of this "*incarnate evil*". On the other hand, in a very arbitrary manner, he considered that the Japanese "*had never represented the same threat to peace and freedom as the Nazis*" and that the use of atomic weapons against them was therefore not legitimate. But given the imperfection of the other options available to the Allies in 1945, does the ethical dilemma not deserve to be posed in these terms: which treatment is the least inhumane, and therefore the least immoral? A horrific nuclear bombardment of a circumscribed part of the Japanese population or the slow death of the whole country and of the millions of people held under the Japanese yoke by an indefinite extension of the naval blockade ? Wouldn't prolonged torture be immoral when a quick victory would be possible? A deontological (rather idealistic) reasoning naturally rejects the deliberate bombing of hundreds of thousands of civilians, while a consequentialist (and realistic) logic obviously tends to favor a rapid end to the conflict that causes the fewest casualties in total and among the soldiers of one's own military in particular.

Finally, to close this controversy around discrimination, it is enlightening to address the very specific mission of sky policing. The decision to shoot down a civilian airplane in flight, in which there are many passengers around a handful of terrorists, is not insignificant. It is a question, in a particularly constrained timeframe, given the urgency of the situation, of deciding to sacrifice, in a certain way, several hundred passengers to avoid the possibility of less acceptable damage. A reasoning guided by the ethics of conviction would incite not to intervene, while an ethics of responsibility imposes to destroy the plane before it is too late.

But the criticism most regularly made against air power is that it is a departure from the traditional balance of risk between the two adversaries. The underlying dilemma is the dissymmetry, or more precisely the disproportionality, between the low risk taken by the airmen and the extent of the damage inflicted. But what about land or naval artillery, insofar as the ranges of CAESAR artillery guns[30] and LRUs[31] are greater than, respectively, 40 and 80 km, while the French Navy cruise missile can be fired from a frigate sailing more than 1,000 km from its target? It seems rather rational, in any form of combat, to seek to inflict damage while avoiding receiving it oneself. Only air weapons make it possible to exploit this logic, and even to push it to its extremes, with the use of armed drones, which nevertheless crystallizes the criticism. On the subject of armed drones, we should specify that the ethical defect of the asymmetry of risk can be opposed by the ethical benefit of a vector which provides its operators with a degree of certainty about

30. CAmion Equipped with an ARtillery System.
31. Unitary Rocket Launcher.

the future target which is undoubtedly unequalled. Indeed, the observation of several people, almost unlimited in time, of the target before the strike, confers a much better understanding of the situation than that obtained, for example, from a fighter plane with limited flight time constraints between two refuelling operations, or even by special forces in the inevitable confusion of combat during a direct assault.

The mention of drones inevitably raises questions about the place of humans in aerial warfare, which is characterized by a strong technological dimension. While humans remain omnipresent in the implementation of armed drones - it is indeed human operators who determine and pilot their trajectory from a distance, who direct the on-board sensors, who identify the target and carry out the strike from the launch of the bomb to impact – the trivialization of SALA mentioned in the introduction would, on the other hand, raise the question of moral disempowerment (to whom should responsibility for an aerial strike by an autonomous system be attributed?) and that of dehumanization (the autonomous system will never be able to show humanity). Tomorrow, other systems will require new thinking, concomitant with the new challenges. But fundamentally, the humanity of war (in the sense that it is conducted by humans) is precisely what guarantees it an ounce of humanity (in the sense of benevolence towards others). John Boyd, a leading thinker on air power, rightly reminds us that "*machines do not wage war; terrain does not wage war. Men fight wars. You have to get into their brains. That is where battles are won*"[32]. Air warfare, whatever the degree of technology involved, will always remain a dialectic of wills and intelligence, to paraphrase General Vincent Desportes[33].

Thus, air power undeniably involves specific ethical issues, linked to the intrinsic characteristics of air weaponry and the environment in which it evolves. At the heart of these issues are men and women, airmen, necessarily marked by the force they handle and intimately imbued with an ethical identity of their own, which distinguishes them, for better or for worse, from their comrades in other armies: the airman's ethics. But that is another story...

32. J. Boyd, quoted in R. Coram, *Boyd: The Fighter Pilot Who Changed the Art of War*. Boston, Little, Brown & Company, 2002.
33. V. Desportes, "La stratégie en théories", *Politique étrangère*, n°2014/2, 2014, p. 165-178.

The temptation of light combat aircraft

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"What makes the strength of temptation is not the grimace of evil, but the smile of good which is mixed in".

In 2017, the U.S. Air Force (USAF) launched the experimental phase of the light combat aircraft program. The goal was to replace the F-15 and F-16 fighter aircraft for Close Air Support missions in permissive environments alongside the A-10 *Warthogs* before eventually replacing the latter as well. It was also intended to strengthen cooperation with smaller foreign air forces that do not have modern combat aircraft or that were upgrading an existing fleet. The Special Forces Command (USSOCOM) later conducted a similar study for its own needs. After many twists and turns, the U.S. defense budget bill passed in December 2020 clouded the prospects for light combat aircraft development in both the USAF and USSOCOM, cancelling all funding for the program through 2023 and requiring a thorough analysis. Against all odds though, the U.S. Department of Defense (DOD) announced as soon as May 2021 the restart of competition to field a light attack aircraft for the benefit of USSOCOM. The temptation of the advent of a turboprop-powered light fighter remains a persistent one in Washington, dividing those who see it as a way of reducing the pressure to use fighter aircraft in low-intensity conflicts, and those who, on the contrary, see it as a threat to the force structure, considering the resurgence of competition among the great powers.

On the other side of the Atlantic, French fighter aircraft are also heavily deployed, such as in the Sahel and the Levant, where they operate with their flagship multirole aircraft, the *Rafale*, and with the *Mirage 2000*, in conjunction with weaponized Remotely Piloted Aircraft (RPA). The level of this commitment should be seen in the light of the downsizing of the fleet since the end of the Cold War onwards and the concentration on a reduced number of platforms, partly as a result of choosing versatility as a tactical capability. These issues raise several concerns for the French Air Force, including the ability to field enough "ready-for-combat" fighter aircraft (i.e., with all the necessary equipment and weaponry) for high-intensity combat, and the ability to be better prepared for such combat. It ultimately raises the question of fleet differentiation in the Air Force structure.

It is therefore legitimate to wonder about the transposition of the American debate on *Light Combat Aircraft* (LCA) to the French air force model, including the more distant future of the *Future Combat Air System* (FCAS). If "*the smile of good mixed in*" makes the temptation of a propeller-driven aircraft dedicated to fire support missions attractive as a solution to the current challenges, a closer look at the issues highlights "*the grimaces of evil*" and urges us to weigh this option for financial, organizational and conceptual reasons in the face of a worsening strategic environment. For low-intensity conflicts, and considering the French strategic ambition, the Air Force must rely in the short term on the flexibility allowed by the reach, speed and overall responsiveness of jet fighters, combined with the real-time *Intelligence—Targeting—Strike* capability offered by its fleet of weaponized RPA. In the medium term, France and willing European partners could help the G5 Sahel countries structure their combat aviation around the *Super Tucano* light aircraft, in order to promote organic and operational synergies and ease the pressure on French involvement. In the longer term, the arrival of the FCAS could go with a new high/low mix within the force structure: the *New Generation Fighter*, upgraded *Rafale* and remote carriers would then be used on a priority basis to operate in contact with the enemy in high-intensity conflicts; a new, lighter and less expensive single engine jet could be developed in parallel to carry out less-demanding missions, over a broader spectrum than fire support.

Turbulence in the American program

Background

The idea of a light combat aircraft was born out of the USAF's need to have an air force adapted to counter-insurgency conflicts and to unravel the complexities resulting from a strong airborne commitment concentrated on a reduced number of aircraft (*High Demand / Low Density assets*).

The project underwent many twists and turns across the Atlantic. First, in 2017, the USAF embarked on the OA-X program to study the off-the-shelf acquisition of light combat aircraft specialized in fire support, surveillance and armed reconnaissance missions (*Light Attack/Armed Reconnaissance - LAAR*). The project then continued as the *Light Air Support*[1] program, in which the USAF aimed to acquire up to 300 such aircraft. In early 2018, the USAF selected two models to test at Holloman AFB: The A-29 *Super Tucano* and the AT-6 *Wolverine*, a variant of the T6 Texan II used for aircrew training. Several international partners attended the demonstrations and tests conducted in New Mexico (Canada, Australia, United Arab Emirates, Paraguay).

In the wake of the *Air Force*, the experimentation inspired the special forces, which launched their own light attack aircraft[2] acquisition program in July 2017. The project was then renamed *Armed Overwatch*, with the first five aircraft to be acquired in 2021 for $101 million, with an eventual target of 75 aircraft.

US drivers for light combat aircraft

The U.S. Air Force's 2009 framework document[3] identifies five guiding principles for these aircraft. First, the LCA fleet must be more simple yet robust and cheaper than jet fighters, with low-logistics footprint, naturally leading to the choice of a turboprop. As an example, the cost per flight hour of the Super Tucano is estimated at $2,000, or 1/20th that of an F-16 and 1/60th that of an F-22[4]. Such a turboprop must be capable of operating from the surface to 25,000 feet with an operational speed of about 300 knots. More importantly, it must provide military commanders with increased playtime over a conventional fighter, up to five hours on station. It must also have accurate and responsive direct fire capability, in order to address the need for dynamic targeting. Thus, the gun and laser-guided rockets will remain indispensable weapons. In terms of connectivity, light attack aircraft must be equipped with modern communication systems to support the emergence of *Digital Aided CAS* (Da-CAS) and, more generally, to be in phase with the digitization of the battlefield. Finally, the acquisition strategy must give priority to short development cycles in order to control costs and ensure industrial responsiveness. To do this, off-the-shelf purchases (*Super Tucano*) or the adaptation of an existing training aircraft (AT6) are still two suitable solutions. The second option would also enable synergies to be developed between operational transition schools and LCA-equipped units.

1. Purchase of a small fleet of attack aircraft to train the Afghan Air Force.

2. Program initially known as *Light Attack Support for Special Operations* (LASSO).

3. "Air Combat Command (ACC) Light Attack/Armed Reconnaissance. Request for Information", July 27, 2009. https://www.fbo.gov

4. J. Turner. "The OA-X experiment: is there a future for light attack aircraft?", *Air Force technology*, June 2018. https://www.airforce-technology.com

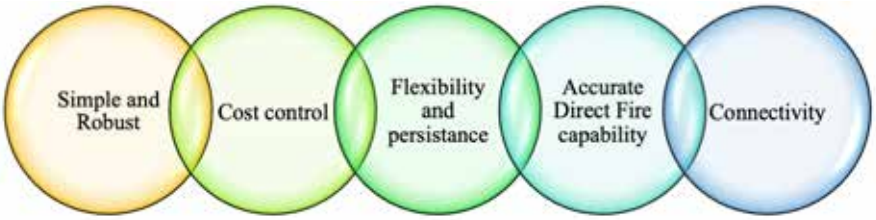

Figure 1: *Characteristics of light fighter aircraft*

Beyond the search for military efficiency in the lower end of the spectrum, the USAF's *Light Air Support* program had two other defining requirements. First, it aimed to bring together partner countries of the United States that do not have conventional fighter aircraft for a specific mission – that of combating violent extremist organizations– and providing an interoperable weapons system for which they would provide support: *light combat aircraft*. For example, the Afghan Army already operates *20 U.S.-supplied and -funded Super Tucano aircraft*. *"We're looking at light attack aircraft through the lens of allies and our partners",* David Goldfein, the previous USAF chief of staff, told members of the Senate Armed Services Committee at the time. "*A big part of the project is to build a common architecture and intelligence sharing network, so that those who would join us would be part of the campaign against terrorist or violent extremist organizations*"[5].

But more importantly, the project was intended to free up resources for the USAF to focus on its core operational readiness in higher-end missions, as General Arnie Bunch explained at the time: "*If we can get light attack aircraft operating in permissive combat environments, we can alleviate the demand on our fourth- and fifth-generation aircraft, so that the crews operating them can train for the high-intensity combat for which these aircraft were designed*"[6]. The introduction of a dedicated fleet, less costly and more adapted to low-intensity conflicts, reflects an effort to implement a new high/low mix of combat aircraft in the force structure.

Both programs seem to have fizzled out, at least for the moment. The USAF has considerably curtailed its initial ambitions, keeping only a few aircraft to prolong testing. Congress dashed the hopes of U.S. Special Forces by refusing to fund the *Armed Overwatch* program during the 2021 budget vote. To justify its decision, the US legislature insisted on the need to conduct a thorough analysis of the survivability of these aircraft in the light of the escalation of threats, as well as the impact the arrival of these aircraft could have on the force structure, employment policy, as well as pilot training and education.

5. *Ibid.*
6. *Ibid.*

The future of light combat aircraft thus appears to be on hold pending the results of additional assessments, and it is difficult to imagine a favorable outcome at a time when the American defense apparatus is focused on preparing for high-intensity conflicts and withdrawing its troops from "never-ending" wars.

The French dilemma of versatility in a context of extensive military involvement.

The setbacks to the program have not, however, eliminated the main American motivation: to ease the pressure on the use of fighter jet, which are heavily involved in low-intensity operations, in order to free up human and material resources in view of the anticipated resurgence of competition between great powers. This motivation is mirrored in France, which is facing the same difficulties, albeit on its own scale.

Since the arrival of the *Rafale* in 2005, France has chosen versatility and high technological value over aircraft specialization, whereas specialization had previously been the objective with the *Mirage* series. This choice has enabled the French armed forces to upgrade their fighter aircraft and streamline their fleets for greater efficiency. But this effort went hand in hand with the reduction of the fighter fleet by half since 1991[7]. Versatility has therefore resulted in a double phenomenon of contraction and concentration of the fleet on a reduced number of very modern and very capable aircraft.

At the same time, thirty years of intense conflicts followed the Cold War, during which time French airpower was widely used, consistently achieving clear superiority over the enemy. The French Air Force was then relentlessly engaged in these low- or medium-intensity conflicts, and it continues to be so today in the Sahel and the Levant regions[8]. The choice of versatility, coupled with a strong commitment of a limited number of aircraft, has placed combat aviation under great pressure, and the armed forces are faced with a dilemma when confronted with the possible resurgence of great power competition. This dilemma relates to three areas of concern: force structure, training for high-intensity combat and controlling costs on operations.

Versatile does not mean ubiquitous

The first point of emphasis concerns force structure. The choice of versatility has in fact been used as a pretext to streamline fleets, partially neglecting the needs and constraints of force structure[9]. However, versatile does not mean ubiquitous, especially when facing simultaneous conflicts. The more fighter

7. The Air Force and Space Ministry had 450 aircraft in 1990, whereas the 2030 operational target is 185 multirole aircraft.

8. Even if the Russian presence in eastern Syria makes the situation more complex and ambiguous, with a partial dispute over airspace, the Levant theater is still a theater reflecting the lower end of the conflict spectrum.

9. J. Henrotin « Des armes à tout faire ? Modularité et polyvalence des équipements militaires », Focus stratégique, n° 54, October 2014.

aircraft are employed in selected low-intensity overseas operations, the less available they are to create a favourable balance of power in the event of the resurgence of wars that are more violent. However, geopolitical upheavals, the hardening of operational and strategic environments, and the ever-growing contest of multidomain superiority, now make the hypothesis of a direct confrontation between great powers credible. The *Armée de l'air et de l'Espace* must therefore ensure that they are ready to scale up to this demanding future and to muster a sufficient number of "ready-for-combat" aircraft in order to avoid a tactical setback when faced with an enemy that seizes the initiative.

A deceptive operational readiness

The second point of emphasis concerns operational readiness, which is hampered by a number of flying hours below NATO standards, insufficient to hone the skills of full-spectrum war, especially the high end when faced with a peer-competitor. As Joseph Henrotin points out, "*no equipment, even if it is designed to do so, is versatile if its users are not*"[10]. However, current operations consume the lion's share (50%) of the annual flight hours allotted to French pilots for a very specific type of mission thus creating a deceptive impression of operational readiness.[11]. In fact, the remaining flight hours are not sufficient to fully master missions involving high-intensity combat such as first entry, counter-air in demanding environment, deep strikes or all-weather low-level penetration.

The performance of versatility in low intensity conflicts

The last point concerns controlling the cost of operations. For example, in 2015, reserve colonel and historian Michel Goya estimated the cost-effectiveness of operations Chammal and Barkhane at "*one million euros per neutralized jihadist*", calling into question the effectiveness of joint operational strategy and tactical choices[12]. While the figure put forward remains debatable and is a caricature taken out of context, Colonel Goya does have the merit of reminding us that versatility can be costly in low-intensity conflicts, especially when it is based on high-end technological solutions[13]. In contrast, the ambition of the LCA concept is to reduce acquisition costs to $10 millions per aircraft and activity costs to $2,000 per flight hour. In comparison, the cost of a *Rafale* is estimated at 80 million euros for an operating cost per flight hour of around 17,000 euros, i.e., 10 times higher for acquisition and scheduled maintenance of equipment.

10. *Ibid*
11. D. Pappalardo, « Le Levant » in J.B. Jeangène-Vilmer and J. Fernandez (dir), *Les opérations extérieures de la France*. Paris, CNRS éditions, 2020, p.285-292.
12. M. Goya. « Un million d'euros le djihadiste », Blog La voie de l'épée, 24 September 2016. https://lavoiedelepee.blogspot.com
13. *Ibid.*

In this context, trading the concept of versatility for increased differentiation in the use of combat aircraft is tempting. At first glance, the adoption of a fleet of propeller-driven light combat aircraft, less expensive and more adapted to low-intensity conflicts, could be a way to respond to the difficulties of the *Armée de l'air et de l'Espace*: resources that can be mobilized for high-intensity combat would increase (*readiness*); *Rafale* crews could devote a more significant part of their air activity to high-intensity combat, for which the aircraft was primarily designed (*preparedness*); the cost of operations could be controlled below a more sustainable threshold, freeing up financial resources for activity or capability improvements (*sustainability*).

