

# VORTEX

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# CONTENTS

Overview	
Jean-Christophe Noël .....	3

## AIR AND SPACE INTELLIGENCE

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Looking over the Hill: the Air Force's true DNA	
Patrick Bouhet .....	9
Strategic Aerial Intelligence in France (1945-2005)	
Baptiste Colom-y-Canal .....	19
Review and Outlooks of two Decades of Adapting to the Evolution of Conflictuality in the 3rd Dimension	
Sylvain Polizzi –Thierry Maurin .....	31
The Special Operations Air Forces Contribution to Intelligence Manoeuvring	
Julie Bruscoli, Matthieu Lourenco .....	43
New Perspectives on Spatial Data Collection	
Xavier Gallais .....	57
SIGINT and Electromagnetic Operations: All But Forgotten in Future MDOs	
Nicolas Dion .....	71

## VARIA

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Russia's Long-Range Aviation: The Spoiled Child of Impoverished Parents	
Malcolm Pinel .....	87
Selecting Pilots of the French Air and Space Force	
Frederic Choisy .....	113
Space: The Continuation of an Economic, Technological, and Financial War	
Rachel Vijayapandian .....	129
The Future of Air Missions in a Carbon Neutral World	
Nicolas Leprince, Thibault Ricci, Xavier Rival .....	147
<i>The Eagles Are Coming!</i> Tolkien, an Air Warfare theorist?	
Adrien Gorremans .....	159

HISTORY

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WWI and the Birth of Strategic Aerial Intelligence  
Baptiste Colom-y-Canals .....175

INTERVIEW

---

Interview with colonel John A. Warden III  
Jean-Christophe Noël .....191

REVIEWS

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Allies in Air Power A History of Multinational Air Operations  
Read by Pierre Vallée.....203

Airpower in the War against ISIS  
Read by Elie Tenenbaum.....211

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# Overview

Jean-Christophe Noël

Dear readers,

Let's take three iconic aircraft of their time, like the *Breguet XIV*, the *Spitfire* or the *F-4 Phantom II*. Whether they were designed as bombers, fighters or even fighter-bombers, they all have at least one thing in common: all of them had a reconnaissance version developed. The French, the British and the Americans have all designed a version in charge of gathering intelligence from the skies with their most powerful aircraft of the moment, developed for other missions.

If such an effort has been made, it is because this reconnaissance mission has always played an important role in the exercise of air power. Despite satellites, aircraft and now drones still fly over the battlefield or the adversary's territory to provide a vertical image. This is the theme of this fourth issue of *Vortex*: intelligence and air and space power.

Six articles explore this subject, mainly devoted to the way in which l'armée de l'Air et de l'Espace approaches it. P. Bouhet first shows that the use of the third dimension, both aerial and spatial, is intimately linked to observation. The adventure always begins with the same ambition. It is a matter of taking advantage of the resources offered by this high point and preventing the adversary from benefiting from them. Reconnaissance is the DNA of air power, from which everything stems.

Yet what seems natural to airmen is not always shared by other actors. B. Colom-y-Canals tells us the story of the slow re-emergence of strategic reconnaissance in the French Air Force after 1945. Two events accelerated the process. The implementation of the airborne component of the nuclear deterrent and the lack of information available to feed the political decision-making process at the time of the Gulf War. This frustration led to a reorganization of the intelligence chain in France, with the creation of the Directorate of Military Intelligence, which celebrated its 30<sup>th</sup> anniversary in 2022.

The Air Force must adapt to this new situation and draw a line under the legacy of the Cold War with the creation of the Air Intelligence Center (AIC, in French, *Centre de renseignement air*, CRA), which has risen as the fight against terrorism becomes the norm. S. Polizzi and T. Maurin tell us this story, punctuated by AIC remarkable participation in the Air Force's main operations in the 2010s. The authors also talk about their difficulties and the challenges that await them, especially with the integration of new technologies, such as artificial intelligence that will accelerate information processing.

Both sensors and intelligence providers, the Special Air Forces (SAF, in French, *Forces spéciales air*, FSA) are now an essential element of the Special Operations Command (SOC, in French, *Commandement des opérations spéciales*, COS), promoting the use of the third dimension for the success of operations. J. Bruscoli and M. Lourenco demonstrate the adaptation and innovation capabilities of the FSA since the 90s in various theaters with constantly renewed means. This learning and this particular culture of the SF could be very appreciable whereas the SAF seem to decide to develop their original vocation of assistance to the strike or the projection in depth of the French Air and Space Force's aircraft in a renewed geopolitical context.

The way in which intelligence is collected and exploited from space has also evolved considerably since the end of the Cold War, with the appearance of new architectures favoring quantity over quality. In this respect, the *New Space* has barely appeared when it seems to have already been overtaken by the *Next Space*. So many challenges for the new Space Command (*Commandement de l'Espace*, CDE) that X. Gallais describes for us in an article about certain threats lurking on our spatial means, and the need to know the situation in outer space to act better.

Finally, N. Dion concludes this article collection by alerting us to the deficit of the French armed forces in the field of electromagnetic intelligence gathering and associated means of action. This situation is all the more detrimental as this field is essential for the implementation of Multi-Domain Operations, which should become the norm in the future. The trade-offs in a constrained financial context have always been unfavorable. Being aware of this would be a first step in trying to find a remedy.

The *varia* section has probably never deserved its name so much. The theme of air power is declined in several different categories for, we hope, your greatest pleasure and surprise.

This section begins with an article by M. Pinel on the role of the Russian Long Range Aviation (LRA) in the Ukrainian conflict. Perhaps the least visible component of the VKS and the Russian army in general, Russia's LRA has nevertheless been mobilized since the first hours of the conflict. Although it has a strategic, even nuclear, vocation, the author shows that the Long Range Aviation has also been used for tactical and operational purposes. The strategic strikes of these bombers on the Ukrainian energy production complex must nevertheless

be supplemented by Iranian suicide drone attacks costing 20,000 dollars each. A symptom of the difficulties of the VKS? A revolutionary turn in the form of air warfare? Only the future will tell.

Focused on another topic, F. Choisy explains how the selection of future pilots is done in the French Air and Space Force. The processes and criteria are dissected, offering the opportunity to better understand what is expected in the operational units. This article reminds us that beyond the debates on the capabilities to be acquired, it is first and foremost the people who make up the air forces. Their performances are merely a reflection of the qualities of the airmen.

*Vortex* also addresses management sciences thanks to R. Vijayapandian who explores in detail the advantages of the Public-Private Partnership for the development of the space industry in France and the Space Command. Her article echoes the developments noted by X. Gallais in the dossier of this issue. She highlights successful examples from abroad, does not ignore certain risks associated with this choice of financing, but finally regards that this option should be better considered.

N. Leprince, T. Ricci and X. Rival deal for the first time in France with a subject that is likely to become very common. How can air power contribute to the fight against global warming? The authors show that even if the share of military aircraft in this phenomenon is very small, airmen cannot remain idle in the face of this global challenge. Some interesting first steps are proposed. No doubt that other initiatives will follow in the future.

Finally, the fans of *Fantasy* and air power are particularly pampered with the last article of the *varia* section written by A. Gorremans. The author has the particularity of speaking Elvish – even if he admitted to us that he had lost a bit of fluency, our meager knowledge of the subject did not allow us to corroborate it! As a fighter pilot and a connoisseur of Tolkien's work, A. Gorremans was undoubtedly in the best position to describe the place of air power in Tolkien's work. And even if it is finally meager or badly assumed, this article offers us the opportunity to escape for a moment and to remember the epic battle scenes of the *Lord of the Rings*, with dragons or *Nazgûls* in particular.

Our faithful readers will then discover our traditional columns. The historical article echoes this issue's feature and discusses the birth of strategic reconnaissance in Military Aeronautics during World War I. B. Colom-y-Canals shows that strategic reconnaissance gradually became an integral part of everyone's mind as the war progressed, technologies evolved and the need to observe the enemy's position in depth became indispensable.

The interview gathers the words of one of the greatest air strategists. J. A. Warden III was kind enough to confide in us, to evoke his career and to develop his various ideas. We hope that this interview will inspire our readers to go further and learn more about his theses. Like many military thinkers, Warden is

often reduced to a formula, an expression. In his case, it is rather an image, that of the five circles. But at a time when air power must once again demonstrate its full potential in a context of state confrontation and Great Power rivalry, rather than counter-insurgency, reading again (or simply discovering) J. A. Warden III is imperative. In this respect, consulting J. A. Olsen's books entitled *John Warden and the Renaissance of American Air Power* or *Airpower Reborn: The Strategic Concepts of John Warden and John Boyd* offers excellent keys to start reading those strategic thinkers. We hope that the reader will enjoy this interview as much as we enjoyed talking to J. A. Warden III.

This issue concludes with the review section, with two long book reviews. P. Vallée first reports on *Allies in Air Power: A History of Multinational Air Operations* edited by S. Paget. The author insists on the historical approach adopted in this book, which ends with a case study of the 2003 campaign in Iraq. The historical depth of the book seems to come at the expense of highlighting current issues.

E. Tenenbaum then gives us his impressions of B. S. Lambeth's book entitled *Airpower in the war against ISIS* and devoted to the air operations conducted against Daech during the 2010s. As a connoisseur of the period (see his book *La guerre de vingt ans* co-written with M. Hecker), E. Tenenbaum notes the importance of this book which narrates for the first time the events of the 2010s war in the Levant seen from the air. However, he sometimes seems to regret the author's bias.

