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.