The *grimace* behind the *smile* of temptation

To ignore or disregard the benefits of a propeller-driven light combat aircraft for the *Armée de l'air et de l'Espace* would be both inexcusably thoughtless and dangerously reckless. However, a closer look at the issue reveals that the light combat aircraft concept also faces major difficulties in the French context.

No actual savings to achieve the same result

This solution is in fact more costly at the same level of ambition. It sacrifices concentration allowed by the reach and responsiveness offered by fighters in the hope of regaining flexibility at the local level. By its very nature, it only partially responds to the "tyranny of distance", imposed by intra- and extra-theater sprawl. Thus, in order to maintain a close air support capability over a wide theater, it would be necessary to multiply the number of forward bases along with the logistics, the resources required to ensure defense, support assets, and human resources.

Let's take the example of Barkhane and limit ourselves to the following areas of interest: the Madama and Toumo passes in northern Niger and Chad; the Aïr massif in Niger, the central Niger delta in Mali, the Adrar des Ifoghas in northern Mali and the Lake Chad region. For *Barkhane*, consider a situation where the fighter component is armed with two expeditionary wings in Niamey and N'Djamena, allowing the force to cover the entire theater in a responsive manner. To carry out the same missions, five LCA units would be needed, but they would not be able to deal with contingencies and unforeseen events in the region (such as a hostage crisis in Timbuktu or a conflict in the Central African Republic).

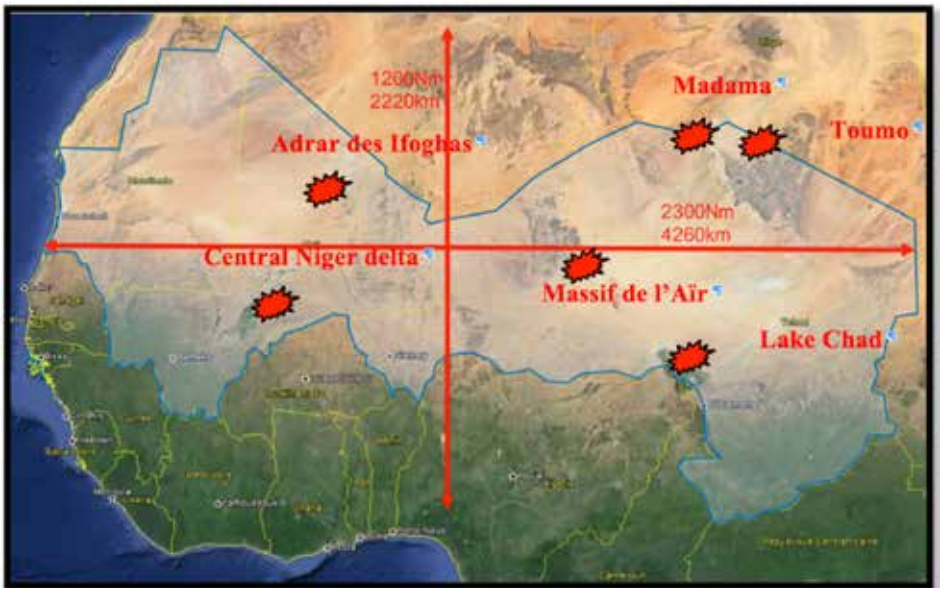

Figure 2: Scope of the *Barkhane* operation

Therefore, the "tyranny of distance" sheds new light on the estimate that LCA are ten times cheaper in terms of acquisition and maintenance costs, especially at the same level of ambition. First of all, the human and logistical costs associated with the multiplication of deployment sites should not be ignored in the equation, particularly in view of the difficulties induced by the mobility function (number of transport aircraft available for intra-theater logistic) and that of the protection and defense function. In terms of deployment, these light combat aircraft, even if they are "rustic", cannot be accommodated out of nowhere, but must be supported by the creation of Forward Air Bases (*Bases Aériennes Projetées*).

In addition to these operational and logistical requirements, there would inevitably be the organic and technical costs, with the creation and maintenance of operational and maintenance pools that are adapted and specialized (need for a training school to ensure rotations). The application of the methodological guide for calculating operational contracts thus allows us to estimate an increase of about 80 pilots and 15 aircraft in the Air Force fleet volume for the crisis management mission alone, restricted to the Sahel theater (Table 1).

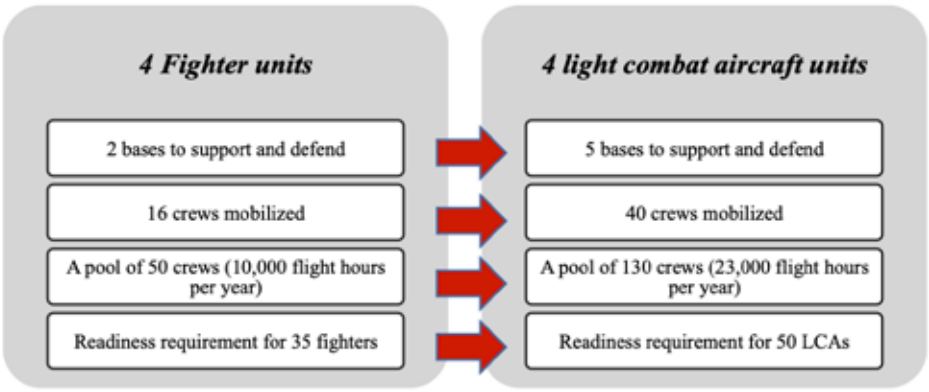

Table 1: Impact of LCA on crisis management operational contract limited to Sahel

Strategic ambition and the risk of downgrading

Moreover, the quality and quantity of our aircraft ultimately determine the level of our political and operational assertions, which, when the last budgetary law was passed, stood at 185 multirole combat aircraft. Any commitment to a propeller-driven light combat aircraft concept must not be carried out to the detriment of this capability, otherwise we will have to downscale our ambitions in terms of major engagements and deterrence.

Macroscopically, the United States, for example, has budgeted $2 billions for the *Light Air Support* program, which is more than the total cost for developing the F4 *Rafale* standard (excluding *retrofit* costs). With the respective differences having been considered, the acquisition of such a fleet of light combat aircraft would inevitably weaken the force structure and the necessary upgrading of the combat fleet, at a time when the Air Force is engaged in the build-up of FCAS to hedge against *Anti-Access/Area Denial (A2AD)* postures.

The prospect of a heightened surface-to-air threat

Lastly, the LCA concept is based on a risky strategic assumption: that air superiority will remain acquired even in this type of conflicts. However, the profusion and proliferation of surface-to-air systems increases the vulnerability of these slow, unarmoured aircraft. In this respect, the contestation of air domain is already perceptible in the Levant, where the notion Close Air Support in denied environment is re-emerging. This is why the *Mirage 2000* had to be replaced by the *Rafale* in the Levant from 2016 onwards, where the Russian presence complicated the work of the coalition. The Rafale had indispensable air-to-air self-protection against intimidating Russian aircraft, as well as a more comprehensive array of air-to-ground solutions[14].

14. D. Pappalardo, « Le Levant » in J.B. Jeangène-Vilmer and J. Fernandez, *op. cit*.

More generally, the presence of surface-to-air threats, even at short range, requires adapted flight profiles and tactics. A combat helicopter – even one that is vulnerable to light infantry weapons – can always hide in the local terrain and activate its self-protection means in close combat. A fighter aircraft can rely on its speed and electronic warfare capabilities to defeat this type of threat, or on its GNSS-guided[15] *stand-off* weapons to stay out of their interception range. On the other hand, while light combat aircraft must be able to operate at the same altitudes as a traditional fighter, they cannot benefit from their speed, EW capabilities or stand-off munitions. Worse, the effective use of their direct fire weapons (cannon and rockets) would require them to descend into the lethal envelope of enemy ground-to-air systems, including light infantry weapons.

In short, there is no indication that tomorrow's air support missions will be conducted in the operational comfort of today. On the contrary, prospective analysis of current conflicts highlights an ever-increasing constraint on the freedom of movement in the third dimension, combined with a challenge to the use of the electromagnetic spectrum. Therefore, engaging in a propeller-driven light combat aircraft acquisition program would be more in line with "yesterday's war" than "tomorrow's", where salvation will come through the definition of a global air combat system, made up of an interoperable network of manned and unmanned weapons systems, interconnected with each other.

The *extensive* implementation of the light turboprop aircraft concept to meet the needs of the *Armée de l'air et de l'Espace* thus seems to lead us into a threefold financial, organizational and operational dead end. In its current state, it could not constitute a new paradigm on which to base operational crisis management missions, unless the French strategic ambition is reviewed. Far from generating budgetary savings, the risk is, on the contrary, that of wasting resources that are already scarce. This does not mean that the idea should be dismissed. On the contrary, we must continue to reflect on how to adapt the concept to French ambitions and resources within the future force structure.

What force structure to fit what end?

For the foreseeable future, France will have to continue to deal with crisis management missions (the most likely but least demanding) and the return of strategic competition between great powers (the least likely but most dangerous missions). The force structure of the *Armée de l'air et de l'Espace* must make it possible to hone the skills of a full-spectrum war by building the best possible compromise. In the short term, this compromise involves a

15. Global Navigation Satellite System.

combination of fighter jet and armed RPA for crisis management missions. In the medium term, France could propose a propeller-driven light combat aircraft solution, not for its own needs, but to help regional partners like the G5 Sahel countries in developing air support capabilities. In the longer term, the arrival of FCAS should trigger discussion around a new *companion trainer*, which could pave the way for an in-flight refuellable lighter combat jet, in addition to the *New Generation Fighter*, the *Rafale* and remote carriers, which are more specifically designed to operate in contact with the enemy.

The synergy of fighters and RPA in crisis management

To date, the combined use of fighter aircraft and armed MALE[16] RPA is the best possible combination for fulfilling the crisis management missions entrusted to the Air Force: fighters offer reach and global responsiveness over very large areas and great survivability, while RPA, thanks to their persistence and surveillance capabilities, offer local responsiveness over a much more restricted area. Close by when *persistence* is needed and capable of acting without delay *at long distance*, this combination contributes to the implementation of a true chrono-strategy, capable of combining time in all its forms (speed, duration, frequency and opportunity).

First of all, fighter aircraft are adapted to sparse areas, as is the case in the Sahel. The long reach of fighter jets allows them to operate in depth while limiting their footprint to a specific theater, particularly with regard to the political objectives and constraints set for an operation. Their speed makes them relatively ubiquitous, allowing for the rapid concentration of forces when faced with a grouped enemy, or the almost immediate shifting of forces across a huge theater, depending on priorities. Their global responsiveness theater wide allows them to offer in a few hours an initial significant military response capability to a crisis, even at a very long distance. Finally, air power is capable of delivering effects at all levels, from strategic to tactical[17].

In a complementary manner, armed UAVs enable the implementation of a true *Reconnaissance-Strike* capability, offering local responsiveness and optimized time control: in the long term, thanks to the permanence of the system, and in the short term, thanks to the real-time dissemination of information. In 2021, the armament of the *Reaper* Block 5 has thus made it possible to benefit from a wider range of solutions than previous versions, with the firing of dual laser/GPS-guided bombs (GBU-49) and direct trajectory

16. MALE : Medium Altitude, Long Endurance.
17. D. Pappalardo. "Airpower: An Enabler Offering Strategic Opportunities The Force of Flexibility, Synergistic Effects and Versatility", *Journal Over The Horizon*, March 7, 2018. https://othjournal.com

Hellfire[18] missiles. The *Armée de l'air et de l'Espace* must continue its effort beyond the 2019-2025 military procurement act, whose annexed report provides for the increase of these capabilities to 8 MALE systems (24 aircraft). The increase in the number of systems will make it possible to multiply orbits, subject to an adequate increase in human resources.

On the other hand, these MALE RPAs remain extremely vulnerable as soon as surface-to-air systems, even relatively unsophisticated ones, appear in a theater. The *Armée de l'air et de l'Espace* must therefore be prepared to deal with the emboldening of regional powers and the return of power struggles. High-intensity conflict is no longer simply a distant and abstract hypothesis: fighter aircraft, which will include manned aircraft and drones that are very different from the *Reaper*, will have a significant role to play in overcoming these challenges, guaranteeing the preservation of air superiority and avoiding the risk of strategic downgrading.

A catalyst for cooperation and integration within the G5 Sahel

In the medium term, use of propeller-driven light combat aircraft could also be a means of relieving the burden on the air and space forces by proxy by helping the G5 Sahel countries (Burkina Faso, Mali, Mauritania, Niger, Chad) to structure their own air power based on a joint initiative. These countries are engaged alongside French forces in Operation Barkhane in the fight against jihadist organizations and operate a heterogeneous fleet of combat aircraft, which does not facilitate organic and operational synergies to achieve greater operational effectiveness on the ground. Burkina Faso, Mali and Mauritania are already using Super Tucano aircraft (although in different versions), which fall into the light combat aircraft category.

France, with willing European partners, would benefit from proposing a joint procurement, training and operation offer, or even helping the G5 Sahel countries develop a doctrine of use that would guarantee better interoperability, including with the Barkhane force. This project could be part of the capability development assistance for the G5 Sahel Joint Force, allowing the pressure on the air force's fighter component to be eased and providing additional room to maneuver in view of the return of competition between great powers.

Funding for this operational military partnership project could be provided by the European Union's European Peace Facility (EPF), within the framework of the future Capacity Building project inside the Permanent Structured Cooperation (PESCO)[19]. This model could be extended to other partners beyond the Sahel.

18. For the record, the two Reaper Block 1 systems are only capable of firing laser-guided weapons (GBU-12).

19. The CSP regulation requires that at least two Member States join France in this project to be eligible for funding

The perspective of the *companion trainer*

In the longer term, the French Air Force is committed to building FCAS, designed as a system of systems, including the *Next Generation Weapon Systems*, at the core of the collaboration with Germany and Spain. The NGWS is to be built around a *New Generation Fighter* (NGF), unmanned vectors, remote sensors and/or effectors with a certain degree of autonomy (*Remote Carriers*), all interconnected in a much larger system of systems (*Combat Cloud*)[20].

Of course, the *Rafale* will remain an essential partner of the NGF within FCAS until 2060, combined with remote carriers for the most dangerous missions. However, initial concept studies suggest that the NGF will be larger than the *Rafale*[21] and will be designed for combat in a disputed environment. Its arrival in the forces will likely go hand in hand with the need for a *companion trainer* that is less expensive to operate while offering performance similar to that of enemy fighters. This aircraft should primarily serve as a training partner for operational readiness (*Red Air* missions) while providing additional activity for crews. It is also possible to make it a lighter combat aircraft, easier to engage in the most permissive missions. In the future force structure, light combat aircraft would have their place, but in the form of a light, single-engine aircraft, refuellable in flight, with a man-machine interface similar to the NGF to facilitate the transition from one vector to another. This aircraft could be developed in cooperation, as the need for air power force generation is widely shared in Europe.

However, this aircraft must not crowd out the volume of NGFs so as not to compromise the ability of the *Armée de l'air et de l'Espace* to prepare for the return of high-intensity warfare. The upscaling of threats requires reconsidering quantity as a quality essential to successful operations. In a war of potential attrition, the number of aircraft, ammunition and crews is indeed decisive.

Conclusion

As the strategic update published at the beginning of 2021 indicates, the future environment will be marked by the persistence of entrenched crises, to which will be added the threats already identified in the 2017 Strategic Review. In particular, the return of strategic and military competition is now assumed by the major powers, while regional powers are taking advantage of the relative disengagement of the United States to assert their interests at the cost of growing military adventurism. The outbreak of a major war could once again become a credible possibility.

20. Exploratory concept "Collaborative connected aerial combat" n°00501068/ARM/EMAA/SCPA/BPLANS/NP, avril 2020.
21. 30-35 tons class compared to 24 tons maximum for the *Rafale*.

In this context, France must have a combat air force capable of dealing with the entire spectrum of conflict. In this light, embarking on the adventure of a light combat aircraft based on a turboprop engine does not seem appropriate, on pain of strategic downgrading. On the other hand, the future must be prepared by reconciling technological superiority with the need to regain sufficient combat mass to offer a favorable balance of power and withstand attrition over time.

A lighter jet fighter could therefore be developed in cooperation to serve as an operational transition aircraft after the PC-21s are retired, as a Red Air aircraft representative of future threats, but also as an attack aircraft for missions in permissive environments, with a logic of differentiated use of fighter aircraft: the NGF and the most modern *Rafale* for high-intensity combat alongside remote carriers; a light single-engine fighter for less demanding, but nonetheless essential missions. It is in this spirit that the *Armée de l'air et de l'Espace* should think about a light combat aircraft for the 2030-35 horizon, not by giving in to the temptation of a turboprop, which is ill-suited to sparse areas and unable to overcome the tyranny of distance.

HISTORICAL

The Evolution of Heliborne Operations in the Cold War Conflicts of Algeria, Angola and Rhodesia, 1954-1979

Stephen Rookes

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"Confuse the enemy. Keep him in the dark on your intentions. Sometimes what seems a victory isn't really a victory, and sometimes a defeat isn't really a defeat. Whether in attacking, counterattacking, or defensive tactics, the idea of attack should remain central, to always keep the initiative."

Général Vo Nguyen Giap

If the helicopter's innate qualities made it a valuable asset to armed forces, its early use was restricted to enabling duties such as the treatment and evacuation of casualties (casevac) from the battlefield or the transport of supplies. Despite these somewhat humble and perfunctory beginnings, as the face of warfare became more irregular in nature it was soon realised that the qualities in question (the ability to hover, the ability to take off and land in confined areas, etc.) might be exploited so that the helicopter became a frontline actor rather than acting as backline support. This evolution taking place within a matter of years, by the end of the 1950s rotary-winged aircraft had progressed to providing air mobility for ground troops. Concurrently, engineers at Bell Aircraft were investigating helicopter gunships and by the end of 1967 had produced the first dedicated attack helicopter, the Bell AH-1 *Cobra*. Though a not so iconoclastic feature of the Vietnam War the Bell

UH-1 Iroquois or 'Huey', its development and use contributed to the Soviet Union also examining the possibility of transforming the common passenger helicopter into an assault weapon. First producing the Mi-8 in 1967, Mil then went on to create the Mi-24. Featuring prominently in the Soviet Union's fight against Afghanistan's Mujahedeen in the 1980s, by the 1990s this 'Hind' gunship could be found in Sierra Leone in the fight against the Revolutionary United Front (RUF). Piloted by a Rhodesian mercenary employed by Executive Outcomes, it defeated rebel forces almost single-handedly.[1] As of today, helicopter gunships such as the Eurocopter Tiger are being used by French forces in the fight against Jihadist-led terrorism in the Sahel.