If you wish to react to the content of this issue, or for any information request, any proposal, we remain at your disposal on the address [vortexlarevue@gmail.com](mailto:vortexlarevue@gmail.com).

We wish you an excellent reading.

## ***Air and Space Intelligence***



# Looking over the Hill: the Air Force's true DNA

Patrick Bouhet

*Patrick Bouhet is a historian and strategist. He is a senior administrative attaché and deputy head of the strategy division of the Air and Space Force General Staff.*

*“All the business of war, and indeed all the business of life, is to endeavor to find out what you don’t know by what you do; that’s what I called ‘guessing what was at the other side of the hill’”.*<sup>1</sup>

This quotation, attributed to Arthur Wellesley, Duke of Wellington, corresponds to a concern shared by all military commanders since the earliest times. The search for information, intelligence, and of course the enemy, is central to the conception, planning and conduct of military operations at all levels: tactical, operational and strategic<sup>2</sup>.

This aspect is scarcely discussed or even downplayed in historical studies. However, it is nonetheless central to explaining the successes of great leaders and also their defeats. Julius Caesar and Napoleon took painstaking care in gathering and analyzing information, in accordance with the resources available at the time<sup>3</sup>.

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1. J. Croker, L. J. Jennings (eds.). *The Croker Papers: The Correspondence and Diaries of the Late Right Honourable John Wilson Croker, Secretary of the Admiralty from 1809 to 1830* (Vol. III, Ulan Press, 2012 [1885]): 276-277.

2. “The basis of any military operation is, first of all, the knowledge of the terrain under its double defensive and offensive aspect; then, that of the position, the strength, and if one can, the thought of the enemy” Quoted in F. de Brack. *Avant-postes de cavalerie légère* (Paris: Anselin, 1831): 188.

3. For intelligence in ancient Rome, see M. R. Sheldon. *Intelligence activities in ancient Rome: Trust in the Gods but Verify* (London: Routledge, 2004): 320 p. For the First Empire, G. Arboit. *Napoleon et le renseignement* (Paris: Perrin, 2022): 542 p.

The image of Wellington, which illustrates the necessity of discovering what “lies behind the hill”, is significant in terms of the advantage provided by natural high ground, whereas by the end of the 18th century, more artificial high ground had become available with the advent of balloons and aircraft. The high ground is the elevation that allows one to count the enemy’s numbers and to understand their maneuvers. To see behind the hill, it is best to take control of it, or failing that, to find a higher position. Balloons or aircraft offer the advantage of no longer being dependent on physical geography, making it possible to enjoy a potentially permanent artificial high ground.

In order to obtain a complete perspective of the enemy at strategic level, in-depth intelligence is necessary. It was the light troops, notably the cavalry, that took on this role until the First World War. The French light cavalry of the Grande Armée made reconnaissance runs sometimes a hundred kilometers in advance of the main forces, as did their Prussian, Austrian or Russian adversaries. This was only possible because the fronts were not contiguous, and there were gaps that made it possible to avoid the enemy’s forces and to penetrate their positions. Additionally, the weaponry available at the time could not effectively impede access to the terrain except at short range. In the 1860s, the Confederate and later the Federal cavalry excelled in raids combining intelligence and deep attack. The sheer immensity of the theater of operations, the patchy front areas, and the impossibility of allocating sufficient resources to maintaining a dense and extensive “defensive curtain”, as well as the unavailability of mobile reserves, made any attempt to prevent this type of action extremely difficult.

Two constants seem at this stage to be prerequisites in reconnaissance, discovery and intelligence gathering in the field of military operations: height and speed. First height, to extend one’s field of vision and to overcome the obstacles that could limit it (a simple bell tower may, for example, suffice on open, flat ground), and speed, to escape the enemy, to act more swiftly than the main troops and to precede them in their action. Intelligence can be transmitted and processed at a faster rate than actual troop maneuvers so that it can be used to assess the situation and make decisions in a timely manner.

Height was, from the beginning, the advantage afforded by the first balloons used by the French army in 1793, but not speed. The balloons of Commandant Coutelle<sup>4</sup> were not suitable for the movement-intensive warfare waged by the French armies. Indeed, the mere preparation of the equipment for a flight took at least 36 hours which was not suitable for these types of operations. Consequently, by the Directoire’s decree on February 18, 1799, the companies of balloonists were thereby disbanded.

It was not until the end of the 19th century and the appearance of the steam engine, then the internal combustion engine, that the use of lighter-than-air

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4. Coutelle, Jean-Marie-Joseph, (1748 - 1835). This Engineer was appointed as an officer in 1794 to manufacture balloons for the French armies. He participated in the Egyptian expedition, but the balloons were lost during the naval battle of Aboukir. He then participated in the work of the Institute of Egypt.

aircraft (balloons and dirigibles) and heavier-than-air aircraft were once again considered for military missions. And it is naturally the missions of discovery and reconnaissance that were in the spotlight and lead to the development of countermeasures, fighter and anti-aircraft defense, and a new means of military engagement: bombing. These were to form the backbone of military action in the air. The same evolution seems to be reproduced concerning operations in outer space, which makes Intelligence, Surveillance and Reconnaissance (ISR) the foundation, often underestimated, of the development of military missions in air and space powers.

### **Before the First World War: assumptions and beginnings**

Before 1914, two branches of the Army were particularly interested in the development of air capabilities: Artillery and Engineers. These laid to the foundations of what would later become the Air Force, starting in 1933<sup>5</sup>.

As far as artillery is concerned, until the end of the XIX<sup>th</sup> century, the method of firing was direct fire, on sight. The battery was set up facing enemy lines, sometimes even under infantry fire. This approach can be explained by the limited range of the weapons, the non-existence of sophisticated sighting systems and, above all, lack of means of observing the effect of the fire. In addition, the battlefield was quickly obscured by the thick smoke produced by rifle and cannon fire, which only reinforced these practices.

The overall tactics of the infantry were similar to the use of artillery: maneuvering in more or less close and deep ranks, with limited fronts, and firepower that was often insufficient to stop any movement or have a decisive effect in a short period of time.

However, the wars of Crimea, Secession and 1870-1871 proved that the firepower of artillery and infantry had greatly increased, notably thanks to the rifling of tubes (precision and range) or breech loading (rate of fire and ability to fire while remaining under cover). In addition, in 1881, the French engineer Paul Vieille developed smokeless gunpowder, gelatinized cotton-powder, as a direct consequence of this progress. The direct consequence of these advances was a clear evolution in tactics. There was no longer any question of setting up in battery formation under the enemy's gaze, while rifles had acquired precision and speed, to which must be added, from the end of the 19th century, the density of mechanical gunfire. Any movement or deployment in the open could result in immediate and total destruction.

The power of the artillery forced the opposing batteries to go under cover, or else be quickly counterattacked and destroyed. Scarfing, flanking, counter-slope firing (i.e. indirect fire) were developed and became the norm. The problem that arose was the target recognition and above all the controlling of the effects of the

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5. The law n°1934-07-02 of July 2, 1934 established the general organization of the Air Force, as published in the official journal on July 19, 1934, but the possibility of creating an independent Air Force was officially recognized by an inter-ministerial decree dated on April 1, 1933.

fire. "Artillery ladders", simple devices that could only be scaled to a height of some twenty meters, quickly became inadequate for shots aimed deep within the enemy's position, which had become technically feasible.

The 12 pdr gun, used in the Second Empire period, had a maximum range of about 3,000 m, the 75 mm 1897 model had a range of 6,500 m and the 105 mm adopted in 1913 had a range of more than 10,000 meters. As for the heavy artillery with a long range composed of 320 or 400 mm pieces, it reached or even exceeded 20 km.

For such systems to work, because the 75mm model should already be considered as a true modern weapon system, the artillery officer needed to have a new point of observation to best use available assets while remaining out of range of enemy fire. Airplane, tethered balloons and dirigibles were the best observatories imaginable, whether for reconnaissance or for adjusting battery fire. The experience of the Balkan War led General Herr, an artilleryman, to write in 1913: *"The only way to see, is to have observers in airplanes. The artillery needs airplanes as soon as the infantry is engaged, and in order to carry out the numerous missions that would be entrusted to them, it is necessary that these airplanes remain at their exclusive disposal"*<sup>6</sup>.

The development of artillery equipment and resulting changes in tactics explain the necessity of using aircraft to expedite battle action.

However, the artillery were not the only ones interested in aviation. Engineers had also been experimenting some various devices for quite some time. The corps of balloonists (or "aerostatists") of the Revolution was already dependent on Army branch. However, the intentions were different. First of all, the engineers had significant familiarity with balloons, but little experience with airplanes. Then, between 1909 and 1913, the airplane remained an obviously perfectible asset that had not yet demonstrated its true capacities, whereas balloons and dirigibles were better known and already in use. For the engineers, the balloon or the airplane must be able, in the tradition of the branch, to provide long-range staff reconnaissance. They needed to be able to penetrate deep into the enemy's positions in order to assess, for example, the extent of the enemy's reserves. They needed an aircraft with a range of at least 100 km, with a flight altitude of at least 1,000 m over two thirds of the trajectory. However, the aircraft available in 1909 were still very far from meeting these requirements.

So there were two opposing schools of thought: that of the artillery, which wanted to use the airplane as it already was, in a tactical role, and that of the engineers, who preferred a strategic reconnaissance tool and who initially favored balloons and dirigibles. But in both cases, dropping bombs, and even less pursuit by fighters, were not yet on the table. For the moment it was only a question of observing, performing reconnaissance, targeting and assessing the situation.

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6. F.-G. Herr (General). "Enseignements de la guerre des Balkans." *Revue d'artillerie*, (January 1913): 325-332.

Nevertheless, Major Estienne, who was a graduate of the renowned Polytechnique School and was an artilleryman, who directed the Vincennes aviation establishment or laboratory from 1909, logically envisaged a more extensive role for “*heavier-than-air flying machines, of which the aeroplane is the eminently perfectible prototype, [which] already allow us to foresee results that can be used in warfare: in exploration, in the search for fixed artillery targets and in the attack of enemy balloons*”<sup>7</sup>.

Thus, between 1910 and 1914, the arming of aircraft, bombing and also the detection of targets, first by sight and then from photographs, were tested. Experiments took place as early as August 1910 at Châlons and at Verdun during practice sessions on siege and field artillery. These were continued every year until the war began.

The clash between artillery and engineers tended to diminish as technical progress made it possible to carry out all the missions envisaged. The engineers won the competition to a certain extent by being assigned overall responsibilities in the aeronautical field, but the work of the artillery nevertheless continued.

During the major maneuvers in Picardy held from September 9 to 19, 1910, three aviation groups were created, one attached to headquarters and two to each of the army corps involved. Reservists from the nascent aeronautical industry formed the contingent of pilots: Paulhan, Bréguet, and Latham. The other pilots were career soldiers, half of whom belonged to the engineers or the artillery. All the aircraft used were two-seaters with the exception of a *Blériot* flown by Lieutenant Bellanger. From the 13th to the 18th, fifteen reconnaissance flights took place: this was the only mission entrusted to the airborne resources. In September 1911, maneuvers took place in the Ardennes region and in the East of France: 22 airplanes participated in the former, 25 in the latter.

A squadron of airplanes transportable in trailers even became part of the 49th field artillery regiment. The techniques for adjusting fire control by means of an airborne observation officer were then developed.<sup>8-9</sup>

Everything was in place for a practical implementation of aerial reconnaissance from the first battles of the First World War.

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7. Letter from Commandant Estienne to Mr. Waddington, Rapporteur for the War Budget in the Senate, January, 19, 1910, fonds privés, carton 1K193, Service historique de la défense (SLID), Paris.

8. The differences in perspective having led to the *de facto* creation of two airborne services, one for the engineers, the other for the artillery, some of the staff—as well as some politicians—were concerned about the resulting dispersion of resources. Consequently, the airborne service was placed under the direct authority of the army’s chief of staff in February 1910, then in June, this responsibility was given to the engineering Directorate. Finally, in October, a permanent inspection of military airborne forces was created, the first institutionalization of the Air Forces in France. Without questioning the existence of the struggle and competition between the engineers and the artillery during this period, it would perhaps be useful to bring it back to more accurate proportions than those presented in the typical historical perspective as developed in the Air Force for decades.

9. For example, see Captain Bellanger’s note of January 24, 1912, and Lieutenant Marzac’s note on a way of observing control salvos in an airplane, (SEÆ).

## **Trial by fire**

The new airborne assets, used universally by the main adversaries demonstrated their effectiveness in the first weeks of the conflict. However, the key role was still played by the cavalry, until the newly extended range and rate of fire of the artillery and infantry threatened the cavalry, preventing it from fulfilling its missions of discovery, reconnaissance and screening.

In the field of reconnaissance, two crucial battles were fought thanks to air support: Tannenberg, from August 26 to 30, 1914, and La Marne from September 5 to 12. These battles overturned compromised situations due to the retreat of two armies under pressure from the enemy offensive and needing to avoid encirclement.

At Tannenberg, the Germans, clearly outnumbered (with only 200,000 men compared to twice that number), succeeded in blocking the Russian offensive after having abandoned a significant part of East Prussia. The maneuver envisaged by the newly appointed Commander and Chief of staff of the 8th army, General Hindenburg and General Ludendorff, as well as by Lieutenant Colonel Hoffmann<sup>10</sup>, consisted in beating separately the two Russian armies that were opposed to them, the first and second armies of Generals Rennenkampf and Samsonov, by concentrating their efforts first against one, and then against the other. The aerial reconnaissance carried out by the Germans aboard *Etrich Taube* planes allowed them to know precisely the positions of the two armies and especially the distances separating them. They could thus carry out their maneuver with a certain level of security and adapt their position very quickly to the real situation. On the other hand, on the Russian side, maneuvers were carried out without precise knowledge of the position of the German forces, which led one of the Russian armies to pursue a chimera of German forces that were no longer there, while the other army was overwhelmed.

The battle of the Marne was largely decided on the basis of an aerial reconnaissance that detected the change of direction of the first German army. By avoiding Paris, it gave the opportunity to counter-attack the German's left wing and above all to stop the retreat of the French army and thus to rectify the situation. Joffre thus indicated that it was *"the combination of all the partial information reported by the aerial reconnaissance missions and by the cavalry patrols that allowed the Command Staff to gain full knowledge of the situation. But it is certain that the Air Force, and especially that of the 6th Army and the entrenched camp of Paris, played a predominant role on this occasion."*

The battle of the Marne was also an opportunity to demonstrate the effectiveness of the concepts developed by the Vincennes establishment with regard to the adjustment of artillery fire. Estienne, who was appointed to command

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**10.** An often forgotten actor of this maneuver is Lieutenant-Colonel Hoffmann who also belonged to the 8th Army staff and who especially had knowledge of the personalities and dissensions of the Russian leaders. He was stationed in St. Petersburg, specialized in the study of the Russian Army and was appointed as an observer during the Russo-Japanese War of 1905.

the 22<sup>nd</sup> field artillery regiment, took with him a light observation aviation unit composed of two removable aircraft transported in trailers. The regiment formed the artillery of the 6th infantry division led by General Pétain. It took part in the Battle of the Borders, the battles of Charleroi and Guise and followed the retreat of the 3rd army corps towards the Marne. On September, 6, 1914, the division was ordered to attack Montceaux-les-Provins, in accordance with the instructions given by General Joffre ordering the retreat to be stopped. Colonel Estienne sent Sergeant Damberville to reconnoiter the Montceaux-les-Provins sector at around eight o'clock. He brought a sketch to General Pétain's command headquarters showing the location of six or seven German batteries and a large infantry contingent in relation to the roads and church towers. Copies of the plan were drawn up and sent to all the 75 mm groups and even to a 120 C group in a position on his left. On each copy produced, the targeted sector of land assigned to the recipient was indicated. The result of this operation was an undeniable success which led to the destruction of the enemy batteries and the capture of the village without any great difficulty for the infantry. A first empirical application, in a way, of the principle: "*Artillery conquers, infantry occupies*".

But in order for the artillery to be in a position of conquest, the Air Force must reconnoiter the terrain and the enemy's positions and then adjust artillery fire. In order for the infantry to continue to occupy the terrain and not be driven out by enemy artillery, the use of the sky must be denied to the enemy.

This was well understood by the Germans when they launched their offensive against the Verdun sector in February 1916. They deployed nearly 300 aircraft to impede the French observation aircraft, including balloons, from carrying out their reconnaissance and artillery fire adjustment missions. Against them, the French had less than 100 aircraft which were unable to counter the German air offensive. The Germans succeeded in gaining the control of the air, not over the entire Western Front, but over a selected sector. The French then organized an autonomous combat group with instructions to search for and systematically destroy the enemy. The first real air battle was then fought in the skies over Verdun, both in terms of the number of means involved and the duration of the battle.<sup>11</sup>.

The main reason for this rise in power was, to either allow or prevent the execution of artillery reconnaissance, and fire adjustment missions. The air battle was fought only to acquire the superiority that would allow these missions to be carried out.

From then on, everything necessary was in place. Most air fleets were composed of reconnaissance and observation units, along with units coordinating

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11. For the entire period, historical records may be used to assess the evolution over history on this topic: P. Façon. *Histoire de l'armée de l'air* (Paris: La Documentation Française, 2009): 558 ; J.-M. Olivier (ed.). *Histoire de l'armée de l'air et des forces aériennes françaises du XVIII<sup>ème</sup> siècle à nos jours* (Paris: Privât, 2014): 547 ; J. de Lespinois (ed.). *Nouvelle histoire de l'armée de l'Air et de l'Espace* (Paris: Pierre de Taillac, 2022): 479. For a German view see H. Ritter. *La guerre aérienne* (Paris: La Documentation Française, 2013): 279. [translation of P's work *Der Luftkrieg* published in 1926].

with ground forces. Fighters were the indispensable component, and bombers were the logical extension of this. This model continued to be used in France up through the Second World War. Thus, in 1920, the whole Air Force, excluding naval units, comprised 199 squadrons, including 27 fighters, 32 bombers, 57 observation units and 3 colony units<sup>12</sup>. In 1939, the organization of the French Air Force included 115 groups and 17 squadrons, distributed as follows: 23 groups and 9 “regional” squadrons for fighter aircraft; 33 bombing groups, 14 reconnaissance groups, 47 observation groups, and 8 squadrons specific to the colonies<sup>13</sup>.

### **The evolution of Air and Space Forces: shared characteristics**

The control of height and speed was therefore part of the traditional sword and shield battle, and has been so up to the present day. The technical progress of platforms, but also of reconnaissance tools (photography, radar, electromagnetic fields, etc.), favors the coverage of increasingly large spaces while being more precise. They also provide the possibility of guaranteeing against enemy defenses. Anti-aircraft, artillery and missile defenses and fighter interception can be evaded thanks to height, altitude and speed. The *SR-71 Blackbird* with its known speed of Mach 3.32 and its ceiling of 26,000 meters can be considered as the culmination of this concept, as well as the *MiG-25* in its reconnaissance version.