It is somewhat of a paradox that both Rhodesians and French were and are still involved in latter-day helicopter operations in Africa. In effect, and along with Portugal, both Rhodesia (now Zimbabwe) and France played major role in the evolutionary process described hereinabove. To be more exact, the operations designed and / or honed during wars in Algeria (1954-1962), Angola (1961-1974) and Rhodesia (1964-1979) are still highly influential in the development of strategies implemented to combat the type of guerrilla tactics still used by insurgents in a wide range of operations including Barkhane.

While this article presents background information necessary for a contextual understanding of the three conflicts in question,[2] much closer attention will be given to aspects of a more logistical and technical nature. Effectively, the article divided into three separate sections, each dealing with one particular conflict, we then move on to a closer examination of what determined the choice to use helicopters frontline utilities, who made those choices, what adaptations helicopters underwent, and what purpose those helicopters served. Importantly, this article focuses on one type of heliborne operation in particular. Indeed, the emphasis will be placed on the development and implementation of envelopment manoeuvres as they provided the platform for the evolution of future rotary wing operations. Though this expository discussion forms the bulk, it appears essential that we shed also some light on a range of external, and principally, political considerations that were influential in determining the aforementioned choices. To make this more clear, our understanding of the reasons why certain types of operation, certain types of helicopter, or certain types of weaponry were used in operations is incomplete if facets of a political nature are overlooked. This is particularly true in the cases of Portugal and Rhodesia: their security forces were hamstrung by politically-determined limitations. However, we will see that the result of these limita-

1. La Guardia, "Airborne Adventurer Keeps Freetown Free", *The Telegraph*, 18 June 2000.
2. The study of Portugal's contemporaneous wars in Mozambique and Guinea-Bissau has not been prioritised due to their being subject to regional considerations different from those in Angola.

tions led to more inventiveness and an unwitting contribution to helicopter warfare. An underlying theme is French association with the Angolan and Rhodesian conflicts. Indeed, closer examination of the role played by France helps us to gain a better understanding of the Cold War in Africa in the 1960s and 1970s as well as events still unfolding in the western part of the continent.

The Case of Algeria

The Background

Described as a "Savage War of Peace" by British historian Sir Alistair Horne,[3] the Algerian War of Independence (1954-1962) began on 1 November 1954 when soldiers loyal to the *Front de Libération National* (FNL) carried out a series of attacks against symbols of French rule. These attacks known collectively as the *Toussaint Rouge*,[4] the next major action designed to challenge French authority in this part of northern Africa was the massacre of *pieds-noirs* at Philippeville in August 1955.[5] Though the initial reply of French security forces was excessive,[6] the governor general of French Algeria Jacques Soustelle was acutely aware of the role psychological factors played in modern warfare and, after having visited Philippeville, he set about devising a plan emphasising the integration of France's Algeria's Muslim population within the French system.[7] Having carried out further attacks on urban targets that same month,[8] but seeing the scope for further activity repressed by the arrival of France's 10th Parachute Division, ANL commanders decided in Soummam that the most effective military strategy was to take the war away from urban centres such as Oran, Algiers and Constantine and focus its efforts on the mountains in the Aurès and Djudjura, or Algeria's high plateaux and valleys. In this way, the ANL believed it could evade the French military and bolster its ranks by using local militias known as *Fellaghas* to brutalise local populations into either joining the movement

3. Horne, *A Savage War of Peace*.

4. A literal translation is "Bloody All-Saints' Day". Generally considered as the beginning of the Algerian War, Algerian separatists carried out a series of seventy raids against police and army outposts, and industrial infrastructures. Ten people lost their lives in the attacks.

5. The attack on Philippeville was the first major offensive carried out by the FNL. Seventy-one *pieds-noirs* (French citizens born in Algeria) were killed. Another attack occurred at El-Halia, a mining town also in the Constantine region where thirty-seven Europeans were killed.

6. Estimates on the number of dead come from FLN sources.

7. Bocca, 1.

8. Attacks included that which took place in the rue de Thèbes in August and against a cafeteria in September. The first killing 80 people, the second against a local Milk-Bar resulted in the deaths of three people.

or becoming sympathisers.[9] Added to these typically Maoist methods of waging guerilla warfare,[10] ANL strategists devised an organisational plan whereby Algeria was divided up into six regional commands, or *Wilayas*, that served as operational bases.[11]

As for the tactics used by the ALN, they resembled those encountered by the French in Indochina. Used unsurprisingly given that many ALN combatants had served in the Indochinese War and had first-hand experience of Maoist guerilla tactics,[12] the ALN chose to implement a three-phase insurgency strategy consisting, firstly, of carrying out small-scale ambushes and acts of terrorism; secondly, of carrying out more offensive actions once its own forces were large enough; and, thirdly, using conventional methods to meet the adversary head on. Despite the ALN implementing the first phase of this strategy, receiving regular supplies of arms,[13] and using Tunisia and Morocco as additional operational bases, as of 1956 France enjoyed an overwhelming military superiority over the FLN.[14]

The French Reaction

Gaining military superiority over such a short space of time can be explained by the fact that French strategists realised that modern warfare was an interlocking system of political, economic, psychological and military actions designed to overthrow one regime and replace it with another.[15] Consequently, as illustrated by the Soustelle Plan, a significant effort was made to persuade Algeria's indigenous population that the French rather than the regime advocated by the FLN was the most preferable of the two and that France would provide its needs. A second step was convincing Algeria's population that the FLN was the enemy, and demonstrating that any attempt to impose a regime by force would be met with superior force. Stages in this process included the recruitment of a home-grown, pro-French military force known the *Harkis*,[16] and swamping Algeria with hundreds of thousands of metropolitan troops. Numbering nearly 400,000 by 1957, these played a decisive role in securing the Algerian capital, Algiers and its surrounding areas.

9. Though used by the French in Algeria, the term was considered as pejorative. The FLN typically used the term 'junud' to describe its foot soldiers, 'mujahideen' to describe its elite troops, and 'musubilan' to describe auxiliary units. Meynier, 154-160.

10. For more on these methods see, Mao Tse-tung, *On Guerilla Warfare* (1937).

11. The areas covered by each Wilaya is as follows: Wilaya 1 (Aurès-Nementchas), Wilaya 2 (North Constantine), Wilaya 3 (Kabilyia), Wilaya 4 (L'Algérois), Wilaya 5 (L'Oranie), and Wilaya 6 (South Aumale).

12. Shrader, 146.

13. In 1954, the Arab League of States made a commitment to assist other Arab states to gain independence. Cairo became one of the main hubs for the transfer of weapons into Algeria.

14. Galula, 68.

15. Trinquier, 5.

16. Estimates put the number of Harkis at some 300,000. "After 40 years of suffering and silence, Algeria's 'Harkis' demand a hearing", Irish Times, 31 August 2001.

This battle of the Casbahs forcing the FLN further into Algeria's more rural zones,[17] French authorities also initiated a series of measures to ensure that the FLN found it difficult to recruit rural inhabitants. Indeed, Soustelle set up Special Administrative Sections (SAS) in 1955 as part of a hearts and minds programme, and increased the number of security forces serving in remote areas.[18] Further organisational measures came through the *quadrillage* system. A system whereby urban as well as rural areas were divided up into geographical zones in which counter-terrorist operations could be organised on a local level enabling a faster reaction time when enemy activity had been detected. Efforts were also made to secure Algeria's borders from infiltration from Tunisia and Morocco. This was achieved on the eastern border through the construction of electrified fences known as the Morice and Challe lines completed in 1957 and 1959 respectively. Carrying as many as 5,000 volts and 2.5 metres high, each line was equipped with state-of-the-art electronic detection systems, radars and searchlights making crossing into Algeria almost an impossibility. Moreover, the placing of anti-personnel landmines along the perimetres of the lines ensured that the FLN's operational areas were limited to Algerian soil. Thanks to the addition of the French Navy patrolling the Mediterranean, the French therefore managed to stem the flow of weapons on to the battlefield.

The Development of Heliborne Operations in Algeria

The implementation of the quadrillage system and the implantation of the Morice and Challe lines represented the beginning of a heyday for French aviation and, in particular, rotary wing operations in Algeria.[19] The process towards transforming the helicopter from auxiliary to central actor began in the Korean War and the Malayan Emergency with the French realising the potential for helicopters to provide air mobility for ground troops. Effectively, they had witnessed how US Marines had been transported into battle aboard Sikorsky S-55 "Chickasaw" during the Korean War,[20] and had gained first-hand experience of heliborne insertion operations through the assignment of one of its higher-ranking officers, Déodat du Puy-Montbrun, to the British Special Air Service in Malaya in November 1952.[21] These experiences prompted the French Army into commissioning a study in December

17. For more on the Battle of Algiers see, Aussaresses, 2002.

18. Those tasked with the day-to-day running of Special Administrative Sections were known as 'kepis bleus' . They were supported by local Moghazni auxiliaries.

19. At first the French Army used a *ratissage* system whereby tanks, artillery and sometimes aviation was used to unearth enemy combatants from their hideouts in the Aurès Mountains or in Kabylia. Inflicting some losses, once operations were over, these enemy combatants would simply return and start all over again. A side effect of this strategy was that Algerians who supported the French were targeted for assassination thus encouraging other Algerians to join the FLN rather than suffer the same fate. The *quadrillage* system was an attempt to secure defined sectors of Algeria so as to eliminate insurgent activity and to reduce the recruitment of local populations into the ranks of the FLN. Alexander and Keiger, 15.

20. "Coalition Air Warfare in the Korean War, 1950-1953".

21. See Brault.

1953 whose goal was to examine the effectiveness of heliborne operations in irregular warfare.[22] Along with similar investigative studies carried out by strategists of the French *Aviation Légère d'Observation d'Artillerie* (ALOA) late that year, the results of the studies indicated that vertical takeoff and landing (VTOL) aircraft could indeed play an important role in the different phases of modern warfare. More specifically, the particularities of the helicopter meant that it could be used for the vertical envelopment of enemy forces,[23] infiltration missions, to transport troops quickly into hot zones or to establish a bridgehead in enemy territory.[24]

In terms of how these lessons and innovations were implemented in the Algerian War, the French began to codify, organise and optimise their rotary wing operations.[25] The first step, therefore, was to revise the structure of the centralised 5th Air Region and to break it down into smaller units, while the second consisted of overhauling an ageing aviation stock.[26] These smaller decentralised air regions being called *Groupes Aériens Tactiques* (GATACs),[27] to speed up reaction time and to increase flexibility, a sub-division of these five larger units were advanced air commands. These units were initially made up of *Escadrilles d'Aviation Légère d'Appui* (EALA) using Harvard T-6s, MS.500s or Trojan T-28Ds, but with the creation of *Détachements d'Intervention d'Hélicoptères* (DIH) and *Groupements Mobiles d'Hélicoptères*, this fixed-wing stock was complemented with the purchase of around 300 helicopters. Which type of helicopter in each unit depended on whether it was commanded by the *Aviation Légère de Terre* (ALAT), or by the *Armée de l'air*.[28] Additionally, the French set up refueling and rearmament points throughout the GATACs.[29] This was an important aspect given that if a helicopter was lighter with fuel it could carry more men, the dispersed location of DIHs and refueling points meant that helicopter units and commandos

22. British helicopter operations in Malaya also had a significant influence over France's choice to turn to the use of rotary wing aircraft for air mobility. In November 1952, French colonel Déodat du Puy-Montbrun served with the British Special Air Service (SAS) in Malaya. Here, he took part in heliborne operations in the jungle earning the King's Medal. See Brault.

23. Rapport des missions en Corée et au Japon, «Etude des formations d'hélicoptères de l'armée de Terre américaine», December 1963, quoted by Gaujac, 66.

24. Bos, 448.

25. Shrader, 77.

26. At the outbreak of war in 1954 the French Air Force was equipped mainly with air defence, ground attack and liaison aircraft. Aircraft included SE.535 Mistral jets, F-47 Thunderbolts, Vautours, Mystère IVAs attached to *Escadrilles de Chasse* or fighter squadrons (EC); AAC.1 Toucans and C-47s attached to *Escadrilles de Transport* or transport squadrons (ET); and Caudron C-445s and Martinets attached to liaison and observation squadrons or *Escadrilles de Liaison et d'Observation* (ELO).

27. The GATAC system had already been used in Indochina. As for Algeria, GATAC 1 covered the Constantine region; GATAC 2 covered the area around Oran; and GATAC 3 covered three areas around Algiers (Orléansville, Tizi-Ouzou and Aumale).

28. The French Army operated only four helicopters before June 1955 but by 1959 it possessed sixty-four Vertol H-21Cs; nine Sikorsky H-19s; thirty-eight Bell H-13s; and twenty-nine Alouette IIs. Bourgeois, 1987 as quoted in Shrader, 121. During this period, the Air Force operated Eighty H-34s, twenty-five Alouette IIs and a number of H-13s and H-19s, while Flotilla 31 of the French Naval Aviation operated thirty-six H-21s, H-5s, H-19s and H-34s.

29. Peterson, Reinhart, and Conger, 31.

could be placed on a fifteen-minute alert or even five minutes if enemy activity was on the increase in a given area.[30]

Though Colonel Marceau Crespin of the ALAT can be credited with increasing the mobility of the French Army by using Piasecki Vertol H-21Cs [31] as troop carriers as early as May 1955,[32] two colonels in the French Air Force can be considered to having been central in the development of the helicopter from mere armed troop carrier to veritable assault weapon. The first, Colonel Felix Brunet was the commander of the *Escadre d'Hélicoptères 2* (EH2) at Oran-La Sénia, [33] while the second, Colonel Alexis Santini was the commander of the Helicopter Training Division from 1956.[34]

His motto being "*Combattre et sauver*" or fight and rescue, Brunet's experimentation with arming helicopters began as early as 1955 after an episode that saw ground troops pinned down in the Aurès mountains. Piloting a Bell H-47, Brunet had the idea of placing a man in each of the helicopters casualty panniers so that they fire on the enemy as the aircraft circled.[35] The enemy defeated using this strategy, but the Bell being vulnerable to enemy fire, Brunet, aided by Captain Emile Martin, set to work on designing a weapons system for a Sikorsky H-19 Chickasaw.[36]

30. *Ibid.*, 34.

31. In this respect, Crespin played an indirect role in determining the future of the helicopter as a France. Effectively, in late 1956, the Vertol Aircraft Corporation undertook a study commissioned by the French Ministry of Defence to evaluate the role of the H-21C. France. National Defence Committee for Scientific Action, Operations Research Group, "Report of the Operations Research Mission on H-21 Helicopter Operations in Algeria", 1957, as quoted in Shrader, 77.

32. This operation consisted of a detachment of four helicopters transporting 3rd Foreign Parachute Battalion troops to Mount Chélia. «L'aviation légère de l'armée de Terre dans la guerre d'Algérie (1954-1962): organisation et emploi», defence.gouv.fr, 22 November 2017.

33. Brunet took over this role from Déodat du Puy-Montbrun.

34. Nicknamed "*Le Sanguin*" or the "Fiery One", Alexis Santini commanded liaison squadron (escadrille de liaison) or ELA 52 in Indochina. Operating Hiller 360s, Santini was the husband of Valérie André, a fellow helicopter pilot and the first woman to become a General in the French Air Force.

35. Facon, 327-341.

36. The H-19 carried a 20mm Matra cannon, two .50 calibre machine guns, and a 7.5mm light machine gun. The H-19 found to be unlikely to be able to bear the weight of heavy machine guns needed for ground attacks, Brunet turned towards Sikorsky's more powerful H-34 Choctaw. The choice of helicopter made the next stage was to find the weapons most suited for carrying out ground attacks. One concern was that the traditional axial weapons already available would reduce the speed of the H-34 so weapons specialists fitted a lighter, tubular gun carriage to an MG 151 cannon, a German-manufactured 20mm weapon used by the Luftwaffe in WWII. However, not possessing a recoil damping mechanism and its size limiting the capacity to stock ammunition, the gun carriage was finally replaced with a modified carriage mounted on a rubber-cushioned inertia plate and using a recoil brake system. The initial weapons configuration was for the cannon to be mounted in the cargo doorway while a Browning 12.7mm 6P50 machine gun was placed in the right-hand side port. Later modifications included replacing the modified MG 151 with an Oerlikon 20mm cannon, and mounting rocket launchers on the starboard and port platforms. This weaponry composed of 6 LRAC 73 anti-tank missiles, a pod containing 12 SNEB air-to-ground 68mm rocket projectiles were placed underneath. Armament such as this carried on both sides on the aircraft led to it being nicknamed the Mammoth.

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Santini's contribution to the development of heliborne operations came through his having the foresight to use Sikorsky's H-34 instead of the H-21C used by the ALAT. Indeed, the H-21C, or "Flying Banana" lacked the performance and manoeuvrabilty needed in ground attacks,[37] making it unsuitable for operations such as vertical envelopment. A tactic consistently used in a wide range of future conflicts, vertical envelopment consisted of using an armed H-34 (nicknamed the "Pirate") to make strafing runs over an area of enemy activity or to disperse *Katiba* (platoon) sized units while other H-34s (nicknamed "Auroch") would land and offload a cargo of paratroopers and / or Foreign Legion soldiers known collectively as the *réserve générale*.[38] Forming a ring around the enemy, the objective of an envelopment operation was to take the enemy by surprise, engage him in combat, and to cut off his means of escape. Often preceded by jets showering an area with cluster bombs and followed by search and destroy and sweeping operations carried out by troupes de secteur (sector troops), vertical envelopment tactic proved to be particularly effective after the introduction of the Challe Plan in February 1959.[39]An Air Force General, Challes's plan was to put in place an all-encompassing and unified strategy to simultaneously defeat the ANL and win over the general population.[40]In asphyxiating the movement of the enemy, it resulted in one of France's most successful periods of the Algerian War in terms of military gains. In the end, though, military dominance amounted to nothing as France grew tired of a conflict that was costly in lives and money.