Except for the fact that surface-to-air defenses have become more and more effective: the characteristics attributed to the Russian *9M96* missile that makes up the *S-300* weapon system show a speed of Mach 6.5 for an altitude of 27,000 meters. Satellites have proven to be less costly, often more precise, allow for real-time transmission<sup>14</sup> and, above all, to act without entering enemy airspace. But always from above.

This movement started in the 60s for the United States and the USSR. About ten years later, China joined the club of space powers. It was not until another decade that France began to develop a family of reconnaissance satellites, followed by Japan and Israel in 2003, Germany in 2006 and Italy in 2007. The factors that bring the development of these programs are most often the search for sovereign intelligence that meets operational, strategic and political imperatives. What is nevertheless remarkable is the duality of capabilities. It is estimated that 75% of the satellites currently in operation meet, more or less, military needs, while only 20% of them are entirely dedicated to these missions<sup>15</sup>.

The club of countries having developed ASAT instruments is much smaller: only four countries have fired missiles dedicated to this mission. The United States has done so since 1959, followed by the USSR in 1961, then by China

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12. C. Christienne (General), P. Lissarrague (General) et alii. *Histoire de l'aviation militaire française* (Paris: Charles-Lavauzelle, 1980): 219.

13. *Ibid* 345.

14. Transmission absent on the *SR-71* - implemented on later versions *The Lockheed U-2* which, subsonic, was nevertheless intercepted several times notably by Russian *SA-2 Guideline* missiles.

15. On this subject see J. Arnould. *La guerre de l'espace aura-t-elle lieu* (Paris: L'Harmattan, 2022): 100.

in 2007 and India in 2019. Other defense or combat systems have also been developed such as the arming of *Saliout* type stations or the Strategic Defense Initiative wanted by Ronald Reagan in 1983. The creation of *US Space Force (USSF)* as well as that of the Space Command (CdE) in France in 2019 express the need to envisage the eventuality of real military operations in, from and into space. This was 60 years after the first observation satellites were put into orbit.

What has happened since is comparable to what we discussed with regard to aeronautics: the ability to see behind the hill leads to a response from the adversaries, both potential and declared. The ability to use such methods responds, *de facto*, to the need to access, control and even seek superiority in the air and exo-atmospheric environment. This is all the more sensitive in space, as it is no longer simply a question of observation or reconnaissance, but also of communication and positioning, navigation and synchronization (PNT). These resources are as essential to contemporary operations as observation from the sky was for artillery during the First World War. The response can be expressed by destroying the satellite, apart from the Kessler syndrome<sup>16</sup>, blinding it, forcing it to move, or cyber-attacking its software or that of the ground stations. The development of complete systems for warfare in, from and towards space is taking shape. Such systems potentially make it possible to vie for control and superiority not only in space but also at high altitudes, which are not currently used to any great extent, i.e. between 20 km and 100 km, the limit up to which airspace is deemed separate from outer space.

At the same time, the observed evolution of the use of tactical drones in the most recent conflicts, particularly during the current operations in Ukraine, is reminiscent of the concepts developed in the context of artillery aviation. Acting at low altitude and speed, presenting targets of limited size, observation drones or suicide drones prove to be difficult targets to detect and destroy with systems developed to combat more conventional air capabilities. Fighting in this segment of the sky will again entail the development of resources to prevent exploitation of this fringe of airspace by the adversary. And it is very likely that some of these resources, when they have reached maturity, will be threatened by capabilities of the same order to gain control and then air superiority.

As you can see, the ISR function is central to the history of the Air and Space Force. It is central because the characteristics of the two environments will implicitly entail execution of this type of mission. This is central because the exploitation of the two environments resolves tactical blockages thanks to the ability to carry out operational and strategic reconnaissance missions, and then to prepare and accompany land and naval tactical maneuvers.

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16. The Kessler syndrome designates the effect that a volume of space debris in low orbit caused by debris from a threshold above in which the objects in orbit are frequently hit by debris and are destroyed in turn, which produces an exponential increase in the amount of debris and the probability of impacts. Above a certain volume, such a scenario would render the use of satellites almost impossible. In the case of a premeditated attack, the perpetrator would be in the same situation as his adversary and would be denied access to space services by his own action.

These means have not, however, replaced more traditional sources or slowed down the development of other types of additional data acquisition (electromagnetic intelligence, for example). They replaced those that were no longer adapted to the new conditions of the battlefield, in particular the cavalry, and responded to the new dimensions of the battlefield, both in its linear development, with front lines of hundreds of kilometers, and in the increase in its depth, including aspects of logistics.

However, even the new possibilities offered by the air environment are limited by adversary air and anti-aircraft defenses, one of the most accomplished forms of which is currently provided by Integrated Air Defense System (IADS) or Anti-Access / Area Denial (A2/AD) systems that make any air mission in depth, outside of a massive raid, potentially more complex and risky.

The response was the extension of the vertical dimension made possible by access to space. From this point on, we have witnessed phenomena similar to those observed for military air power. The capacity for reconnaissance leads to the development of countermeasures whose concepts are related: satellite killer fighters, anti-satellite missiles or direct effect weapons in ground-to-air defense.

It is therefore the ISR (Intelligence, Surveillance and Reconnaissance) function that has led to the development of the main combat functions required first for the Air Force, and now for the Space Force. It is the need for information, for intelligence, to see behind and beyond the hill, that has led to the conquest, mastery and military control of these two environments, which are new for humanity. To the point that ISR and communication missions continue to represent a good part of the DNA of the Air Forces. To the point that it is these same vital factors – ISR and communication – that make the concept of *Joint All Domain Operations* (M2MC) possible.

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# Strategic Aerial Intelligence in France (1945-2005)

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The Second World War demonstrated the importance of the use of aerial intelligence in the strategic conduct of war. The strategic bombing campaign conducted by the American and British air forces on Germany was based on targeting choices supported by an intense use of aerial reconnaissance<sup>1</sup>. This even became one of the main sources of information for the allied high command to develop its strategic planning<sup>2</sup>. While the French Air Force participated in intelligence-gathering operations to the extent of its limited resources, it was not involved in strategic planning operations, either within the Allied Targeting Services Committee or the *Allied Central Interpretation Unit* (ACIU)<sup>3</sup>. It was not able to benefit fully from the American and British experience acquired with the strategic use of aerial intelligence. Similarly, the French high command had not been made aware of the leveraging of aerial intelligence in strategic planning. Rather the military and political leadership was accustomed to using human intelligence to inform strategic decision-making and naturally preferred to rely on such sources.

In 1945, the main problem for the Air Force was to accomplish their missions with the limited resources at their disposal, while at the same time striving

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1. R. Overly. *The Bombing War: Europe 1939-1945* (London: Allen Lane, 2013): 308.

2. C. Babington-Smith. *Evidence in Camera* (Stroud: Sutton Limited, 2004): 47.

3. G. Krugler. “‘Strike Hard, Strike Sure’ Strategic Reconnaissance and Targeting: Scientific Methods of Allied Aerial Bombardment during World War II.” *Revue Historique des Armées* 4, no. 261 (2010): 14-34.

to modernize their combat units<sup>4</sup>. The development of a strategic intelligence component was therefore not a priority. The view of the Inspector of Reconnaissance Aviation, Major Battle, was particularly harsh in this regard. He noted that “*there is no official intelligence doctrine. Nor is there an intelligence policy, and the consequences of this state of affairs are very serious*”<sup>5</sup>.

How then had France integrated aerial intelligence into its strategic culture? How did strategic aerial intelligence emerge to become one of the main resources for strategic and political decision support?

The beginning of the Cold War, with the decolonization conflicts in Indochina and Algeria, and later the advent of the French nuclear strike force, were the catalysts that drove the demand in France for increasingly sophisticated and comprehensive strategic intelligence. The sustained confrontation with the Soviet bloc and the multiple French military interventions in Africa led to the realization of the importance of such intelligence for political decision-makers. Ultimately, the implementation of a military observation satellite program marked the full inclusion of strategic aerial intelligence in the French decision-making process.

### **The gradual emergence of a strategic necessity**

From 1949 onwards, the Chinese shift to communism, posed the threat of possible interventions by Chinese forces against the French expeditionary forces in Indochina, particularly via attacks from the air. General Hartemann, commander of the French Air Force in the Far East, therefore ordered reconnaissance missions to gather intelligence in order to more accurately ascertain any potential threat<sup>6</sup>. These missions, carried out by P-63 fighter planes equipped with improvised photographic pods, revealed that the Chinese had not positioned a Mig-15 unit near Indochina, which reassured the French command.

This experience underscores the importance of the strategic dimension of aerial intelligence. It was an undeniable asset, providing an “objective” source in the process of cross-referencing various data. Photographs are a faithful transcription of reality that can be analyzed by means of scientific processes such as photographic analysis and measurement tools. This procedure also shows that the French command was aware of the potential of aerial intelligence in the strategic domain, but tended to use it only when the need arose. The lack of resources more suitable for this type of intelligence gathering led to a tendency to use it on an exceptional basis.

The concern about the Chinese air force also encouraged a rapprochement with the United States, whose interest in the region had become acute since the

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4. R. Facon. “Le réarmement de l’armée de l’Air.” in M. Vaisse (ed.). *La IV<sup>e</sup> République face aux problèmes d’armement, Actes du colloque du 29 et 30 septembre 1997 à l’école militaire* (Paris: ADDIM, 1998): 107-128.

5. Commandant Battle, Necessity of establishing and conducting an intelligence policy, 17 February 1949, SHD, DAA, 60 E 1095.

6. Note on reconnaissance missions on the island of Elainan for the general commanding the LEAF, 5 May 1950, (SECE), DAA, 4C 926 and Letter from Lt, (SECE), DAA, 4C 926.

start of the Korean War in the summer of 1950. The US asked the French Air Force for aerial intelligence on the situation on the Chinese border. Exchanges concerning strategic aerial intelligence were thus set up with the aim of assessing the Chinese threat as accurately as possible<sup>7</sup>. In this way, sharing French aerial intelligence made it possible via reciprocity to reinforce French requests to the US concerning military intelligence on China, since they were the only ones capable of providing it. Aerial intelligence thus became a bargaining chip to obtain the information that French intelligence was unable to obtain in Indochina.

Although the strategic aspect did not represent an important part of aerial intelligence in Indochina, it nevertheless constituted a first significant attempt. For the first time, aerial intelligence was used in a theater of operations to successfully assess a strategic threat. This experimentation attracted the interest of Command in the use of strategic aerial intelligence in the wars of decolonization.

During the Algerian War, in the same way, the need to know the military potential of the Algerian National Liberation Army (ALN) on the other side of the Moroccan and Tunisian borders motivated the implementation of strategic reconnaissance missions<sup>8</sup>. From 1956 onwards, the French Air Force periodically deployed RT-33 and subsequently RF-84F jet reconnaissance aircraft to Algeria to support the RB-26Cs in order to carry out reconnaissance missions on airfields and bases that could be used by the ALN in Morocco and Tunisia<sup>9</sup>. These missions made it possible to obtain a monthly overview of ALN activity outside of Algeria while analyzing its potential effects on the interior of the Algerian theater. Aerial intelligence thus became the main source of information on the logistics of the ALN<sup>10</sup>. It offered the advantage of quickly obtaining precise answers to strategic problems, which proved to be a practical and secure way of cross-checking information.

While this practice remained very empirical in Indochina, it was gradually streamlined in Algeria. An intelligence research plan was specifically defined in 1959 to monitor this threat, and ensure weekly coverage of targets. Detachments from the 3rd reconnaissance wing took turns in bolstering the resources already stationed in Algeria<sup>11</sup>. In 1961, missions were carried out four times a week to monitor airfields in Tunisia<sup>12</sup>. At the combined impetus of the Air Force, the Armed Forces Staff and political decision-makers, the question then arose as to the best way to integrate these experiments into a more comprehensive and global system.

From a capability point of view, the need to equip the French Air Force with a strategic intelligence collection platform gradually became apparent from the end of the 1950s. However, the French aeronautical industry was not able to pro-

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7. Dossier tripartite conference on intelligence, October 1952, SHD, DAA, 4C 826, CINPAC, Intelligence division, Special information Report no.2 (Wei-Chou Island, China).

8. Fiche : Photography Missions in neighboring areas, 5 February 1960, SHD, DAT, 1 H 2084.

9. Fiche relative à la surveillance des terrains tunisiens et libyens, 1<sup>st</sup> June 1959, SHD, DAA, 1145.

10. Card-index: Waiver of overflight of Tunisia, 28 June 1960, SHD, DAA, I 145.

11. Fiche surveillance des territoires tunisiens et libyens, 23 April 1959, SHD, DAA, I 145.

12. Surveillance Beyond Borders, 9 September 1961, SHD, DAA, I 145.

pose a functional solution, and no funds were made available for this purpose. Moreover, the policymakers were not yet aware of the interest of this source of intelligence, contrary to the military. They did not yet support such developments, unlike in the United States where strategic reconnaissance aircraft programs, such as the U-2 and then the SR-71 aircraft, were launched in the United States on the initiative of the American president himself.

Nevertheless, the French political authorities were able to step up to reliance on this type of resource when it became necessary. Although there are no archives that confirm the following hypothesis, the Cuban missile crisis might have been a crucial and decisive event in modifying the attitude of French political leaders with respect to aerial intelligence. While General de Gaulle was proclaiming his support for President Kennedy, the military attaché of the American embassy came to the Elysée Palace in October 1962 to show photographs taken by a U-2 spy plane to the French President<sup>13</sup>. Was he impressed by these aerial photographs? Nothing allows us, to this day, to affirm this thesis. However, the episode shows that the political leaders indeed knew— from then on— of the extent to which strategic aerial intelligence could be useful for both decision making and exerting influence.

At the same point in time, the acquisition of nuclear weapons by France transformed its perception of strategic military capabilities. For the French Air Force, this was a true revolution. For the first time in its history, France's defense came to rely primarily on its strategic component, the Strategic Air Force. This mission also required new intelligence capabilities, as the American example had amply demonstrated<sup>14</sup>. Efficient strategic aerial intelligence would reinforce the credibility of the nuclear strike force.

In the decolonization conflicts, in Indochina and later in Algeria, strategic aerial intelligence was oriented according to strictly military needs in the context of the counter-guerrilla warfare specific to these conflicts. The aim was to detect concentrations of troops, equipment and facilities in order to estimate the potential and military battle readiness of neighboring countries and to precisely assess any threats. The advent of the nuclear strike force changed the commander's perception of the use of aerial intelligence as inherited from past experiences. The mission of the *Deuxième bureau* was to monitor the military and political situation in the Union of Soviet Socialist Republics (USSR). It had to prepare targeting scenarios and keep track of the anti-aircraft defenses of the Warsaw Pact forces in order to facilitate the conduct of any missions of penetration towards hypothetical targets<sup>15</sup>. It thus provided strategic intelligence on Soviet defense resources and targets in order to feed into the strategic and political decision-making process in the context of nuclear deterrence.

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13. Interview with General Compagnon, tape no.21, SHD, DEX, GR 3K 11.

14. J. T. Iarquliar. *Need to Know: The role of Air Force Reconnaissance in War Planning, 1945-1953* (Maxwell AFB: Air University Press, 2004).

15. Interview n°563, General Manguy, band 1, SHD, DEX, Ai-8Z.

While the *Mirage IVA*, the future strike force aircraft, was being developed, the Air Force General Staff (EMAA) envisaged developing a platform based on this program as early as 1961 to carry out strategic reconnaissance missions<sup>16</sup>. In order to save money, the aim was to capitalize on the research and development effort to finally acquire a reconnaissance aircraft with strategic reach. In this way, the EMAA was pursuing a policy of adapting platforms designed for fighter or bomber programs in order to extrapolate an intelligence collection system, without committing to a specific program that would prove far too costly.

The 1964 Defence Council, chaired by General de Gaulle, ratified the acquisition of a strategic intelligence collection system in the form of the *Mirage IVA* and a photo pod. In 1965, this decision resulted in an order for twelve additional *Mirage IVAs* equipped with photographic pods. The decision finally seemed to confirm the approval of political leaders to acquire a strategic intelligence collection capability. However, this analysis warrants qualification. Although political leaders had indeed granted approval, no source yet allows us to affirm that there is a real desire to use aerial intelligence to actually feed into the decision-making process.

If the EMAA succeeds in getting the decision to acquire this new intelligence collection system ratified, its ambition seems to be primarily one of obtaining a *capability*.<sup>17</sup> It would appear that the EMAA first wanted to extend its sphere of aerial intelligence collection resources rather than developing a full-fledged strategic intelligence collection tool. The program was conceived and designed in the context of ramping up the effectiveness of the strike force, with a view to strengthening the credibility of deterrence. For the EMAA, it was also a unique opportunity to finally acquire a modern strategic intelligence collection system, with capabilities and range far superior to the platforms it already had.

In accordance with this plan, a platform for collection of SIGINT of a strategic nature was launched at the end of the 1960s. The goal was to ensure the collection of electronic data that would be fed into databases earmarked for electronic protection of *Mirage IVAs* aircraft.<sup>18</sup> It was also a matter of acquiring capabilities for tapping into enemy communications (COMINT) in order to augment, supplement and expand the capabilities of the North “Gabriel” systems, which were limited<sup>19</sup>. This was to be the *DC-8 Sarigue*, a civilian designed aircraft, a SIGINT collection platform with small OPTINT capability. The need for *Mirage IVs* to be able to cross Soviet airspace, and the need for credibility of the French strike force, were the catalysts that spurred the development of French strategic aerial intelligence capabilities.

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16. Fiche au sujet du *Mirage IV* “Reconnaissance”, 8 October 1963, SHD, DAA, 4 E 26745.

17. Fiche relative à l’expérimentation du container photographique CT- 52, 13 June 1969, SHD, DAA, 4 E 26745.

18. M. Gambs. “Sarigue : les missions de l’EE 00/51 ‘Aubrac’.”, in GUERRELEC, *Les avions de renseignement électronique : 50 ans d’activités secrètes racontée par les acteurs* (Paris: Lavauzelle, 2009): 309-319.

19. M. Adam. “Des oreilles et des ailes ou quatre ans à l’escadrille électronique EE 54 “Dunkerque”, 1968-1972.” in GUERRELEC, *Les avions de renseignement électronique, op. cit.*

## **Decisive experiences**

In the mid-1970s, France had a strategic reconnaissance component, but it was limited to a dozen *Mirage IVA* photo reconnaissance aircraft dedicated to the strategic nuclear force and a single *DC-8 Sarigue*. This restricted number of assets precluded any possibility of a permanent presence and did not meet all needs, but provide to France a real strategic intelligence-gathering capability.