37. "Report of the Operations Research Mission on H-21 Helicopter Operations in Algeria".
38. The Alouette II and the Vertol often added to support in vertical envelopment operations. Entering into service in Algeria in 1957, the Alouette II could be fitted with air-to-ground AS-11 wire-guided missile. Designed by Nord Aviation, this type of weapon was very effective against rebels that had taken shelter in the caves of the Aurès mountains. Previous attacks using T-6s dropping napalm had failed to reach the inner-depths of the caves.
39. The Plan Challe was created alongside the Plan de Constantine. This envisaged a five-year economic plan that included the redistribution of land, agrarian reform, funding for education, and the creation of low-rent housing. Horne, 310-311.
40. Canuel, 8.

If the Evian Accords signed on 18 March 1962 drew the Algerian War to a close, the development of the helicopter as an assault weapon continued in the central African country of Angola where the military capabilities of Portugal's security forces would be tested by three armed movements all intended on ridding any trace of colonialism.

The Case of Angola

Whereas Portuguese ruler Antonio Salazar had so far refused to bow to international pressure on the question of Angolan independence and had even amended its constitution so that overseas territories were considered as *de facto* provinces, the recent independence of several African countries and the use of arms to achieve this objective led Portugal's military authorities to believe that the advent of insurgency in its own colonies was inevitable. Consequently, by 1959 they had begun to make preparations to mount an effective counterinsurgency strategy. A start was made when six Portuguese officers were sent to the *Centre d'Instruction de Pacification et Contre-Guérilla* at Arzew in Algeria to study French efforts in countering insurgency.[41] It was an inauspicious start, however, as the report these officers presented on their return to Lisbon warned that Portugal was ill-prepared for irregular warfare and that immediate action should be taken to address the issue.[42]

As was the case with France, Portuguese commanders had recognised that the ability to deploy air power was an essential aspect of any strategy designed to keep insurgents at bay and stop them from keeping the initiative on the battlefield. Concurrently with sending its officers for instruction in Algeria, then, in 1959 the *Força Aérea Portuguesa* (FAP) moved several C-47 transporters and PV-2 Harpoons to Luanda,[43] and Portuguese authorities ordered the construction of two new airfields the following year.[44] The fear that Angolan nationalists would soon turn to the use of arms was cemented in March 1961 when a movement calling itself the United Peoples of Angola (UPA) launched a series of attacks against Portuguese settlers in northern Angola.[45] The Portuguese military responding to these attacks by deploying troop-carrying DC-3s and Beechcraft 18 spotter planes to complement the FAP's existing fleet, official Portuguese forces were backed up by the conversion of civilian aircraft and the creation of a civilian unit called

41. Heggoy, 176, in John Pearce Cann, "Portuguese Counterinsurgency Campaigning in Africa, 1961-1974: A Military Analysis", 98.
42. Cann, *Ibid*.
43. Flintham, 113.
44. Niccoli, 1998, in Corum and Wray, 275.
45. Portuguese forces responded to these attacks by bombing villages in the Icolo e Bengo and Baia de Cassange regions. Sources state that 17 villages were destroyed killing 20,000 people. Heywood, 315.

the *Formações Aéreas Voluntárias* (FAV).[46] Comprised of Piper Clubs and Auster D.5s, the FAV flew a number of sorties over the coming months firing handguns from the cockpit windows of the aircraft.[47]

The next step taken to increase Portuguese air power came when two army battalions and two operational air squadrons (Esquadra 91 and 93) were transferred to bases around the Angolan capital, Luanda. The aircraft of these two squadrons consisting of F-84 Thunderjets and Harpoon P-V2s, in May 1961 the FAP attacked enemy positions in the Dembos Mountains using fragmentation bombs and napalm supplied by the United States Air Force.[48] Following these raids, the first paratroop operations took place in August in the Uíge Province (northwestern Angola).[49] These operations intended to disperse concentrations of rebels holed up in urban areas and to force them into the countryside, it is significant that this point that the FAP increased the diversity of aircraft at its disposal by adding Alouette IIs and Dornier 27s.[50] These were based at Luanda's *Base Aérea* 9, at *Aérodromos Base* 3 in the Uíge Province, and at *Aérodromos Base 4* at Henrique de Carvalho in northern Angola's Lunda Sul Province.[51] The decentralisation of air operations being one elements that modified Portugal's approach to the conflict, events taking place outside of the country were to lead to the FAP acquiring an updated version of the Alouette II and building on the innovations introduced by France in Algeria. The first major event was the support given to the National Front for the Liberation of Angola (FNLA) by the People's Republic of China (PRC) from 1964,[52] while a second was the the direct intervention of South Africa in 1966.[53]

South African involvement in Angola is crucial to understanding why and how Portuguese forces were able to introduce the use of envelopment tactics into its overall air strategy. The story starts with the creation in March 1966 of a third nationalist party in Angola, the National Union for the Total Independence of Angola (UNITA), and continues with this movement's links to a nationalist movement in South West Africa (SWA), the South West Africa

46. Flintham, 124.
47. *Ibid.*
48. Marcum, 229.
49. Flintham, 114.
50. The Dornier 27 was a short takeoff and landing (STOL) aircraft particularly useful for casevac operations.
51. Flintham, 114.
52. In 1962 the UPA merged with the Democratic Party of Angola (PDA) to form the National Front for the Liberation of Angola (FNLA). Its leader, Holden Roberto then established the Revolutionary Government of Angola (GRAE). 1962 is also the year when the Sino-Soviet split became official. The PRC supplied weapons and military advisors to the FNLA. MacDonald, 56.
53. Cuba also supplied weapons and training to Amilcar Cabral's PAIGC, the African Party for the Independence of Guinea and Cape Verde. The first supplies of Cuban weapons arrived in April 1965. In July and August of that year these weapons were supplemented by the arrival of more than 500 Cuban soldiers. George, 27.

People's Organisation (SWAPO). Having been appointed to administrate the former German colony of South West Africa in 1915, South Africa was keen that Angola remain free of communist-inspired insurgency lest this have a direct influence on the internal affairs of South Africa itself. The ruling National Party's domestic policies were already being challenged by the African National Congress (ANC), so what it did not want to see was any further challenge aided and abetted by regional nationalist movements that made maintaining stability even more complicated. Despite these wishes, and the desire that SWA act as a bulwark against communism,[54] 1960 saw the emergence of a socialist and Marxist-Leninist inspired movement intent on causing as much disruption as possible for South African security forces and gradually forcing South Africa so as the country could become an independent nation.

Whereas SWAPO's activities were mainly restricted to those of a more political nature in the years immediately after its formation, in late 1966 its armed wing, the South West African Liberation Army (SWALA),[55] clashed with South African Police counterinsurgency forces at Omgulumbashe in northern Namibia. The result of this confrontation being a overwhelming victory for security forces, it nonetheless confirmed suspicions that guerilla activity in the area was on the increase and convinced the authorities that security measures would have to be reinforced.[56] There was, however, a particular geographical issue linked to ensuring that the SWALA did not gain a foothold in the area. Indeed, the groups principal operational zones centred on a slice of land called the Caprivi Strip. While this was not a serious issue in itself, what was problematic for security forces was that the strip bordered Angola, Botswana, and Zambia. The Portuguese not having complete military authority over Angola and both Botswana and Zambia now independent nations,[57] their proximity to the Caprivi Strip meant that SWALA forces could easily find refuge after having carried out attacks. Here, a kinship that had developed between UNITA's Jonas Savimbi and the SWAPO's Sam Nujoma proved to be mutually beneficial to both movements. In effect, SWAPO provided weaponry to UNITA,[58] while the latter provided food and shelter for SWALA units passing through UNITA territories to attack or flee South African security forces.[59]

Until its security forces intervened in 1966, as mentioned above South Afri-

54. Botswana gained its independence in June 1966; Tanganyika became Tanzania in 1961; and North Rhodesia became Zambia in 1964.

55. SWALA changed its name to become the People's Liberation Army of Namibia (PLAN) in 1973.

56. Campbell, K. 130.

57. Zambia gained its independence from the United Kingdom in 1964. Botswana, another British colony, became independent in 1966.

58. Amukwaya Shigwedha, 1275-1287.

59. Campbell, H. 12.

can security forces had not intervened directly in the Angolan conflict. Indirectly though, since 1961, the year when South Africa became a republic, it had sought to increase ties with remaining colonial powers not just because it became the subject of a UN arms embargo, but also because it wanted to establish stronger ties with like-minded nations involved in the fight against the spread of communism. As for the weapons, South Africa signed an agreement with France resulting in the delivery of 7 Alouette IIs, 33 Alouette IIIs, and 16 Mirage jet fighters,[60] and as for links with remaining colonial powers it approached Portuguese authorities. In July 1961, in effect, the South African Minister of Defence J.J. Fouché visited Lisbon to discuss the possibility of a cooperation between the FAP and the South African Air Force (SAAF).[61] Followed closely by further discussions in April 1962 to look at the possibility of establishing a radio communications network between the two countries,[62] in November 1963, Angola's State Defence Police (PIDE) began to provide South African secret services with intelligence linked to SWAPO incursions taking place along SWA's border with its northern neighbour.[63] Cooperation between South Africa and Portugal continued with an agreement to share intelligence, and in 1964 it led to transfers of a more unsophisticated nature when Portuguese officials requested that South Africa supply spare parts for their Alouette IIIs.[64] Just as the H-34 had a impact on the ways French forces could meet the challenge of a highly mobile and elusive enemy in Algeria, the addition of Alouette IIIs to Portugal's war effort was telling when it came to developing tactics for use against FNLA insurgents in northern Angola and against the MPLA's military wing, the People's Armed Forces of Liberation of Angola (FAPLA), when it moved its operational bases from Cabinda to the Bié Plateau just east of Luanda.[65]

60. «Visite du Ministère de la Défense, Le Cap, 12 juin 1961».

61. NARS, BTS, Box 74/29 (F1), Burgerlike Lugvaart en militêre verbindings. B: 02.10.61/E: 12.11.64. Letter from Portuguese army and air attaché in South Africa, Pretoria, 2 October 1961, in Correira and Verhof, 58.

62. NARS, BTS, Box 74/29 (F1), Burgerlike Lugvaart en militêre verbindings. B: 02.10.61/E: 12.11.64: Top secret letter from Secretary for Foreign Affairs – Secretary for Defence, Cape Town, 9 April 1962, Ibid.

63. AHD, PAA 58: Política Externa e Interna da África do Sul. Acção desenvolvida pela SWAPO: Secret document Informação No 606/SCCI/Assunto: Actividades Terroristas da SWAPO – South West African Peoples Organization', 2 November 1963, in Correira and Verhof, 59.

64. NARS, BTS, Box 1/22/5, Vol 2, Angola: Defence. B: 05.04.61/E: 29.11.67: Secret letter from South African Consul General, Luanda – Secretary for Foreign Affairs, Pretoria, 14 September 1964, Ibid.

65. In 1965, MPLA leaders decided to move its operations base to Zambia. Zambian authorities permitted the unrestricted transit of weapons through their territory and allowed liberation movements to broadcast through the Zambian Broadcasting Service (ZBS). This was because Zambia was a major supporter of the OAU's desire to support liberation movements, and believed that armed struggle needed to be backed up by an effective propaganda machinery. From 1973, the ZBS set up the "War of Words Channel" and allotted 45-minute slots to liberation movements in Angola, Rhodesia, South West Africa and South Africa. Chongo, 10.

Sud Aviation's Alouette SA.316A and SA.316B versions proved themselves to be far more capable that their predecessor the Alouette II. For a start its Turbomeca Artouste IIIB turboshaft produced 870 hp compared to the Alouette II's 530 hp. The Alouette III could carry six passengers as opposed to the Alouette II's four, and what is more it was able to cruise at a higher speed (210 km/h compared to 185 km/h). Added to the passenger capacity was the possibility of carrying a heavier payload. These aspects were essential when it came to the question of providing infantry soldiers with rapid and relatively safe access to insurgent operational areas. Before, transport carrying aircraft were subject to the variables that could affect paratroop drops (injury on landing, missing landing zones, etc.), but by using VTOLs landing zones (LZs) could be pin-pointed so as to ensure a safer and quicker arrival in areas where enemy activity had been detected.

DR

The development of helicopter tactics used by the FAP in Angola and Portugal's other overseas territories went through a similar process to that witnessed in Algeria. There were concerns linked to the vulnerability of helicopters to ground fire especially in the landing and recovery phases, so a priority for Portuguese technicians was deciding which type of weapon was best suited given its weight and the effect it would have on the helicopter's motion. After a number of unsuccessful attempts using hand-held Arma-Lite AR-10s, Mauser MG-42s, and Browning M3s, it was decided that the most suitable option for the provision of heavy firepower was to use the French-manufactured Matra MG-151 cannons. Used by the ALAT on the H-21C and by the *Armée de l'air* to arm H-34 "Pirates", the MG-151 was a particularly effective option given its high rate of fire (680 to 740 rpm).[66]

66. The Vektor GA-1 was also used by the Portuguese. A variant of the MG-151, the SADF used another variant produced by Denel.

Whereas Portugal's connections with South Africa meant that the FAP acquired thirteen more Alouette IIs in 1968,[67] a typical Portuguese heliborne operation consisted of using a flight of five helicopters to insert sections of four men into areas where enemy activity had been detected while using a helicopter gunship (nicknamed the *heli-canhão*) to provide covering fire.[68] If it was decided that tactical operations were needed to clear a particular area, the FAP would firstly use a Dornier to survey the terrain in order to calculate which zones presented optimal conditions for a surprise attack. Usually, this comprised of finding terrain that would provide visual cover for the arrival of five helicopters and drown out the noise of their rotors. With the FAP's helicopter squadron (*Esquadra* 93) kept on standby at bases in Luanda (BA9) and other locations, once a formation had been deployed its arrival at a LZ would be preceded by the gunship which would make strafing runs of a given area and clear the way for the troop carriers. Often accompanied by a second formation of helicopters plus support aircraft such as the Dornier 27, envelopment tactics were followed by sweeping operations that could last for some days after operations began.

DR

Although the addition in 1969 of SA-330C Puma helicopters meant that Portugal was better equipped to meet the demands of modern counterinsurgency warfare, by 1968 the cost of its wars in Angola, Mozambique and Guinea-Bissau amounted to around $300,000 per day and represented around 50% of Portugal total annual budget.[69] And, while in Angola Portuguese forces continued to mount large-scale military operations in 1970 (operations *Zaga* and *Zumba*) and in 1972 (Operation *Attila*), domestic concerns over the policies of the *Estado Novo* regime led to Prime Minister Marcello Caetano being overthrown in a military coup. Replaced in the aftermath of

67. ADN, File 2732.2: Top Secret secret letter, South African Defence Minister, Cape Town - Portuguese Defence Minister, Lisbon, 17 May 1968, in Correira and Verhof, 60. In total, the FAP acquired 118 Alouette IIIs. Baxter, 48.

68. Cann (2015), 242.

69. Wheeler, 425-439.

the Carnation Revolution by General Antonio de Spínola, negotiations at Alvor, Portugal in January 1975 led to Angola obtaining its independence in November of that year. In spite of Portugal's adoption of the tools of modern war, ultimately, and in a similar fashion to what ended the Algerian War, the battle to hold on to colonial possessions was lost not in the field but on the streets of metropolitan cities such as Lisbon.

The Case of Rhodesia

Despite Harold MacMillan's "Wind of Change" having blown across most of Africa granting independence to a majority of its nations,[70] by 1965 the white minority regime that governed the British colony of Southern Rhodesia (now Zimbabwe) still refused to bow to international pressure and extend the franchise to the majority. Dissent had been growing amongst the indigenous population leading to isolated instances of civil obedience, but by and large the ruling Rhodesian Front (RF) remained untroubled by any significant attempt to dislodge it through armed force. Two aspects of the contemporary political context in southern Africa strengthened the RF's resolve. One was the massacre of whites during the Mau Mau uprising in Kenya in the 1950s, while the other was the election of the Labour Party in Great Britain, a party unsympathetic to the continuation of white minority rule. In order to avoid what was seen as interference in Southern Rhodesia's internal affairs, on 11 November 1965 Prime Minister Ian Smith issued the unilateral declaration of independence. At a stroke, all political links to Great Britain were severed and Southern Rhodesia became Rhodesia.

In terms of armed challenge to the Rhodesian government, as in many other colonies its roots were to be found in the growth of Black political activism of the 1950s. In Rhodesia, activism came through organisations such as the Southern Rhodesia National Party (SRNP) in 1957, which then morphed into the National Democratic Party in 1960 (NDP), and two opposing parties the following year. The first was the Zimbabwean African People's Union (ZAPU) led by Joshua Nkomo, while he second was the Zimbabwe African National Union (ZANU) led by Robert Mugabe, Herbert Chitepo and the Reverend Ndabaninji Sithole.[71] Throughout what would become known as the Rhodesian Bush War, both received support either from the USSR and China along with a variety of radical African regimes and the OAU.

70. On 3 February 1961, British Prime Minister Harold Macmillan (Conservative) addressed the Parliament of South Africa stating that his government would not seek to impede the independence of African countries still under British rule. This address is often referred to as the "Wind of Change" speech.

71. Both the ZAPU and the ZANU had armed wings. There were the Zimbabwe African National Liberation Army (ZANLA), and the Zimbabwe People's Revolutionary Army (ZIPRA), respectively.