Although the main mission of these vectors was to contribute to the credibility of the strike force through intelligence gathering, these assets quickly sparked additional interest and generated further expectations from both military and political decision-makers.

The range of the *Mirage IVA* made it possible to monitor “*the rapid growth in threats from certain countries in North Africa and the Middle East, for example*<sup>20</sup>”. The French Navy also wanted to collect precise information on Soviet fleet movements transiting the North Sea or the Mediterranean. CIFAS *Mirage IVs* were mobilized to photograph Soviet ships off Crete and the African coast<sup>21</sup>. These missions were conducted on a regular basis, following a defined search pattern, which constituted the first rationally planned use of a strategic intelligence collection system. The missions also afforded the *Deuxième bureau* the opportunity to develop electronic databases on Soviet defense systems.

But it was especially from the seventies, with the new policies of French military intervention in Africa, that new needs appeared. The first photographic intelligence missions were quickly launched at the time of the Claustre incident. The anthropologist and archaeologist Françoise Claustre was kidnapped and taken hostage by Chadian rebels in April 1974 in Tibesti. A *Mirage IVA* was sent to collect mapping data from the region, in northern Chad, in order to prepare a rescue operation to extract her, which unfortunately end in failure.<sup>22</sup> On this occasion, the photographic collection capabilities of the *Mirage IVA* made it a flexible, discreet and rapid tool for providing photographic intelligence to the AOC (Army Operations Center).

Beginning with the “Lamantin” operation in Mauritania in 1977, the *Mirage IVA* photo reconnaissance aircraft were used to collect strategic intelligence in Africa at the request of the AOC and the President of the Republic and his private staff, and for the benefit of the Chief of Defense Staff, which are the highest decision-making authorities<sup>23</sup>. This direct involvement of political decision-makers, as well as the strategic scope of French actions in these military operations, gave rise to specific needs of aerial intelligence. These external interventions relied mainly on aircraft, and particularly on the action of Jaguar combat aircraft (whence the name “Jaguar diplomacy”) to characterize this use of air power by the political decision-makers to support French policy in Africa. As a result, ae-

20. Interview n°563, General Manguy, tape 1, SEED, DEX, Ai-8Z.

21. Testimony of Colonel (cr) M. Larrayadieu. “L’épreuve photographique.” in S. Gadal. *Forces Aériennes Stratégiques* (Paris: Economica, 2009): 337-341.

22. H. Beaumont. *op. cit.*, 221.

23. Interview with General Méry, tape 5, SHD, DEX, GR 3K4.

rial intelligence was omnipresent and indispensable to operations. The interpretation and analysis of aerial intelligence had taken new importance. With close control over these operations, the political decision-makers wanted to have the clearest possible overview of the situation on the ground. For example, when French forces returned to Chad as part of Operation Sparrowhawk, the *Mirage IVA* photo reconnaissance aircraft was used for two different purposes during strikes on the Ouadi-Doum airfield in northern Chad in 1986 and 1987. The aircraft could thwart anti-aircraft defenses on the site<sup>24</sup>, and it was also able to produce the exact data needed. It was imperative in this context that *pre-strike* and *post-strike* photographs be analyzed by the EMA and the Elysée Palace (location of the services of the presidency of the French Republic), the strategic decision-makers who were coordinating the maneuver designed to send a clear political message to the Libyans, who had invested the northern part of the country<sup>25</sup>.

Strategic aerial intelligence has become an essential part of crisis management, highly appreciated by political decision-makers because of the value of clear proof that it provides<sup>26</sup>. Not only aerial photos are a true reflection of reality at a given moment, but they can be viewed throughout the world. In 1962, during the Cuban missile crisis, President Kennedy used the aerial photographs collected by the U-2s as evidence to support his political position. However, aerial intelligence is not the sum total of the intelligence on which strategic decisions are based. It is only one of the components. The Kolwezi crisis in 1978 showed the limits of the Air Force's resources in this domain, which were unable to ensure a strategic watch capable of meeting the growing requirements of military and political decision-makers. Only the DC-8 Sarigue could intervene, as the region was beyond the range of the *Mirage IVAs*.

### A means of power

Operation Epervier, launched in Chad in 1986 to contain Libyan interventions in that country, with American interests increasingly in evidence<sup>27</sup>, may serve to illustrate the need for strategic aerial intelligence of national origin<sup>28</sup>. This crisis also highlights the French delays as compared to availability of American resources, which were composed of military observation satellites capable of providing very precise photographs. The Americans thus used the intelligence gathered in this way to support their policy in Africa. While they did indeed help France by providing satellite images *via* the military attaché in Paris to improve

24. J. Mérouze. "Opération Tobus; une mission de reconnaissance stratégique." in Comité Historique de l'Association GUERRELEC. *La guerre électronique sur Mirage IV : 40 années de guerre secrète racontée par ses acteurs* (Paris: Lavauzelle): 155-159.

25. J. de Lespinois. "L'emploi de la force aérienne au Tchad (1969-1987)." *Air & Space Power Journal* (autumn 2009) ; M. Forget. *Nos forces aériennes en OPEX* (Paris: Economica): 36 ; Interview n°539 of General Elector Pissochet, tape 10, SE1D, DEX, AI-8Z.

26. M. Elandel. "Leaders and Intelligence." in M. Elandel (ed). *Leaders and Intelligence* (Oxon: Frank Cass, 1989): 3-39 (p. 4).

27. V. Nouzille. *Dans le secret des présidents : CIA, White House, Elysée : les dossiers confidentiels 1981-2010* (Paris: Fayard, 2010): 102.

28. Interview n°539 of General Hector Pissochet, tape 7, SHD, DEX, AI-8Z.

strategic planning<sup>29</sup>, the Americans could also use these pictures to influence French diplomacy, as they did during the withdrawal of Operation Manta from Chad in 1984. The withdrawal of French troops was negotiated on the basis of a joint withdrawal with Libyan troops. While France respected its part of the agreements, Libya kept its troops in place. French diplomacy presented this withdrawal as a success despite intelligence indicating otherwise. The Americans provided the Chadians with satellite images of the reality of Libyan positions, who used this information, thus demonstrating the failure of the French operation<sup>30</sup>.

The problem of autonomy in decision-making then arose for President François Mitterrand. Without strategic intelligence-gathering resources that could compete with American capabilities, French decision-making autonomy was diminished, calling into question the credibility of French diplomatic and military action<sup>31</sup>.

Although France has been interested in military observation satellites since 1963<sup>32</sup>, the lack of financial and technical resources hindered their timely development. The Spot civilian observation satellite put into orbit in 1986 provided the EMAA and policy-makers with their first access to space imagery, despite somewhat limited capabilities in terms of image resolution. American intelligence could now be corroborated, even if sometimes in a very limited way. At the same time, the EMAA was becoming familiar with satellite imagery and was acquiring expertise in its use.

Dependence on American satellite intelligence during the Manta and Epervier operations was perceived as a humiliation by President François Mitterrand. To guarantee France's decision-making autonomy, and based on the experience of French operations in Africa since 1978, he launched the military observation satellite program in 1986, which led to the Helios system<sup>33</sup>. Indeed, the capacity for force projection is inseparable from preliminary maneuvers in terms of strategic intelligence. These operations were not designed to be mere local military intervention, but rather the armed component of French diplomacy in Africa. The precise dimension of military action in these crises was intended to support the action of French diplomacy. These interventions occur in a regional context where local powers such as Libya and great powers such as the United States or the USSR interfere. In this context, satellite intelligence would appear to be indispensable for the credibility of French policy. In the same way, in order to conduct a credible foreign policy in the eyes of our partners, France must acquire strategic intelligence resources suited to its ambitions. As General Patrick de Rousier explained, "*Access to information gives the person who has it a considerable lever of power, which he uses against those who do not have it*".<sup>34</sup> More

29. Interview n°539 of General Hector Pissochet, tape 6, SHD, DEX, AI-8Z.

30. J. Cécile. *Le renseignement français à l'aube du XXI<sup>e</sup> siècle* (Paris: Lavauzelle, 1998): 149.

31. H. Védérine. *Les mondes de François Mitterrand : A l'Élysée 1981-1995* (Paris: Fayard, 1996): 339.

32. Minutes of the Chiefs of Staff Committee, 19 November 1963, SHD, DEM, 6 R 35.

33. F. Mitterrand. *Réflexions sur la politique extérieure de la France* (Paris: Fayard, 1986): 17.

34. P. de Rousier. "The importance of air and space intelligence in the decision-making process."

than any other collection system, the observation satellite reaffirms the adage: “*To know is to be empowered*”.

The Gulf War confirmed the lessons learned since 1945 and the importance of observation satellites in the use of strategic aerial intelligence, as well as the considerable dimension of power afforded thereby to political decision-makers. At the time, Americans dominated the field of space observation which impressed their allies<sup>35</sup>. Although the Spot satellite, with its mapping capabilities, could provide an overall picture of the theater, enabling France to play its part<sup>36</sup>, this was largely surpassed by American satellites equipped with “*Keyhole*” *satellite camera systems*. This could not prevent the Americans from asserting their leadership throughout the campaign. The French Minister of Defense, Pierre Joxe, expressed his frustration when the American generals showed him satellite images without leaving him a copy<sup>37</sup>. He noted the need to master strategic aerial intelligence and to possess military observation satellites to ensure France’s decision-making sovereignty<sup>38</sup>.

Placed in orbit in 1994, Helios was the first French military observation satellite. Although its sensors were limited to the visible spectrum, it had sufficient resolution to provide targeting data. It contributed to providing permanent observation in space and time, “*an essential condition for a comparative and reasoned approach to situations.*”<sup>39</sup>

The Helios satellite enabled President Jacques Chirac to monitor the American-Iraqi crisis in 1996, while preserving France’s decision-making autonomy<sup>40</sup>. During the Iraqi crisis in 1998, the UN requested France’s help in obtaining a reliable and impartial assessment of the situation. The missions conducted by the *Mirage IVP* to gather this information supported France’s position as an internationally recognized mediator. The *Mirage IVP* supported French diplomacy<sup>41</sup>. Since then, space imagery has been used to monitor all crises around the globe. In 2003, it was strategic aerial intelligence, including space imagery, that contributed to providing President J. Chirac with the necessary information on the situation in Iraq to make decisions without being influenced by the Americans.

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in J. de Lespinois (ed). *Politique, défense, puissance : 30 ans d’opérations aériennes : Actes de colloque* (Paris: La Documentation Française, 2011): 39-47.

35. M. Forget. *Nos forces aériennes en OPEX*, op. cit, 60.

36. L. Gautier. “Les conséquences de la guerre du Golfe sur la politique française de défense.” in CEHD. *Cahier du CEHD : La participation militaire française à la guerre du Golfe* (Vincennes: CEHD, 2004): 110-115.

37. L. Gautier. “Les conséquences de la guerre du Golfe sur la politique française de défense.” dans CEHD. *Cahier du CEHD : La participation militaire française à la guerre du Golfe* (Vincennes: CEHD, 2004): 110-115.

38. P. Joxe, “Défense et renseignement : discours devant les auditeurs de l’IHEDN le 6 mai 1991.” *Revue de Défense Nationale* (July 1991): 9-21.

39. J. Boucheron. *Rapport d’information sur le renseignement par l’image* (Paris: Assemblée nationale, 2001): 34.

40. X. de Villepin. *Les premiers enseignements de l’opération “force alliée” en Yougoslavie : quels enjeux diplomatiques et militaires ?*, Rapport d’information no. 464 de la commission des affaires étrangères du Sénat [en ligne] (Paris: Sénat, 1999) [consulted on 11/04/2014], Available at <http://www.senat.fr/>

41. F. Mermet. “Introduction: Information, Renseignement et Commandement.” in P. Pascal-Ion (ed.). *Les armées françaises à l’aube du XXI<sup>e</sup> siècle, T2 L’armée de l’Air* (Paris: L’Harmattan, 2003): 261-265.

These strategic aerial intelligence collection and analysis capabilities reinforced the credibility of France's diplomatic position. At that time, it was not only a collection capability, *i.e.*, the simple ability to collect intelligence using an aircraft. It was the whole range of collection assets, including the *Mirage IV* aerial photographic reconnaissance plane, the Helios satellite, and the *DC-8 Sarigue*, which offers a set of collection systems with varied capabilities and a global collection spectrum. This system is coupled with an organization that handles analysis under the direction of the DRM. Political decision-makers thus had assets perfectly capable of supporting political and diplomatic decisions during a time of crisis.

The war in Afghanistan showed the importance of strategic aerial intelligence based on a set of collection vectors and multispectral sensors to increase France's weight in international coalitions. From the end of the Cold War to the war in Afghanistan, technological developments in terms of vectors and sensors have enabled the development of a real strategic intelligence capability available to the military and political decision-makers. At the same time, the constraints of political control weighing on the conduct of operations and imposing extreme precision on air strikes reinforced the importance of aerial intelligence in the targeting process. The importance given to the air and to "surgical strikes" increased the need for aerial intelligence to identify targets, to accurately determine their geographical coordinates and to determine the risks of collateral damage. Moreover, the need to quickly produce a politically acceptable military result, *i.e.*, avoiding civilian casualties while preserving the lives of French soldiers, by precisely targeting important military objectives producing a measurable effect, further accentuated the strategic aerial intelligence requirements for the policymaker<sup>42</sup>.

In the crises over the last few years, strategic aerial intelligence emerged as an indispensable military and political resource. In the same way, the increasing complexity of crises in terms of local and international actors and the acceleration of the temporality of information further increases the need for data as well as for fluidity and immediacy of communication.

The Cold War was the catalyst for the development of French strategic aerial intelligence. Starting from scratch in 1945, France progressively acquired strategic intelligence collection capabilities *via* specialized platforms, which were acquired and mastered very gradually. This movement enabled France to acquire its first military observation satellite at the end of the Cold War, and then to ramp up capabilities that were to provide strategic aerial intelligence with its current efficiency. It is interesting to measure the time it took to forge these decision-making assets and for the political decision-makers to appropriate them. The slow development of aerial intelligence with a strategic dimension also shows the time needed to adapt and integrate this type of intelligence into our strategic culture.

Aerial intelligence was first used as a strategic source during the decolonization conflicts to assess threats beyond the theater of operations. Although

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42. A. Cordesman. *The lessons and Non lessons of the Air and Missile Campaign in Kosovo* (Westport: Praeger Publishers, 2001): 123.

this was an *ad hoc* usage, it initiated the development of a first core of skills while demonstrating its usefulness and qualities to the high command. But it was above all the creation of the nuclear strike force and the creation of the FAS that led to the acquisition of collection platforms specifically dedicated to strategic collection in the IMINT and ELINT fields. These resources were conducive to the enlargement of the field of strategic aerial intelligence collection, which in turn led to the added dimension of strategic production. In this case, it was the prior acquisition of a strategic collection capability that made it possible to meet the strategic needs related to the conduct of external operations from the 1970s onwards. The French conception of strategic reconnaissance was then characterized by a pragmatic use of existing collection platforms.

External operations in Africa, particularly through “Jaguar diplomacy” and the political control they required, naturally encouraged the use of existing intelligence collection assets to meet new strategic needs emanating from the AOC (Air Operations Controller) and policymakers. This was a catalyst in the appropriation of this intelligence by policymakers. The proof is the move to initiate the program that led to the launch of the Helios satellite. At the same time, the policymakers realized that mastering strategic aerial intelligence, and more particularly satellite collection capabilities, lends credibility to political action in the diplomatic and military domains. The strategic watch provided by airborne intelligence assets has become an essential capability which is effective to underpin policy.

The process continued to evolve after the end of the Cold War, and each crisis since has served to underline the need for France to have its own aerial intelligence collection and analysis capability at the strategic level to ensure France’s independence and decision-making autonomy. The launch of the CSO and Ceres satellites in recent years demonstrates the value of having these collection capabilities.



# Review and Outlooks of two Decades of Adapting to the Evolution of Conflictuality in the 3rd Dimension

Sylvain Polizzi –Thierry Maurin

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*“ There are no more important duties, which an officer may be called upon to perform, than those of collecting and arranging the information upon which either the general, or daily operations of a campaign must be based. ”<sup>1</sup>*

On September the 1st, 2023, the Air Intelligence Center will celebrate its twentieth anniversary. This Center, dedicated to air-focused intelligence, has experienced numerous reorganizations and restructurings throughout the last two decades to maintain its coherence and efficiency, which have been acknowledged in the course of the numerous air operations in which its personnel has partaken.

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1. This is what D. H. Mahan, father of the famous Admiral Alfred Mahan and West Point Military Academy professor from 1824 to 1871, explained to his students, the future general officers of the Civil War. His teaching was based on the leading exegete and abridger of Napoleonic military thought; Antoine Jomini, who professed simply: “In fact, how can any man say what he should do himself if he is ignorant what his adversary is about??”

Faced with the constant changes in the nature of conflict in the third dimension, the CRA continues its evolution to better apprehend threats and meet the challenges of French air power. Since its inception, the CRA has been a unit specialized in the development of air intelligence for the Air Force and the Military Intelligence Directorate, as well as all users of the aerial environment involved in operational missions. Its scope of action extends from the tactical to the strategic level, deployed or in *reachback*<sup>2</sup> mode, wherever air power is likely to be used, in support of users of the third dimension, whether they be decision-makers, planners or executors.

The CRA has had to deal with the acceleration of John Boyd's Observation/Orientation/Decision/Action (OODA) loop in the context of the war on terrorism, and with the crucial synchronization of the intelligence cycle with other actors. While undeniable successes have confirmed the CRA's overall relevance over the last 20 years, they cannot hide certain limits encountered in controlling the delays inherent to the intelligence analysis and dissemination processes, nor the harmful effects of the dilution of expertise or the erosion of the base of knowledge concerning state powers. The conflict in Ukraine and the resurgence of high intensity have highlighted certain doctrinal and organizational limits of the AAE's intelligence tool, which give rise to new areas of effort.

### **The context in which the Air Intelligence Centre was created**

The first series of revisions of military intelligence doctrine dates mainly back to 2003-2004. It reflects the changes taken by the intelligence community after the 9/11 attacks and definitively turns the page on the Cold War by outlining the problems linked to "new threats".

The Air Intelligence Center was born in this context from a clear desire of rationalization and optimization of the AAE's intelligence resources. It was created on September 1st 2003 at Taverny air base 921. Stationed at Metz Air Base 128, a branch subordinate to the CRA 15.542 was created on September 1st, 2004 on the basis of the collection division (DIVREC) of the 54th ERA<sup>3</sup> and the ESERA<sup>4</sup> 12.054.