Facing these groups was one of the most powerful armed forces in the region. Three battalions of infantry were created in 1948 following a general strike and a revision of Rhodesia's military capacity. Whereas one of these battalions became the Rhodesian Light Infantry (RLI) in 1961, two other units created in 1961 were C Squadron of the Special Air Service (SAS), and an armoured car squadron named the Selous Scouts. In 1973, the Selous Scouts became a specialised counter-insurgency unit composed of both black and white Rhodesians. Another unit was the Rhodesian African Rifles (RAR) recruited from the black African population. Created in 1940, the RAR had fought in Burma during WWII and, along with the South East Asia Volunteer Unit (later C Squadron SAS) took part in operations against Communist insurgents during the Malayan Emergency. The RAR also played a role in the 1956 Suez Crisis when they assisted British and French forces, and in Rhodesia the regiment was often used to suppress civil unrest in support of the British South Africa Police (BSAP), a paramilitary force created in 1889. This was another security force unit comprising both black and white Rhodesians, and its experiences of warfare included supporting the British during the Second Boer War (1899-1902) and fighting German forces in the neighbouring German East Africa during the First World War.

The Rhodesian Air Force (RhAF) being among the most powerful air forces in southern Africa,[72] the first serious incursions of a war known as the Second Chimurenga by rebel groups were sporadic and were easily repulsed by Rhodesian security forces. The deadliest confrontation occurred in August 1967 near Lake Victoria when around 90 ZAPU guerillas were killed, and in this operation (Operation Nickel), RhAF Alouettes played an important role as did Provosts and aircraft of the Police Reserve Air Wing (PRAW).[73] A second major encounter in these early years of the war involved Hawker Hunters of 1 Squadron that strafed guerillas during the unit's first operation sortie the same month, and a third eventuated in March 1968 when Vampires carried out similar operations against guerillas who had crossed the border from Tanzania, one of ZAPU's main operational bases, the other being Zambia.

If political events taking place in a wider political arena strengthened Rhodesia's position in the early 1970s,[74] and a secretive military alliance with Portugal and South Africa strengthened it even further.[75] Simultaneously,

72. At its independence, the RhAF was made up of 1 Squadron (operating Hunter FGA.9s), 2 Squadron (operating Vampire FB.9s), 3 Squadron (operation C-47s), 4 Squadron (operating Provost T.52s), 5 Squadron (operating Canberra B.2/T.4s), and 7 Squadron based near Salisbury (Harare) which operated Alouette III helicopters.

73. Flintham, 125.

74. In July 1969, Nixon and Kissinger laid out their policy for Southern Africa in National Security Study Memorandum (NSSM) 39. Otherwise known as the 'Tar Baby' option, NSSM 39 declared that although *apartheid* and colonialism were unpleasant, they were on the other hand realities that should be accommodated in respect of a wider reaching geopolitical strategy known as *realpolitik*. For more see, Lockwood, "National Security Memorandum 39 and the Future of United States Policy Toward Southern Africa", 63-72.

75. The alliance in question is the Alcora Exercise. An acronym for *Aliança Contra as Rebeliões em Africa*, the immediate objective of the Alcora Exercise was to examine the ways in which the three countries in question could counter nationalist ambitions militarily. Ribiero de Meneses and McNamara, 201-215.

China was increasing its commitment to nationalist forces and more sophisticated Soviet weaponry was being supplied to rebel forces in Africa.[76] Furthermore, the independence of Mozambique in 1975 presented another challenge. With the FAP having withdrawn, ZANLA forces had more freedom to roam along the Mozambican border with Rhodesia and the frequency of incursions began to increase.

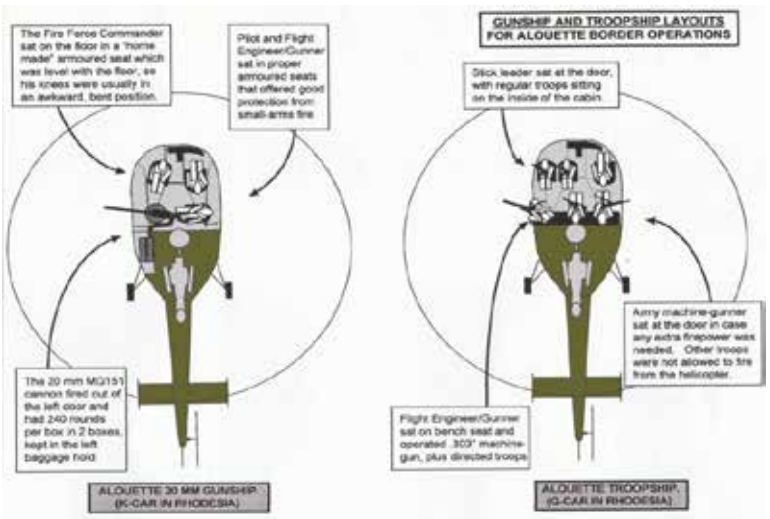
The RhAF responded by firstly striking ZANLA camps inside Mozambique itself. Its existing fleet of aircraft was bolstered by the purchase of twelve BN-2 Islander light utility aircraft, 35 Alouette IIs and IIIs, and Cessna FTB.337Gs.[77] A second RhAF strike took place on 28 February 1976 when Hawker Hunters attacked a ZANLA base at Pafuri in Mozambique, while a third was carried out in May 1976 against guerillas operating from Botswana who had damaged the Botswana-Bulawayo railway line. Later that month, the RhAF attacked a ZIPRA arms depot in Mozambique, and in August the Selous Scouts killed 600 ZANLA rebels also in the former Portuguese colony.[78] Rhodesian forces having by now defined four main operational areas in the north-east (Hurricane), in the east (Thrasher), in the south-east (Repulse), and in the south-west (Tangent), the most significant development as far as countering the movement of rebel forces and their contact with local populations was the Fire Force mission. Indeed, Rhodesian security forces comprising just under 43,000 members, the over 400,000 square miles of territory that had to be secured presented a daunting task.

The development of Fire Force missions began as early as February 1974 when military planners decided to implement strategies used by the Portuguese in Angola. Firstly, instead of using the conventional battalion model of three companies and four platoons, each battalion of the RLI was remodeled so that it was made up of four thirty-man platoons. Secondly, each platoon was then broken down so it contained not eight-man squads, but smaller units made up of four commandos and called "Sticks". The reasoning behind the decision to use smaller squads was that the Alouette III was central to the Fire Force mission as a whole and could only carry four passengers plus the pilot. A second development came with the establishment of observation posts inside each operational zone and the creation of forward airfields and Joint Operational Centres (JOCs). Initially these centres were found near Umtali (now Mutare) in the east, Mount Darwin and Mtoko in

76. The USSR began supplying surface-to-air missiles to the PAIGC in 1973. Westad, 215.
77. By 1979, Rhodesia possessed around fifty Alouette IIIs. Some were provided by South African company Armscor under license from Aérospatiale. Parts were shipped from Toulouse and then assembled in South Africa. Anti-Apartheid Movement, "Fireforce Exposed: the Rhodesian security forces and their role in defending white supremacy".
78. Flintham, 125.

the north-east, and at Buffalo Range airfield in the south-west. However, as enemy incursions increased, temporary bases were also set up in the Honde Valley, Shabini, Fort Victoria and in the capital, Salisbury. [79]

A typical mission involved the participation of four Alouette IIIs, a C-47 troop carrier plus a Cessna (Lynx in the RhAF). One of the Alouettes was equipped with a Matra 20mm cannon (the K-car) and transported the operation commander and the gunner, while the others (G-cars) carried four troops armed with either machine guns or rifles. In an organised strike on rebel positions, the Alouettes would take off some 10-15 minutes before the C-47 due to the latter's greater speed once in the air. As it was usual for larger guerilla groups to break up at the sound of approaching helicopters, or be alerted by inhabitants of the area, the strategy was to fly in low and to disembark as quickly as possible. If guerillas were visible, they would be attacked beforehand by the K-car, but all missions involved encircling an enemy position so as to ensure that guerillas did not escape into the surrounding area. This was done by using paratroopers dropped by the C-47 and a second wave of troops called the "Land Tail" could be transported to the zone to sweep the area if the terrain permitted this type of operation.



In spite of Rhodesian forces being able to hold out against rebel forces until early 1979, as was the case with France and Portugal beforehand, a mixture of international pressure and / or a growing number of better equipped rebel forces plus a shortage of manpower made Rhodesia's position increasingly untenable. It had tried to compensate for this lack of manpower by recruiting US Vietnam War veterans, Australians, New Zealanders, British

79. Cocks, 45.

and a company of around 200 French mercenaries, the 7 Independent Company, but in the end the odds were overwhelmingly stacked against them. Indeed, it has been estimated that by January 1979, there were as many as 12,000 guerillas inside Rhodesia while another 22,000 ZIPRA and 16,000 ZANLA guerillas lie in wait outside the country.[80]

In order to face up to the inevitable, in March 1978 Smith sought to reach an agreement with moderate African nationalist leaders Bishop Abel Muzorewa, Ndabaningi Sithole and Jeremiah Chirau. However, unhappy with this Internal Settlement agreement, ZANU and ZAPU acting in unison as the Patriotic Front promised to keep fighting until it had attained military victory. Despite Muzorewa becoming Prime Minister in April 1979 and despite the country being renamed Zimbabwe-Rhodesia, as a demonstration that nationalist military forces would use virtually any means to achieve their goals for a completely independent Zimbabwe, ZANU's armed wing ZIPRA had shot down two unarmed Vickers Viscount civilian airliners in September 1978 and February 1979 respectively. To appease these groups and to reach a peaceful conclusion, British Prime Minister invited representatives from all sides to London in late 1979. The subsequent Lancaster House Agreement signed on 21 December 1979 brought an end to the existence of Rhodesia. Elections held in February 1980 saw the arrival of Robert Mugabe as president of the newly-created Zimbabwe. This was a position he would hold until he was ousted from power in November 2017.

Conclusion

A far cry from its humble beginnings as a utility aircraft used in casevac operations, the helicopter evolved into a veritable weapon of warfare that had gained almost iconic status. This position attained through cinematic projections of the role of the helicopter in the Vietnam War, the adaptations this VTOL underwent in the 1950s and 1960s transformed the development of military strategies implemented to confront the challenges of irregular warfare. Effectively, the guerilla could no longer seek a safe haven in familiar terrain, and neither could he feel that he was out of reach and able to act indiscriminately among local populations. Furthermore, when the guerilla did venture out to attack his enemy, he could be sure that sooner or later a heliborne operation would be launched to stop him in his tracks.

Still very much a part of contemporary conflict, the development of helicopter warfare made an inestimable contribution to the way war was waged in African colonial conflicts. Providing a kill rate in Rhodesia of up to 80 to 1,[81] the evolution of the helicopter enabled armed forces to switch from

80. Beckett.
81. Wood.

conventional to irregular methods in order to gain the upper hand over an enemy little concerned by an obligation to engage in a frontal war. However useful the helicopter was in irregular warfare, any contribution it did make was ultimately hobbled and negated by political embattlement and psychological conditioning: all three of the wars we have presented in this paper resulted in a loss for supposedly superior military forces.

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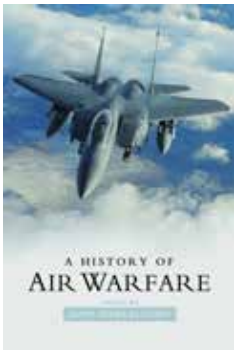
INTERVIEW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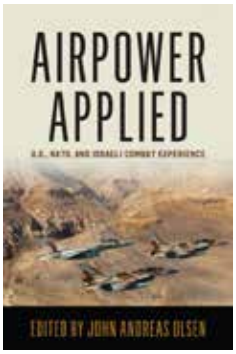
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AIRPOWER
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DESTINATION
NATO
Rohan Maxwell and John Andreas Olsen
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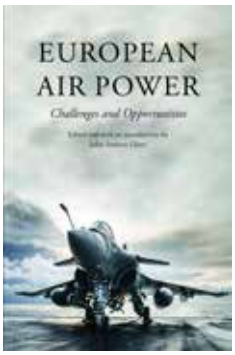
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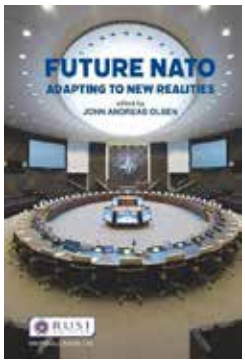
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ADAPTING TO NEW REALITIES
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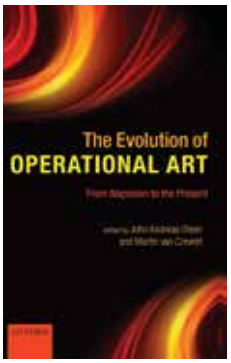
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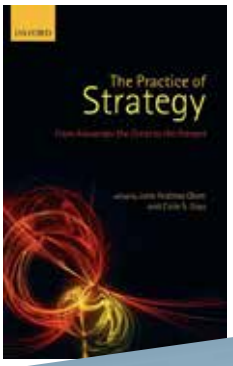
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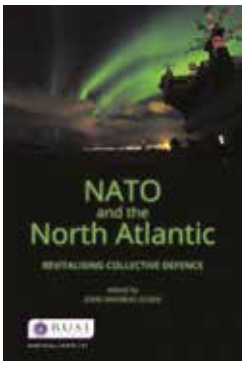
NATO
and the
North Atlantic
REVITALISING COLLECTIVE DEFENCE
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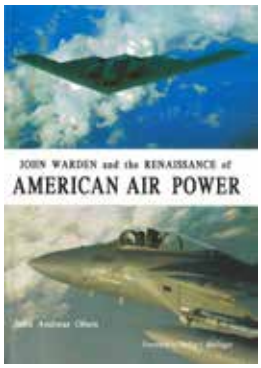

JOHN WARDEN and the RENAISSANCE of
AMERICAN AIR POWER


Routledge Handbook
of Air Power


SECURITY IN NORTHERN EUROPE
DETERRENCE, DEFENCE AND DIALOGUE
RUSI


STRATEG
AIR POW
in Desert

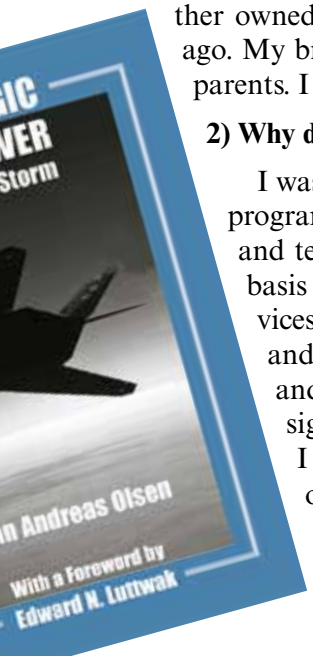
Interview with Colonel John Andreas Olsen

Jean-Christophe Noël

You have written and edited many books on air power, becoming one of the most important authorities in the area of air power studies. However, our readers do not know a lot about you. Could you tell us more – among other things, to provide background on your books?

1) To begin with, could you tell us a little about your upbringing?

I was born in Stokmarknes, Norway, a small town on the north-west coast, well north of the Arctic Circle. I spent most of my first eighteen years there, except for a three-year spell in Melbourne, Australia. I took an interest in schoolwork, especially mathematics, geography and history, and played football for the local team. My father is a watchmaker, and he and my mother owned a watch- and jewellery boutique until they retired some years ago. My brother and I had a very good upbringing with caring and loving parents. I could not have had a better childhood and youth.



2) Why did you decide to join the Air Force?

I was initially attracted to the Royal Norwegian Air Force's two-year programme that offered a combination of military leadership training and technical education. I thought the combination would be a good basis for whatever I decided to do next. Also, of the three military services, I thought the Air Force was the most technologically advanced, and I still believe that is the case. I was not interested in aircraft per se and decided to specialize as a radar technician. During my first assignment at Sørreisa radar station in Northern Norway, 1989-1992, I came to appreciate the opportunities that the Air Force had to offer, so I stayed.

3) You also had the opportunity to pursue academic studies, in part while you were already on active duty in the Air Force. Can you tell us about them?

I received a BA in electronic engineering from the technical college in Trondheim in 1994, an MA in Modern British Studies a year later from the University of Warwick and then a PhD in History and International Relations from De Montfort University. Although I enjoyed engineering – and have used its systematic flow-chart problem-solving methodology ever since – I discovered I was much more interested in strategic studies in general and warfare in particular. During my MA studies I decided to get back to England at the first opportunity to complete a PhD. After two years at the Air Force's Materiel Command, I signed up for a doctoral program.

4) Why did you decide to work on the Gulf War? A great deal had already been published and what happened in that conflict seemed quite clear. Also, the Balkan war was raging in Europe and strategists were talking more about CAS than about strategic bombing.

My MA thesis focused on UK involvement in the Gulf War of 1991, Operation Granby, and specifically on national politics and media, not on air operations per se. When I discussed the possibility of pursuing a PhD with my supervisor, and said I wanted to focus on the utility of air power in a recent campaign, he advised me to avoid centring my work on an ongoing conflict, such as the Balkans. This was good advice. When I applied for a PhD grant from the Royal Norwegian Air Force I made the case that air operations in the Gulf War of 1991 would offer valuable lessons that in turn would be relevant to teaching at the Royal Norwegian Air Force Academy. Early on in my research I became fascinated by the strategic air campaign and the ideas of Colonel John A. Warden, so I decided that my PhD thesis would focus on the strategic air campaign in Desert Storm and how it affected the Iraqi regime and Saddam Hussein's decision-making apparatus. I had access to the USAF officers who planned and executed the air offensive and to Iraqi generals who had defected to London during my period of study, 1997-2000. I also had the opportunity to meet the former chief of intelligence, General Wafiq Samarrai, and other senior Iraqi officers and officials who gave me unique insight into how the air campaign was viewed from 'the other side of the hill'. After I had completed my PhD I spent three years teaching at the Royal Norwegian Air Force Academy and turned the manuscript into my first book, *Strategic Air Power in Desert Storm*, published in 2003.

5) Since almost 20 years have gone by since the publication of the book, would you alter any of your conclusions?

I still believe that the strategic air campaign against the Iraqi regime was very effective, especially when combined with control of the air and the tactical air campaign against Iraqi tanks, artillery and troops, but it would have

been even more successful if the Coalition had possessed a better understanding of the inner workings of the Iraqi regime. John Warden's Five Rings Model and his effects-based approach, when adapted to the realities of any given war and based on insight into the opponent's political-social-economic-military constructs, can have an enormous impact. I believe this will be even more true in future wars than in the past, as situational awareness and precision technology continue to improve. A leadership-centric campaign requires a solid understanding of how the opponent's state and society function – a genuine net assessment. If such a campaign is based on an accurate analysis of the regime of interest, air assets can have a disproportionately greater effect when applied against the leadership, key nodes and high-value targets as opposed to a strictly battlefield-oriented approach.

6) Can you draw some generally applicable conclusions from the Gulf War, or were the conditions of that conflict unique?

It was the 'Perfect Storm' in many ways: the U.S. political and military leadership established and acted on clear and achievable objectives; the Iraqi leader was incompetent as a wartime commander; the U.S.-led Coalition forces were exceptionally well prepared and professional; the Joint Force Air Component Commander (JFACC) had all the air assets he could have hoped for; and he (General Charles A. Horner) was blessed with air planners who understood the strategic as well as the tactical application of airpower. In wars of the past, the commander had to manage shortages; in this one the Coalition enjoyed the management of riches. It also demonstrated for the first time that air power could be the leading element in a war, that a war strategy can be based on what air power can achieve, and that game-changing technology can be turned into a game-changing strategy when applied in conjunction with innovative thinking. The emphasis on systemic paralysis and strategic effects as opposed to traditional destruction and attrition made a difference by ensuring relentless pressure while avoiding unnecessary casualties and collateral damage. The air campaign also demonstrated an alternative to the then-standard AirLand Battle approach. Desert Storm remains the most successful air campaign in modern history.

7) You insist on the importance of pursuing systemic paralysis and strategic effects rather than just military attrition. The strategic level of war seems to be especially important for your work. You even edited a book on strategy with Colin Gray. Do you think strategy is the most misunderstood level of war in the Western military world today?

Most Western militaries understand the tactical and technological levels of war well. Military officers are masters of technology and innovative tactical manoeuvres. What's more, a large amount of literature on international relations, diplomatic art and statecraft gives scholars within that discipline insight into the political and grand strategic levels of war. So students of

warfare have adequate knowledge about the *ends* and the *means* of war, but less about the *ways*, because we do not sufficiently understand the strategic and operational levels of war. As a result we have a weak link in the ends-ways-means nexus, because very few focus on military strategy and the operational level. This is why I contacted Professor Martin van Creveld about collaborating on a book about the evolution of operational art and Professor Colin Gray on a book about the practice of strategy. The books were designed to help military officers and scholars better comprehend the strategic and operational levels of war. I learned a lot from working with these two professors.

8) How do you remember working with Colin Gray?

He was a superb scholar and he was in many ways the intellectual leader of our times on military strategy. He inspired others to think and write – and to think again! – whether they agreed or disagreed with him. He offered insights into the links between air power and strategy in what I consider one of the best books in the field, *Airpower for Strategic Effects*. He was great to work with – very honest, dedicated and always willing to help. He was an encyclopaedic source of knowledge about warfare, never short of an anecdote and he had a great sense of humour. It was a real pleasure to get the chance to work closely with him on the strategy book and I will be forever grateful for his chapter in *Airpower Reborn*, a book that focused on the strategic concepts of colonels John Warden and John Boyd. He had very strong views on the strengths and weaknesses of both men's ideas. I was very sad to hear that he passed away last year, after he had struggled with cancer for some time.

9) By the way, who are the authors, scholars or theorists who have influenced you most?

In general, I have been most influenced by the works of Basil Liddell Hart, J.F.C. Fuller, Michael Howard, John Keegan, Edward N. Luttwak, Martin van Creveld, Colin S. Gray, John R. Boyd and H.P. Willmott. In terms of air power thinking specifically, I would single out John A. Warden, David A. Deptula, Richard T. Reynolds, Charles A. Horner, Alan Stephens, Richard P. Hallion, Philip S. Meilinger, Benjamin S. Lambeth and Tony Mason.

10) How did your career progress? Are there any particular moments you especially like to remember?

I have tried to pursue a military and academic career simultaneously. I have been very lucky in my assignments and never had a bad one. I remember fondly my time as Dean of the Norwegian Defence University College and Head of Strategic Studies from 2006 to 2009, the following two-and-a-half years as Deputy Commander and Chief of the NATO Advisory Team at NATO HQ Sarajevo and my two years as Director in the Department of Security Policy in the Norwegian Ministry of Defence, 2014-2016. The time

in Bosnia and Herzegovina, when I was working on operational issues with a focus on defence and security sector reform, was very special. I had the opportunity to speak about NATO and BiH's road to joining the Euro-Atlantic partnership throughout the country and meet with the national leadership. We held seminars in every single municipality in Republika Srpska, as well as in the majority of municipalities in the Federation, but the most challenging aspect of course was finding ways to engage with the Bosnian Serbs on future NATO membership. Some of them were very confrontational and emotional, but I enjoyed these battles tremendously. My current assignment as Defence Attaché to the United Kingdom and Ireland offers a unique opportunity. My wife and I have enjoyed our time in London tremendously; it is our favourite city. It has been said that if you are tired of London you are tired of life. My favourite football team, Liverpool, has had some exceptionally good seasons lately which has added delight to living in a country that takes the Beautiful Game so seriously. On a more professional note, it is extraordinarily rewarding to work on improving bilateral relations between Norway and the United Kingdom and to operate in such a vast international diplomatic community. I will acknowledge that I have been very impressed with the French officers during my tour.

11) You have published a series of books on air power that were sponsored by the Swedish National Defence University. They deal with many aspects of air power (historical, leadership, sociological and geographical, European and global) and your editing of the Routledge Handbook of Air Power is kind of unique! Even if you do not think that these books contain rigorous lessons to learn, you do seem to believe that the utility of airpower is highly situational and the books represent an incentive to think rather than recipes for success. What are the most important points you would like to emphasize?

I was a Visiting Professor at the Swedish National Defence University from 2008 to 2019. It is a great workplace and I had the chance to contribute to closing what we considered gaps in the air power literature. I began a journey of publishing books on air power history, operations, theory and leadership. My motivation is that military professionals must explore the historical record to identify what succeeded and what failed in the past, and must translate those experiences into principles and 'best practices'. These publications are intended to help them develop a rounded understanding of our air power profession, not to advocate a specific theory or doctrine. The series of books is intended to inspire officers to think holistically without fearing or favouring any single viewpoint, and not simply to look to the past. The main message is the importance of ideas and of officers developing concepts and strategies rather than merely focusing on technology and tactics. In order to do that they need literature that covers the depth, breadth and context of air warfare. I was honoured when I was asked to edit the *Routledge Handbook of Air*

Power, which is a kind of confirmation that air power has become an academically respectable field of study. The book explores *why* political leaders have come to regard air power as their instrument of choice to deter and if necessary coerce adversary regimes, *what* air power can and cannot accomplish as a tool of national strategy in the ever-demanding and ever-changing international security landscape, and *how* air power should be studied to gain an appreciation of its complexity and its influence on war and peace.

12) What are the turning points in the history of aerial warfare?

World War II was crucial, because we witnessed the application of air power on a scale and scope never seen before. It had a major impact on the outcome of the war in several theatres. Undeniably, the invention of nuclear weapons has influenced political and military thinking tremendously. The Cold War did not involve any spectacular 'turning point' applications of combat air power, with the exception of Israel's 1967 war and signs of brilliance in 1973 and 1982, but Operation Desert Storm truly was a master class in air warfare compared to any application of military force since the Second World War. It set new standards for what the public, politicians, and all military services expected from airpower and it represented a new phase in the evolution of military operations, capabilities, and effectiveness. It combined new revolutionary technology (stealth and precision) with innovative effects-based concepts. It was the first-ever test of assigning a JFACC – a single air manager. Air power has performed well in later campaigns, especially in Operation Allied Force over Kosovo in 1999 and the initial high-intensity phases of Operations Enduring Freedom in 2001 and Iraqi Freedom in 2003, but these were building on the success of the Gulf War of 1991 rather than new 'turning points'.

13) What should never be done when using air power?

Political leaders and military planners often base their assumptions on abstract notions and mirror imaging. History shows that at times states enter wars without clearly defined achievable objectives. Decision makers need to appreciate that even the most robust and capable air weapon can never be more effective than the strategy and policy it is intended to support. The Vietnam War, especially Operation Rolling Thunder from 1965 to 1968, provides a good case study of how NOT to use air power in particular and military force in general. It showed that one should avoid long-distance micro-management, avoid complicated rules of engagement and avoid air engagements not governed by an overall strategy. It also showed that politicians and military leaders have to be honest with the media and the people they serve and that a military operation must have a clearly defined chain of command. The gradualist and incremental tit-for-tat drizzle approach did not work; air power should be applied strategically, decisively and effectively.

14) You have also edited books on NATO. Does that mean that the series of books on air power is finished? Are there some aspects you would still want to deal with?

When I arrived in London as defence attaché the Norwegian Ministry of Defence agreed to publish a series of books on the importance of NATO. I contacted the Royal United Services Institute (RUSI) and we agreed that I should produce a trilogy in its Whitehall Papers series that would contribute to a more informed discourse on security, foreign and defence policy. The results were *NATO and the North Atlantic* (2017), *Security in Northern Europe* (2018) and *Future NATO* (2020). In tandem with the publications, I presented these books at seminars in more than twenty capitals, covering most of Europe and North America. I lectured in Paris twice – and each time there were very candid and perceptive discussions on the future of the Alliance. I might write more about NATO, and I will definitely write more about air power. As we speak I am about to complete an article on the leadership of General Chuck Horner, focusing on the man, the pilot and the commander.

15) You have also taught air power to political and military elites. How do you define air power with them? Is it easy to teach them about this topic, or do you feel there are a lot of misunderstandings?

I find that there is a general interest when the focus is on air power's role in national policy, international relations and statecraft. It is important to frame lectures or seminars so that they offer perspectives on the political purpose, strategic meaning and military importance of air power. I get a fair hearing when emphasising how warfare has changed over the last few decades and why airpower has become a prominent factor in modern war. These audiences also show interest when I talk about the people and personalities behind the ideas and when we together try to translate theory into practice. Very few are interested in purely academic views; theory must be applicable to action. In general, students of warfare do not understand modern air power. Even air force officers struggle to gain a proper appreciation of this phenomenon, because they are still overly focused on technology and tactics rather than wider perspectives of air power. Many Western nations have fifth generation aircraft but they do not have fifth generation air force organisations and fifth generation air power doctrines.

16) You are Norwegian, and one of your neighbours is Russia, which has renewed and impressive air power means. But your books have very few chapters about Russian or Chinese air forces. Don't you think these two countries have alternative views of air power that could be very useful to study?

Both these countries are becoming more and more air power savvy and their mind-sets and values are very different from those common in Western countries. A brief examination of Russian and Chinese combat air

power trends gives reason for concern. We know that both countries invest in new capabilities and that they give priority to equipment, training and increasingly complex and advanced exercises. Both are moving away from the ground-centric view of air power as primarily an auxiliary contributor. You are right; my books focus primarily on U.S. and Western air power, although I have included chapters on both Russia and China in *Global Air Power* and the *Routledge Handbook of Air Power.* More in-depth studies are needed because the more we study and learn about Russian and Chinese aerospace power the better prepared we will be to develop credible deterrence and capable defences. We can then engage in a more meaningful dialogue and even promote cooperation on matters of common interest. From a policy perspective we should pursue a dual track approach of deterrence and defence on one hand and dialogue and détente on the other; the air power conversation should be framed within that construct.

17) By the way, what is the role of air power in hybrid warfare?

You could make the case that air power is the backbone of hybrid warfare for two reasons: in terms of deterrence to avoid escalation beyond subthreshold activity, and in terms of ISR (intelligence, surveillance and reconnaissance) and potential follow-up with precision strikes. In these scenarios, real-time information is key to proper decision-making processes and air power can strike with extreme precision over long standoff distances on very short notice. If you know where something is you can hit it, although that does not necessarily mean that you should. Looking to the future, and drawing on historical examples from Afghanistan in 2001, Iraq in 2003 and Libya in 2011, the combination of real-time ISR, precision strike and Special Forces can be a very powerful tool to deal with a myriad of asymmetric scenarios. Collaboration between air power and Special Forces has enormous potential, especially in grey-zone scenarios of various sorts.

18) When we consider air power, it is often through the lens of American literature, and that is the perspective of a superpower. But what does air power mean for a country like Norway, which can only operate a couple of fighter squadrons? How can you make the best use of your assets?

The United States IS an air power; the rest of us have some degree of it. NATO is designed for U.S. leadership; without the U.S. there is no NATO. Thus, the way the U.S. develops – politically, economically, militarily and socially – is of utmost importance to friend and foe alike. Norway has been a member of NATO since 1949 and we consider ourselves NATO's eyes and ears in the north. To have a strong defence, and contribute to NATO's purpose and missions, we have decided to invest in 52 F-35As. That is a considerable commitment for a nation of a little more than five million people but a necessity given the size of our country and its particular geographic location. The new F-35 offers Norway a unique military capability,

as well as flexibility. It can contribute to three of the four main air power missions: control of the air, ISR and precision strike. The more we use the F-35 the better we will come to understand its revolutionary capabilities. The investment allows us to have state-of-the-art aircraft as well as interoperability with many of our closest allies. We are also purchasing P-8 Poseidon maritime patrol aircraft to replace our P-3C Orion and overall we are investing in air defence, radars and helicopters. We contribute a C-130 Hercules to the operations in Mali and our pilots are very professional. All in all, the Norwegian Air Force can be a player where and when needed. As part of a larger Alliance, this is a very solid point of departure for defending king and country.

19) How do you see the future of air power?

In comparison to land and sea warfare, I think the role of air power will become ever more important in both deterrence and other military missions. The UK Ministry of Defence's Combat Air Strategy is an ambitious vision for the future, designed to preserve national advantage and maintain choice. Its conceptual approach to finding a new aircraft to replace the fourth-generation Typhoon, epitomized by Team Tempest, offers one glimpse into the future. This new affordable aircraft – whether manned, unmanned or a combination thereof – is set to operate alongside the UK's F-35Bs. Maintaining the ability to gain air superiority over peer opponents will remain paramount. Western nations need to invest in new platforms and weapon systems and increase automation of command and control – that is, take full advantage of capabilities offered by the Fourth Industrial Revolution and then match those with appropriate concepts aligned to the notions of strategic effect, systemic paralysis and systemic empowerment. The future of air power lies just as much in the intellectual as in the technological realm.

20) Do you see the rise of drones, and the new importance of space and cyber, as important developments that could change the nature of air power?

New technology and new concepts might change the character of air warfare, but not its underlying nature, not the fundamentals. I think air power as we know it today will continue to evolve, including manned fighter-bombers as well as drones. As we continue to develop drones we must never lose sight of International Humanitarian Law (IHL), especially the concepts of legality and legitimacy and the principles of military necessity, proportionality and human rights. The politically desirable and technologically possible must never be allowed to trump IHL. The same applies to space power, which is more than a linear extension of air power. It is a domain in its own right and we will need to expand both our logical approaches and our imaginative capacities to understand the new role of space in war and peace. Cyber is a new domain as well, and it is a wild card that we have yet to fully

comprehend. We cannot think of space and cyber in the same way we think about the three classical domains, because their ramifications lie outside the areas normally considered within scope of the traditional military mind. To ensure we make full use of these domains we must explore inter-service, inter-departmental and cross-domain concepts; we need to learn how to think differently while adhering to IHL. Throughout this process, we must realise that lateral thinking and imagination are just as important as scientific logic and military knowledge.

Thank you very much, John.

REVIEWS

Wartime paradigms and the future of western military power

by Olivier Schmitt

Review by colonel D. Pappalardo

OLIVIER SCHMITT, Director of the Center for War Studies (University of Southern Denmark) and Director of Studies and Research at the French Institute of Advanced Studies in National Defense

In *Wartime Paradigms and the Future of Western Military Power*, political science professor Olivier Schmitt invites us to reflect on the art of conceiving time within strategy[1].

According to him, since 1989 the Western world has locked itself in a new Wartime Paradigm under two characteristics: a praise of speed at the expense of patience, and reducing war to a "mere expeditionary tool for risk management". For the last three decades, this paradigm, which was widely endorsed by the United States, has shaped the way we lead operations as well as our capacity choices and our defense architecture. In order to cope with the evolution of warfare - on the one hand, the spread of Anti-Access / Area Denial (A2/AD) postures, and on the other hand, the wide-ranging use of "hybrid" strategies and actions within "gray zone" it seems essential to renew our wartime model by assessing all the dimensions of time within conflicts (duration, frequency, sequence and opportunity).

Olivier Schmitt starts out with a reminder of the direct link that binds

1. O. Schmitt, "Wartime paradigms and the future of western military power", *International Affairs*, Oxford University Press, The Royal Institute of International Affairs, vol. 96, n. 2, March 2020

strategy and time. Rather than an objective reality, time is seen as a construction by which the coordination between past, present and future (*regimes of historicity*) is understood. Our perception of time influences our conception and our conduct of war, through what he calls the *wartime paradigm*.

Since the end of the Cold War, the Western wartime paradigm has been at the crossroads between two imaginary constructions. The first of these is technological and conceptual: it highlights the acceleration of both time and speed, whilst strategy remains based on a project, which is forecast over the longer term. At a conceptual level, John Boyd's OODA loop[2] embodies this trend perfectly as it is often misunderstood. Some people place too much emphasis on its speed, however the synchronization of effects is what guarantees operational superiority. The second construction reflects a political imaginary, which stresses risks rather than threats and turns the military apparatus into a risk management tool.

This paradigm is by no means neutral and has shaped the way we approach war. By favoring a strategic posture, it prioritizes modular and expeditionary quick response forces that are able to "manage risks" in "forever wars"[3]. It has also promoted attempts to paralyze the adversary by relying on faster execution, as illustrated by the American concepts of Revolution in Military Affairs (RMA), of the Network Centric Warfare (NCW) or of the Effects-based Operations (EBO).

Olivier Schmitt continues his argumentation by describing the main factors of evolution of warfare, which set the limits of this wartime paradigm. These include:

- A2/AD postures, mainly implemented by China and Russia;
- the spread and dispersal of increasingly lethal and sophisticated technologies[4];
- the use of "hybrid" strategies aiming to obtain gains by coordinating the effects of their diplomatic, military, economic, informational and legal actions, according to an overall dynamic which is ambiguous and often difficult to detect (therefore calling for an ability to anticipate, detect, understand, and set counter-actions when needed);
- the conflict over the electromagnetic spectrum, through electronic warfare, Positioning - Navigation - Time warfare (NAVWAR[5]), or through offensive cyberoperations (including information warfare);

2. Observe, Orient, Decide, and Act.

3. The 'forever war' is fundamentally a vision in which armed forces must be able to act fast, wherever, whenever and for as long as deemed necessary: it is in fact a vision of 'forever policing'

4. What Audrey K. Cronin calls a '*widespread lethal empowerment*' (A. K. Cronin, *Power to the people: how open technological innovation is arming tomorrow's terrorists,* Oxford, Oxford University Press, 2019).

5. NAVigation WARfare.

- broadening warfare into exo-atmospheric space;
- a greater propensity for urban warfare, resulting in an increasing complexity in operational conduct.

According to Professor Schmitt, these changes in the character of warfare question the bases of the wartime paradigm in which we are locked. To this end, armed forces must free themselves from their solely risk management mindset to revert to the coercion[6] and deterrence tools they once were. We must also relearn to master time and control its rhythm at all levels of war (*slowing down the pace of operations in certain areas and accelerating it in others*).

At a strategic level, information warfare and strategies of ambiguity require us, for instance, to slow down the pace of operations in order to obviate the trap of escalation. At the operational level, A2/AD postures also require relearning patience and attrition: "*Baiting' the defence by testing it, eventually forcing the operators to fire expensive missiles, and waiting for the right opportunity to engage is one of the ways to achieve some limited air superiority in defence-rich areas of operations*".

At a tactical level, whilst speed will remain an element of domination, its payoffs will likely decline as opponents scale up.

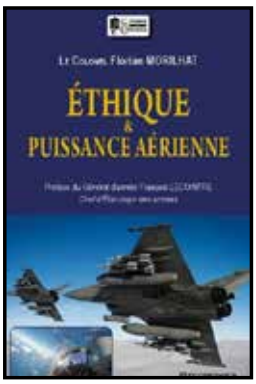
This article's contribution to strategic thinking is all the more relevant and welcome as the military community is generally more inclined to view time in terms of speed rather than slowness or its other meanings. Olivier Schmitt's words are an invitation to think outside the box of current strategic thinking and to stop repeating old mantras that limit our reasoning, such as "shorten the OODA loop".

Rather than truncate our perception of time, we should reason through its four dimensions (duration, frequency, time, opportunity). Cardinal de Retz seemed to have understood this in his maxim, which perfectly fits into military strategy: "There is nothing in the world which does not have its decisive moment and the masterpiece of good operational conduct is to know and seize this moment".

6. In the sense of « *exploitation of potential force* » as defined by Thomas C. Schelling in *The Strategy of Conflict*, published in 1960.

Éthique & Puissance aérienne

Colonel Florian Morilhat



Review by
lieutenant colonel Raphaël Briant

Is there such a thing as air power ethics? What about airmen's ethics? What moral dilemmas do pilots face when opening fire in the heat of the action? These are some of the queries that Lieutenant Colonel Florian Morilhat attempts to answer after a thorough and unprecedented reflection. As he points out, the topic - ethics and air power – had as yet never been addressed in a holistic manner. This observation compelled the helicopter pilot and officer of the French Air and Space Force, to draw upon his rich operational experience as well as his theorizations around the ethics of decision-making, which he also teaches at the French National Institute of Languages and Oriental Civilizations (INALCO). And he happens to do so very convincingly. A matter of course is lain forth when turning the final page of this book. By querying the airman unequivocally on the way his identity, his values and his traditions influence the way he faces his responsibilities, the author succeeds in demonstrating the centrality of ethical questioning within airmen's commitment, going against some preconceived ideas.

The next lines do not intend to summarize the author's comprehensive approach, but to enlighten the reader in a critical way, by resituating some of the notions that are mentioned within the wider field of humanities and social sciences. This is, in fact, what Lieutenant Colonel Morilhat encourages us to do in the prolegomena, by reminding us that airmen's ethics are rooted in both their personal convictions and in their shared experience. This is why it must be approached through both an individual and a collective angle, at the crossroads between multiple disciplines, such as sociology, history and law. Whilst the moral and legal concepts developed by F. Morilhat indisputably demonstrate the existence of ethics that are unique to air power, other arguments of his are more debatable on a socio-anthropological front, inter alia those surrounding the ethics of care. Therefore, the point is here to contextualize the essay within a multidisciplinary debate rather than to make a one-dimensional review.

Ethics and courage

One of the main aims of Florian Morilhat's essay is to reinstate airmen's moral conscience. This is a major challenge. Indeed, while it may be relatively difficult to grasp the question of military ethics due to their surrounding paradoxes[1], querying the ethics about air weaponry is an even more sensitive matter. One merely has to reflect for instance on the devastating effects of air bombings during WWII or the Vietnam War. Yet, if we refer to the various strategic bombing doctrines that were inspired by the first air power theorists such as Douhet or Trenchard, the end goal has always been to use air power to annihilate the enemy's will and ultimately abbreviate the horrors of war. Unlike preconceived ideas, ethics were far from being inexistent in the initial considerations on the use of air weaponry. However, the trauma of strategic bombings are deeply rooted in our collective subconscious and has caused sustainable damage to the airman's chivalric image, turning him into a cold-blooded murderer with no moral virtue.

Would it be possible today to imagine, as Patricia Cook[2] quite rightly points out, that a pilot could aspire to blindly bomb civilians? Between aspiration and reality, the ambivalence surrounding the question of airmen's ethics is the reason why F. Morilhat endeavors to untangle the threads of ethics that are unique to air power on the one hand, and military ethics inherited from the customs of a ground war on the other hand. In terms of the use of air weaponry, the author limits himself to three legal frameworks: *jus ad bellum*, *jus in bello* and *jus post-bellum*. Though he establishes that, due to its political significance and intrinsic violence, air weaponry is primarily concerned by laws of armed conflict - as recognized by article 49 of the first

1. Lucas, G. R., (ed.), *Routledge Handbook of Military Ethics*. London, Routledge/Taylor & Francis Group, 2015. p. 36.
2. *Ibid.* p. 37

additional protocol to the Geneva Convention - he also notices that when it comes to *jus post-bellum*, its application is more limited. We may remark that some authors go much further than F. Morilhat on these points. David Cumin, for instance, explains that despite the special right regulating the use of air weaponry in *jus in bello*, air power has brought the principle of combatants versus non-combatants into question, as it "widens the *theatrum belli* and (abolishes) the distinction between front and rear"[3]. Some other authors, such as Daniel R. Brunstetter, also refer to *jus ad vim* as a normative framework around a use of air power that is limited to carrying out corrective actions under the threshold of armed conflicts[4]. Moreover, the *jus ante bellum*, which considers the importance of law in the preparation of war, would have warranted a more substantial place within this essay[5].

Having unfolded the normative aspects which frame air power along with the precedence of rules of engagement, the author returns to the difference between ethics and morals[6]. Since "law obliges but ethics recommend", an expression, which we owe to French Army General Benoit Royal, the airman's behavior in the heat of the action will be determined by a lot more than the rules of international law. F. Morilhat thus notes that the airman's ethics come, first and foremost, from a need to take on the potential consequences of his actions *ex ante*, regardless of whether they are in perfect compliance with the rules set out by the legal frame within which they take place. In other words, the airman's courage must be acknowledged in the light of the acceptance of the potential consequences of the damage that he has yet to cause. As opposed to an infantryman who often fights in the name of higher values such as glory, honor and nation, the airman acts according to accountability, as it was theorized by sociologist Max Weber at the beginning of the 20th century. This is why the physical distancing between the aircrew and their target must not be seen as a way of paring down accountability.

Modern-day doctrinal evolutions and technical progress, because they associate the increase of weapons range with a certain dilution of responsibilities within the chain of command, admittedly call into question a hypothetical "decline in airmen's ethical reflexes"[7]. Hence Gerard Dubey and Caroline Moricot's legitimate question: "what are today's thoughts, feelings, hardships, of those whose work it is to open fire, to bring destruction and chaos, but remotely, far from the screams and far from the blood (…) far

3. B. Durieux, J. B. Jeangène Vilmer, and F. Ramel, (dir.), *Dictionary of War and Peace*. Paris, PUF, 2017. p. 388.
4. *Ibid.* p. 750
5. G. R. Lucas, (ed.), o*p. cit.,* p. 47
6. Morilhat, F., *Ethics and Air Power*. Paris, Economica. 2020. p. 8.
7. *Ibid.* p. 69

from the dread of war itself?"[8]. An answer can be found in the mention of courage, which can be both physical and moral. According to the two authors, whilst the ethics of warmongering is effectively "based on putting one's life at stake in order to rise above oneself to face one's fears"[9], according to French Army General Thierry Marchand, "other levers, such as the nobility of the cause to defend, inurement or group conditioning, enable to face the threshold of fear". He adds "but they would not suffice unless supported by a personality trait, a temperament or an individual virtue which is commonly called courage"[10].

Courage is therefore a moral virtue. Robert Sparrow explains that moral bravery lies in the ability to do what seems right whatever the circumstances and to face the consequences[11]. The prologue to « *La guerre vue du ciel* », which narrates a Mirage 2000D pilot's missions in Afghanistan, gives a very good example of this conceptual notion of courage, through the moral dilemmas faced by Commander Marc Scheffler when the rules of engagement prevent him from supporting friendly troops under enemy fire[12]. However, moral bravery can also be seen somewhat as a tolerance for error. T. Marchand, basing his argument on a fighter pilot's experience, explains that "the more technical progress there is, the more decision-making and responsibility there is, adding more weight to human error which is now hunted down by airborne recorder systems". Thus, he writes, "confronted with the fear of making a mistake, courage becomes only intellectual"![13]

In order to improve the understanding of the nature of the moral dilemmas faced by aircrews, it is necessary to examine how air weaponry is used in modern warfare: counterinsurgency warfare, hybrid warfare and the increasing use of armed drones and autonomous weapons systems. In the first case, close air support missions are characterized by a significant interweaving of forces on the ground and combat among populated areas. Caught between very restrictive rules of engagement and the will to effectively intervene in support of ground forces, aircrews regularly find themselves confronted with moral dilemmas that force them to take full responsibility for opening fire. This is the exact situation that Marc Scheffler finds himself in when he decides to deliver ordnance in order to save his fellow soldiers on the ground before even being authorized to do so by his hierarchy. Secondly, in the case of asymmetric warfare or "gray area conflicts", Benoit Royal explains: "even

8. G. Dubey, C. Moricot, *Dans la peau d'un pilote de chasse: le spleen de l'homme-machine*. Paris, PUF, 2016. p. 16.
9. *Ibid.* p. 39
10. T. Marchand, « Military Courage », *Inflexions*. 2013, vol.22 n° 1. p. 96.
11. G. R. Lucas, (ed.), o*p. cited.* p. 383
12. Scheffler M., Lert, F., *La guerre vue du ciel: Les combats d'un pilote de Mirage 2000D*. Paris, Nimrod, 2017. p. 15-31.
13. T. Marchand, *art. cit.,* p. 96

if the methods of the enemy are rooted in a tactic and a strategy of terror without any ethical consideration, it is not acceptable to have one's ideals and one's values contaminated by the temptation of tactical effectiveness regardless of any human morality."[14] In a context of engagement where the airman enjoys relative impunity, the main moral danger for him is to corrupt the use of force, thus depriving the act of war of its initial meaning, that is to say, preventing it from reaching necessary conditions for the return of a lasting peace. Finally, the use of armed drones and autonomous weapon systems also raises questions, especially in the case of targeted elimination campaigns. Complementing the previous point of view, Shane Riza identifies two main reasons for the observed discrepancies: the first is that, unlike the pilot in his plane, a drone operator is unable to perceive the effects of a higher order on the human environment of operations meaning that his restricted field of vision does not allow him to understand the systemic consequences of targeting within the population. The second is that drones and autonomous weapon systems violate the principle of "mutual respect" for the adversary, without which no dialogue, and therefore no political outcome, is possible[15].

To further broaden the perspective on the ethical consequences of technological progress in modern air warfare, it is worth considering this warning from General Gallois: "Technology atrophies energy and decisiveness. […] It leads to an exaggerated confidence in the equipment and to a decline in personality and temperament among specialists"[16]. We can therefore legitimately question the behavior of crews from an ethical point of view, seen as mere "system managers". Far from noting a "disintegration of martial virtues"[17], Sophie Lefeez observes on the contrary that the combativeness of the pilots is exacerbated by the need to control their environment. She notes, for example, that the majority of missiles fired during recent air combat (Falklands, Iraq, Serbia) were fired at very short distances because the pilots in flight, even when they had the possibility of engaging form a safe distance, have generally sought to get closer to the enemy even if doing so could expose them to danger. This is, she said, the only way they could justify the act of killing without being ostracized by morality.[18]

14. B. Durieux, J.B. Jeangène Vilmer, and F. Ramel, (dir.), *op. cit.,* p. 512.
15. M. Shane Riza, *Killing without Heart: Limits on Robotic Warfare in an Age of Persistent Conflict*. Washington, D.C, Potomac Books, 2013, p.219.
16. J. Henrotin, *21st century Air Power: challenges and perspectives of airborne strategy*. Bruxelles, Bruylant, 2005. p. 93.
17. G. Dubey, C. Moricot, *op. cit.,* p. 171
18. *Ibid.* p. 28

Airmen's ethics in question

As F. Morilhat remarks, ethics specific to air power, dictated by the uniqueness of the environment and the technological nature of air weaponry, guide the airman in the exercise of his responsibilities. Nevertheless, as a human being, how well does he cope with the moral dilemmas before him? The modern-era debate distinguishes the ethics of the soldier from the ethics of the airman, but also individual ethics from collective ethics. To better understand the ethical uniqueness of the airman, it is therefore necessary to use the tools of the human and social sciences in order to apprehend the facets of the airman's temperament.

Ensuing the work of Charles Moskos and Bernard Boëne, F. Morilhat first calls to mind the mainly occupational nature[19] of the role of the serviceman in the air and space force. It is inherent to the airmen's condition. In fact, the latter is steeped in the culture of civil aviation. As previously mentioned, the decline of martial virtues has also accentuated the tendency to establish safety as the paramount value to the detriment of more traditional soldier's values. C. Moricot and G. Dubey highlight in particular how dexterity and fineness have gradually established themselves amongst the features that are now characteristic of airmen[20].

While the proud distinction of the first pilots originated in the desire to differentiate themselves from the anonymous infantryman, technical perfectionism today tends to suppress this desire for differentiation. The airman must therefore appeal to traditions to rediscover the chivalrous identity to which he claims to be. However, as the author points out, this is not a question of the military tradition in the broad sense, but rather plural traditions understood from a community perspective[21]. It is through the traditions that cement the cohesion of the group that the identity of the airman endures. His personal ethics are thus inseparable from collective ethics.

Is it even possible, however, to define the airmen's ethos through a collective point of view, going against numerous preconceptions? Paradoxically, F. Morilhat insists first of all on what forges his ipseity, that is to say, a relative autonomy within action which relies on a stimulating collective[22]. The story of a Royal Navy Sea Harrier's first victory over an Argentine *Mirage III* on May 1, 1982 during the Falklands War, as told by the 800 NAS Commander[23], gives a good account of the fighter pilot's freedom of action at the command of his plane. As opposed to a war vessel's crewmembers, he is the

19. F. Morilhat, o*p. cit.,* p. 63
20. *Ibid.* p. 172
21. F. Morilhat, o*p. cit.,* p. 83
22. *Ibid.* p. 70
23. N. D. Ward, *Sea harrier over the Falklands*. London, Cassell, 2001. p. 200.

master of his own fate and sole responsible for the successful outcome of the maneuver. For the pilot, it is not only about engaging oneself body and soul in combat[24], but also about living up to the myth by relying on a collective that makes up a backdrop to his own feats. It sometimes arises that, in the excitement of combat, the pilot detaches himself from the collective to pursue the heroic act. This is related by Iftaq Spector, who takes the example of an Israeli squadron in the early 1970s, whose pilots, out of pride, were in the habit of getting rid of their air-to-air missiles to seek out victories by canon over the Egyptian Migs. [25]

The evolution in the use of fighter aircraft over recent decades, moreover when it comes to fire support, has progressively reinforced the weight of the collective in the conduct of air warfare. This is the case for instance within the way that responsibility is shared between the team and the Joint Terminal Attack Controller during Close Air Support missions. Individual action thus no longer prevails, instead it is the shared willingness to reach the outcome. Trust is thereby erected more as a cardinal virtue, and the way in which the patrol is managed becomes the key to victory, epitomizing a collective that from then on takes on a levelling role as it represses excessive personalities. "Mutual looks gauge, appreciate, measure, check (…) that there is a necessary order relevant to every unexpected situation, that an immediate action comes in response to every given order. From these reciprocated looks stems a very strong and imperious collective requirement which applies to each and every one according to their position and rank."[26] *Ceteris paribus*, these words, borrowed from General Lecointre, apply just as well to an air mission. Ultimately, for F. Morilhat, "airmen's ethics are not to seek to replicate a heroic model or follow a glorified ideal, but rather to recognize their belonging to a more intimate group, of which members feel both supportive and dependent".[27]

Far too few accounts shed light on airmen's very own ethical collective, yet the history of the French Air and Space Force abounds with them. Consider for instance the story of Captain Jean Robert, patron of the French airbase 942 of Lyon-Mont Verdun. He lost his own life whilst saving that of his gunner, Warrant Officer Jannin, on June 4. 1940. Chased by three *Meerschmidt 109* on his way back from a photographical reconnaissance mission in the region of Guise, he managed to escape and land behind French lines before succumbing to his injuries. How could he justify not completing his commitment if the importance of responsibility of protecting the lives of

24. J. B. Stockdale, *Thoughts of a Philosophical Fighter Pilot*. Stanford, Hoover Institution Press, 1995.
25. I. Spector, *Loud and Clear: the Memoir of an Israeli Fighter Pilot*. Minneapolis, Zenith Press, 2009. p. 198.
26. T. Marchand, *art. cit.,*
27. F. Morilhat, o*p. cit.,* p. 82

his crew did not overrule everything else? The story of Captain Maurice de Seynes, who died on July 15. 1944, attests of comparable magnanimity. Following a hydraulic failure after takeoff, the Normandie-Niemen pilot, despite receiving the official order to proceed to the evacuation of the aircraft in flight, made four attempts to land in order to save the life of his Russian mechanic who was not equipped with a parachute. He failed to land due to the severity of the breakdown, but his desperate gesture is the epitome of the fellowship at play in fighter squadrons.

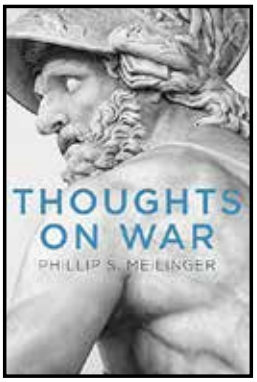
All in all, does this amount to the expression of the ethics of care as suggested by Morilhat? If this approach seems in the very least unusual, it is hard to believe that it could influence airmen's moral concepts in a determining manner. The high percentage of women within the French Air and Space Force (22%) as highlighted by the author, along with Carol Gilligan's essentialist conception of feminine morals[28] only marginally account for the strength of the solidarity that unites airmen within their communities. Conversely, airmen's absence of curiosity and of historical knowledge he deplores seems excessive[29]. One look at the traditions which still thrive within some operational units of the French Air and Space Force and the extent to which they reinforce cohesion within those same units suffice in proving the very opposite. Nevertheless, other factors could weaken airmen's collective ethics. On the socio-anthropological front, it is unclear that the impact of a rise in drones and autonomous systems would ultimately only be marginal. C.Moricot and G.Dubey do not hesitate to see in this "men without quality", in reference to Robert Musil; bereft of the titles of (moral) nobility that are ordinarily bestowed upon the "barons" of air power. On a separate note, the essay unfortunately lacks to mention the ethical consequences of the use of performance-enhancing substances of crews in operation, a topic which interested several Anglo-Saxon studies.[30]

To conclude, there is no doubt that Lieutenant Colonel Morilhat's book will make its mark. It is essential that those who will next wield the incumbency of making air strikes read it. Remarkably well argued and written, it brings many answers relative to the moral questioning which is brought forth by the use of air power and concurrently reconciles the airman with himself. At a time where the use of drones and autonomous weaponry systems is becoming more generalized in operations, this book is a firm reminder that any distancing with war must not equate to moral non-accountability. The airman, in his diversity, must become aware of the fact that he must use the values, beliefs and traditions anchored in the collective as a guide in action to face the increasing complexity of operations.

28. *Ibid.* p. 73
29. *Ibid.* p. 82
30. G. R. Lucas, (ed.), *op. cit.,* p. 406

Thoughts on War

By Phillip S. Meilinger



Review by colonel Jean-Patrice Le Saint

Does Colonel Phillip S. Meilinger, author of the famous *"Ten Propositions Regarding Air Power"* and coordinator of the monumental *"The Paths of Heaven: The Evolution of Airpower Theory*", need any introduction here?

A 1970 US Air Force Academy (USAFA) graduate, he was awarded an MA at the University of Colorado and a PhD in history at the University of Michigan. He first served as a C-130 pilot. At the end of the 1980s, after being posted to the USAFA as a professor, he joined the Pentagon Air Staff's Doctrine Division, then the *Instant Thunder* planning cell during the Gulf War. From 1992 to 1996, he was dean of the *School of Advanced Airpower Studies (*SAAS), the brand new and promising school for US Air Force strategists. He then taught strategy at the US *Naval War College,* before joining Northrop Grumman where he ended his career as an analyst.

The author of 12 books and a hundred articles about military history, airpower theory and military operations, Meilinger is a leading figure in the study of airpower history and strategy. His experience as a practitioner, historian, strategist and educator, gives a unique and almost unclassifiable trait to his work. He is a biographer[1], an organizational historian[2], an historian of ideas[3] but also a theorist. Accurately documented, his writings contribute

1. Biographies of Generals Hubert R. Harmon and Hoyt S. Vandenberg.

2. *Bomber : The Formation and Early Years of Strategic Air Command*. Maxwell, Air University Press, 2012, 372 p. https://media.defense.gov/2017/Mar/31/2001725259/-1/-1/0/B_0127_MEILINGER_BOMBER.pdf.

3. *Airpower and Air Theory, A review of the Sources*. Maxwell, Air University Press, 2001, 164 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a398817.pdf

to the rediscovery of the great figures, the major authors and the history of Airpower, an essential approach to know its principles, the conditions for its successes and the circumstances of its failures.

Published in 2017, his *Limiting Risk in America's Wars,* already took a different standpoint from his prior publications. This book is more political, more Joint-minded, more prescriptive. Noticing the United States' difficulty in achieving strategic successes since 1945 in spite of its military power, Meilinger observes that operations promoting the projection of large land forces often led to a stalemate or even a failure. On the other hand, the combined use of intelligence and airpower capabilities, and Special Forces in support of local combatants, led to quick wins. The concept is even more relevant to the United States: for interventions where its vital interests are seldom at stake, the only way to withhold popular support is to reduce costs. Meilinger consequently advocates a new, more indirect military strategic approach, which consists in moving the combat where it is possible to establish local superiority, at a lower cost and lower risk.

Thoughts on War extends and deepens this theory. It is not a brand-new piece of work, but like *Airwar: Theory and Practice* published in 2003, it is a collection of reviewed essays, already published in various magazines from 2007 to 2017*: Air and Space Power Journal, Joint Force Quarterly, Parameters, Strategic Studies Quarterly.* However, unlike *Airwar, Thoughts on War* does offer some original pieces, and the entire work is arranged in three large consistent parts.

A first conceptual part deals with the theories of war. It invites us to take a step back from the Clausewitzian precepts, considered excessively structuring and partially unsuited to contemporary issues. The claim that "war is a political instrument" has led to multiple interpretations, arguably well beyond Clausewitz's initial intent. It shed little light in advising political and military authorities on decisions and actions, and covers only some situations; war is often triggered on cultural grounds, such as pride, honor, fear, desire for revenge, love, hatred or prestige. According to Meilinger, the supposedly immutable nature of war is also questionable, as evidenced by the development of new combat methods that condition war itself. After having underlined the recent changes in conflict, this part ends by proposing principles of war that are better suited to the contemporary era.

A second, more historical part, mentions the use of secondary fronts throughout history, from the Sicilian expedition during the Peloponnesian War to Operation Torch in 1942, and draws lessons learned. One essay emphasizes the importance of mastering time, which physical and psychological effects (surprise, shock) can be considerable, providing a good synchroni-

zation of operations, especially those combining the engagement of multiple components. A separate essay uses an analysis of the 1940 Norwegian campaign to expose the harmful and even counterproductive consequences of an overly segmented conception of joint operations.

A third part eventually focuses on US experiences. It emphasizes the primacy of cultural factors in a strategy's design and implementation. Their divergence of perspectives and ethos explains why soldiers, sailors and airmen understand war and prepare for it differently. This also accounts for why each component has its own analysis of past battles, and the reasons leading to win or defeat. Melinger uses the example of the War in the Pacific between 1941 and 1945 to illustrate this. For sailors, this is the imposition of a submarine embargo that amounted to the United States' eventual victory. Soldiers contend rather MacArthur's campaign, while airmen still have in mind the effects of strategic bombing, which culminated in Hiroshima and Nagasaki. However, as Meilinger reminds, it was the conjunction of each of these efforts that paid off, in spite of the friction generated by the theater's complex organization of command.

In this third part, two essays address air power more specifically. The first explains its essential role in the targeting process development during the Second World War, illustrating airmen's singular view of war and the most effective way to achieve victory. Unfortunately, appropriate intelligence organization, technology and methods used to assess strikes effects did not exist at the time - and they won't until the 1990s. The second essay logically analyzes the effects of Anglo-Saxon strategic bombing campaigns, through the 1944 survey ordered by President Roosevelt (USSBS, US Strategic Bombing Survey). As a conclusion, the final chapter revisits the model recommended in *Limiting Risks in America's Wars*, intended to capitalize on speed and surprise, on each component's specific strengths, and on new technologies and doctrines: limited engagement, indirect approach, preponderance of aerospace capabilities.

What can we retain upon reading this profusion of themes, analyses, examples and concepts, over a period running from Antiquity to contemporary operations in the Levant? *Thoughts on War* is in fact a protean work, suited to both strategists and military historians.

Strategists will appreciate its challenge of the Clausewitzian paradigm, which still fundamentally conditions the Western art of war, especially through the strive towards a decisive battle that is resource-heavy and seems increasingly difficult to stage. This paradigm, which was erected as a dogma by advocates of direct confrontation, essentially the US Army, seems all the more inadequate today as it was elaborated by a Western thinker in the

early 19th century, who concentrated on "grand style" warfare, ignoring the importance of the technical factor, the maritime fact and moreover the air dimension and then the spatial, cybernetical and informational dimensions of modern warfare.

Likewise, and just as stimulating, is the invitation to rethink the principles of air warfare, other than by transposing to the third dimension the precepts elaborated in other times for grounded combat. In this respect, Meilinger's 10 principles propose an aggiornamento that is certainly debatable, but salutary, because it is representative of both contemporary engagements as a whole and of their joint character: air, space, cyberspace and naval supremacy; homeland security; unity of command; integration; jointness; intelligence; netcentricity; mobility; precision; media awareness and initiative. Lastly, strategists will benefit from the insights on the notion of decisive victory, which has become so overused that it has lost all meaning and practical usefulness. For Meilinger, decisive victories are rare, despite the brilliance of some tactical successes, because it is first and foremost by its long-term consequences that the decisive character of a battle or a campaign can be assessed.

Conversely, historians will appreciate the omnipresent references to the past, which are drawn from – but not limited to - Western heritage. They will perhaps object, however, that, just like Liddell Hart, to whom Meilinger is particularly attached, the examples are purposely chosen to build and support a thesis from the outset. This classic objection is partly admissible, as the author's intellectual rigor is undeniable, owing to his utilitarian approach to lessons of the past.

One could regret *Thoughts on War*'s essentially American prism. The political-military relationship, the context of decision-making, the operational concepts focus on those in force in the United States. Considering the ease with which he manipulates concepts and articulates ideas, the reader would have liked to see Meilinger delve into an even broader perspective, elaborate on the applicability of his ideas to more minor powers, or on the stakes of contemporary coalition operations. This, however, would omit the book's primary intent: to provoke and nourish an informed thought process among his compatriots. Having received the glowing tribute of eminent figures, including General David D. Deptula and Professor Richard P. Hallion, *Thoughts on War* may not be the most remarkable book of the last 20 years as the latter claims. It is nonetheless a valuable contribution to the renewal of thoughts on Airpower and, for fans of Meilinger's clear line, a book to have in one's library. A book to read and reread.

A book on which to meditate.

Les fondamentaux de la puissance aérienne moderne

Philippe Steininger.

Read by Jean-Christophe Noël

There are two ways in which to introduce Philippe Steininger. First, as a brilliant General Officer, born in 1960, who joined the French Air Force Academy aged 20 before leading an integral career as a fighter pilot. He made his air defense debut on the Mirage IIIE, then flew the F-4F Phantom as part of an exchange program with the Luftwaffe. He specialized in conventional attack on the Jaguar before closing his operational career as the Commanding Officer of the 1/12 Cambraisis fighter squadron flying the Mirage 2000. He was next posted to the French Air Force Staff, in roles at the crossroads between the military and the political spheres. His final assignments were as the Strategic Air Force Commander, then Deputy Secretary-General at the General Secretariat for Defence and National Security. In this latter position, he became Senior Official of an institution in charge of coordinating the actions of the ministries within these two fields. Currently the military advisor to the President of the French National Centre for Space Studies (CNES), P. Steninger is therefore far more than an airman. He is a man of the military, well acquainted with political requirements and contingencies.

Yet he is also a air power thinker, not to say one of the few French air power thinkers of his time. He drew attention with his French translation of J. Warden's *The Air Campaign*, published by Economica in 1998, contributed to the development of a journal specialized in strategy and aeronautics, the "BDOC", and published multiple valuable articles on air power, albeit sporadically due to the pervasiveness of his professional activities. All he had yet to accomplish was to write a referential document which could represent the entirety of his standpoint on the air power.

His track record is now complete with his 2020 publication, *Les fondamentaux de la puissance aérienne moderne*. This book is a study of the use of air power over the last thirty years, with an opening on the challenges to come. Inspired by British author J. F. Fuller, P. Steininger mentions the effects of air weaponry in the physical, mental and moral spheres. To this end, he turns to a three-stage process.

The first part deals precisely with the range of effects that air power can trigger. As expected, he opens on a mention of the diplomatic and political dimensions, before focusing on more military aspects. This allows him to outline J. Boyd and J. Warden's theories, which he completes with an article of J. Barlow in the Winter 1993 *Airpower Journal*. Amongst the military effects he highlights, he places the most emphasis on mass, reach, accuracy and reactivity. The contribution of military aviation in counter-insurgency conflicts is not left out, with a brief theoretical introduction of this strand of war.

The author then introduces the coercive use of air power, with a distinctive focus on the fact that its effectiveness could have pervasive effects. Politicians would expect too much from it, either because they are unfamiliar with the way it works or because they imagine it is omnipotent.

Next, the author highlights the elitist aspect of air power. It only involves a handful of professionals, therefore efforts must be made for military and political stakeholders to better understand it. At the same time, its effectiveness relies on cutting-edge technologies, especially in the fields of stealth, accuracy and information. Mastering these technologies is crucial to ensuring air power's success.

The second part turns to the specificities of air power and the knowledge its appropriate use calls for. Achieving air superiority is of course a requirement proven by the main conflicts of the 20th and 21st centuries. Having reminded how the control of air space by western forces is currently threatened, the author matter-of-factly demonstrates the importance of the number of aircraft and crews trained to carry out such a task.

P. Steininger pursues his analysis with an examination of C2. In light of the lessons learned from the former Yugoslavian conflict, he explains how the lack of a centralized command hindered the action of air power, as political constraints held back decision-makers. Instead, he advocates the rapid and forceful use of air power to ensure its effects.

The author concludes this section by recalling the transient nature of air power, due to the technological limitations of aircraft. UAVs do not change this fact, as their use is rather confined to permissive theaters of engagement.

The third and final part tackles future challenges. The first of these challenges is a cutback on combat fleets along with a decision between quality and quantity. The author rightly reminds us that the worst thing would be to give up on both. However, if a choice must be made, he favours quality, by demonstrating that technological superiority has proved more decisive than number in recent conflicts.

The second theme is the hardening of probable engagement scenarios. P. Steininger turns to mathematics to show how a high attrition rate could swiftly put an end to any operation within the third dimension. He suggests an array of ways to remedy this situation. He then delves into the future requirements for interoperability, highlighting the United States' dominant position in this area. It can dictate its standards, in particular thanks to sales of F-35 to most of its allies, and it can decide on the level of cooperation it wishes. In a way, it holds a share of their partners' sovereignty. The closing chapter discusses the influence of technologies such as directed energy weapons, hypersonic delivery systems or artificial intelligence: Steininger concludes on the way air power could connect to orbital systems.

Three appendices extend the book. P. Steininger proves to be both a brilliant lawyer and an uncompromising prosecutor. He first assumes the lawyer's gown, in his explanation of the airborne nuclear component's continued relevance. He then becomes a prosecutor, pointing out the combat helicopter's limits within modern conflicts, as well as the marginal relevance of the aircraft carrier, especially for countries that only own one. In the first case, he reckons that the use of helicopters in autonomous in-depth missions is of a high risk. In the second case, he considers the arguments in favour of the use of aircraft carriers. Seemingly convinced of their usefulness – in high number - or when they move the same weight as American carriers, he raises many pertinent questions, beyond the French Navy's legitimate need to replace the *Charles de Gaulle* aircraft carrier.

Les fondamentaux de la puissance aérienne moderne is a truly well-written book, an easy read allowing any curious reader to master the general principles of air power and to better grasp its issues. The author shows a rare and extensive knowledge which he uses to defend his theses.

Some weaknesses can certainly be found here and there. One may regret the book's very austere layout, some typos, the use of a rather long succession of examples to demonstrate a point, as in the paragraphs on the political dimension. The author could have attempted, even in passing, to better specify overused terms such as "flexibility" or "reversibility", that are tied to air power as if self-evident. A few more elaborations on Pape's thesis, which marked the 1990s and provoked a brief, mild controversy with Warden, would have been appreciated. Some sources could also have been quoted for the reader to delve deeper into certain ideas or facts. Lastly, no bibliography is listed.

The explanation for these shortcomings is quite simple. This book is not an academic book. It is, in our opinion, a book intended to educate through a plea for air power. Just as any advocacy, it is passionate, committed and persuasive. Passionate, because the author shares with us his fervor, and incites us to follow him into the mysteries of war in the third dimension. Committed, because the author - which really is very appreciable - is not content with presenting problems. He shares with us his vision, his beliefs and suggests us to take certain ways to solve these difficulties. Lastly, it is persuasive, because the arguments it presents are often oriented in a direction that is in favor of air power. The limits of the use of military aircraft are naturally acknowledged, but commentators are likely to bring more subtlety to certain narratives here and there.

As a reader, his plea may irritate or delight you, but it cannot leave you indifferent. This is why we must read this fascinating book, the fruit of forty years of reflection. It would undoubtedly deserve a wider release and a greater response, both in France and abroad, to contribute to a quality debate. We shall leave it up to the military leaders and potential publishers to judge. Meanwhile, it is recommended to the readers of this journal.