The Taverny CRA and its Metz branch replaced the command structure of the 54th Air Intelligence Wing and the Air Bureau for Operational Intelligence. Until now, the Air Force's intelligence tool has been focused primarily on Eastern Bloc surveillance, but it must now reorganize its personnel and sensors to deal with new "irregular" threats, as ordered by the heads of the military intelligence chain of the military intelligence chain.

Whereas the main task previously consisted of determining the probable axes of progression of Warsaw Pact forces on a map of Europe, the objective is now to anticipate elusive, even indeterminate, enemy's future actions in a multitude of theaters, each with their own socio-political and military particularities<sup>5</sup>.

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2. Intelligence support to operations conducted from metropolitan France.

3. Air Intelligence Wing

4. Air Intelligence Support and Training Squadron

5. J. Henrotin. "Les mutations du Renseignement militaire. Dissiper le brouillard de la guerre ?," *Focus Stratégique*, no. 71 (Paris: IFRI, January 2017).

The ensuing consequences on the use of air forces call for the creation of new structures of intelligence adapted to managing these new threats. The CRA thus supports and grows in strength alongside the Centre for the Planification and Conduct of Operations (CPCO) and the Air Operational Staff (EMO) in a profoundly changed post 9/11 world.

### **Regrouping air intelligence expertise and sensors closer to the operational personnel**

In 2004, the French Air Force brought its expertise in air intelligence closer to its operations. Taking over the duties of the Air Intelligence Support and Training Squadron and the 54th ERA's Collection Division, the CRA antenna was created at the Metz site.

The Air Defense and Air Operations Command is being centralized simultaneously in Paris, Lyon and Metz following major reorganizations of the structures of the French Air Force. Combining the CRA and its branch office in a single location is consistent with this logic. This organizational effort favors the emergence of new forms of cooperation between intelligence specialists and serves to accelerate the process of correlation and fusion of intelligence destined to combat units. The proximity that is sought between the center and the operational units also fosters the emergence of synergies with combat units and Air Force combat Staffs. The CRA must become a tool that works "by and for air operations".

The French Air Force's intelligence tool took on its final form after the official announcement on July 24th, 2008 regarding the closing of Air Force Base 128 at Metz-Frescaty. In the summer of 2012, as part of the Defense Modernization Plan, the CRA joined the Air Force Base 942 in Lyon Mont-Verdun.

The concentration of all these skills in a single location enables this unit as a reservoir of specialists, capable of providing Air expertise to joint, combined (PCIAT SERVAL, SANGARIS, Daman, HQ ISAF, CPCO and DRM) or inter-ministerial structures. The CRA has fully espoused its role as a complete and interoperable intelligence pillar, essential to a Joint Force Air Component (JFAC) type command and control structure during an air operation of opportunity.

### **DAIC and deployed echelons for in-depth analysis (N2): forward air intelligence support for aerial operations**

The attributes of the terrorist threat, such as mobility and intermingling, call for greater agility and reactivity in collecting, merging and disseminating intelligence to both planners and combat units. It is a question of deploying analytical intelligence tools as close as possible to operations in order to better serve them. The proximity between the crews and the intelligence analysts enables the rapid review of the results of the collection mission, the identification of the most significant elements as well as any missing ones, which will become the focus of subsequent orientation actions. The momentum of this process of analysis and the reorientation of sensors enabled the targeting cycle to be spurred on and maintained the initiative in order to catch the enemy off guard. Furthermore, the provision of modular intelligence teams in direct support of the deployed air force provides a valuable analytical capability that permeates the planning and

preparation processes for air missions, while at the same time driving the search operation. Composed of analysts and image and signals experts, the Deployed Air Intelligence Centre (DAIC) structures have established themselves over the past two decades as flexible tools whose operation and interoperable structure greatly facilitate the flow of intelligence to air units so as to optimize performance and visibility at both the inter-allied and joint level.

The DAIC is also connected with other actors. The interface between the DAIC and the joint intelligence chains allows for the harnessing of intelligence of air interest and for its fusion with national intelligence to fuel the intelligence cycle and support the decision-making process. The modularity of the deployed structures is ensured via the use of experts from the IMINT, the ELINT and the HUMINT, as well as analysts, according to the available data flows and the operational demands linked to the time required for exploitation and dissemination to the decision-making echelons and the combat units.



Figure 1 The CRA Intelligence Cycle

## **The practical contribution of CRA intelligence experts to air operations**

### *The intelligence support to the Permanent Air Security Posture (PPSA)*

The attacks of September 11th, 2001, marked a profound change in the perception of the aerial threat on a global scale. The hijacking of civilian aircraft and their use as large-scale weapons of destruction was taken into account by the aviation security system, whose aim is to react to any event that could jeopardize the airspace's security, its users and, more generally, threaten the French national territory and its citizens. While adapting to the threat of terrorism, deepening its tactics, techniques and procedures, the PPSA operators had to face the Russian threats. The CRA and the intelligence division of the CNOA<sup>6</sup>, in conjunction with the other intelligence services, continued to monitor Russian air activity and analyze their practices in order to better anticipate their actions. The analyses made available to the authorities have facilitated the threat assessment and

6. Centre National des Opérations Aériennes

effectively supported the National Air Operations Centre in its decision-making process.

This effectiveness was notably illustrated in 2016 when the French Air Force detected an increase in maneuvers conducted by Russian aircraft over international waters near French airspace. On February 17th and September 22nd 2016, French fighter aircraft, in close collaboration with the two Nato operation centers in the North and South and the CNOA, intercepted and escorted several Russian Tu160 Blackjack bombers, capable of deploying strategic weapons<sup>7</sup>.

#### *Libya, the added benefit during Operation Harmattan*

CRA personnel were instrumental in providing intelligence support to the Libyan air operation. The CRA distinguished itself by playing a leading role in the establishment of theater command structures while providing support to the decision-making authorities in metropolitan France. The Center has thus committed itself to the daily dissemination of appropriate analyses likely to bring substantial added value to the production of first-line airborne sensors. For example, in the field of SIGINT, these productions have enabled a detailed understanding of the threat level and have enriched the work of the military staff in charge of mission planning. Finally, the implementation of an image processing chain deployed in Solenzara fed into an ultra-short ISR loop, which was vital to the air campaign. Thus, multiple fleeting military targets, such as armed pickups and armored vehicles, were neutralized by fighter aircraft thanks to these precise and responsive orientations.

#### *A decisive tool for Operation Serval's framework in Mali*

As of January 2013, the CRA supported the implementation of a coordination structure for airborne collection activities within the framework of a C2 Air JFAC structure in Lyon. This ISR mission planning capability is a first, operationally speaking, for the AAE, which thereby brings into play a full spectrum of national and allied airborne sensors. This initiative inspires the inter-area level while waiting for the implementation of a theater structure. The quality of the DAIC in N'Djaména's productions, analyzing the threat on aeronautical platforms and monitoring the evolution of tactics, techniques and procedures of armed terrorist groups, is praised by all joint operational units. The staff of the CRA has been able to adapt to the most demanding and unpredictable conditions: as reinforcement for the CPCO in Paris, the JFAC in Lyon, the CAOC<sup>8</sup> in N'Djaména or the AOCC in GAO, the personnel have provided input to the entire hierarchy.

#### *A key role in Operation Chammal*

On September 8th 2014, precursor elements were dispatched to the United Arab Emirates to the Al Dhafra air base, ensuring the successful completion of the first intelligence gathering missions and the damage assessment due to air strikes. As a key player in SIGINT, image processing, multi-sensor fusion and support to forces and planners alike, the CRA maintains a permanent presence

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7. B. Foussard, T. Garreta. "Quelle action de l'armée de l'Air face aux menaces au-dessus de nos villes," *Revue Défense Nationale* 1, no. 796 (2017): 63-67.

8. Combined Air Operations Center

at the coalition's air operations command in Al Udeid, Qatar. Working both in Jordan in support of the C160G and in Qatar in support of the air force, the CRA makes a direct and indispensable contribution to the conduct of Operation Chammal. In Operation Inherent Resolve, the contribution of Level 2 analysts, in direct support of sensors, has proven to be decisive. During March 2019, when the fighting in Baghuz Faqwani was still raging and the territorial Caliphate was in its dying days, CRA intelligence specialists, for example, provided particularly reliable information on enemy's morale, capabilities, and intentions. The resulting intelligence proved crucial in identifying the threat posed by the remaining Daesh positions.

## **Current CRA limitations**

### *Time-based contraction and constant expansion of the field of action*

French air power can be deployed anywhere in the world within a particularly short timeframe. *"Speed, length, flexibility of use, guarantees of the capacity to react, to surprise and to strike an adversary wherever they may be, have become the main characteristics of military air power; which has extended the same principles to space, according to similar logics"*<sup>9</sup>.

This aerial specificity translates into a permanent need for intelligence and an increased reaction capacity. To master the effects of air power, its command structure must meet the requirements for agility, responsiveness and efficiency. Its intelligence tool must inevitably exceed its limits and adapt to both evolutions in technology and capacity in order to feed the preparation and planning processes, which are more and more constrained by time. The effort of anticipation required by the RIA<sup>10</sup> is particularly important as the performance of new platforms such as the A400M or the MRTT offers new perspectives in terms of power projection.

Thus, while it takes a week for a naval group to reach the Pacific zone, air power can be deployed there in less than 40 hours. These significant differences between the two environments show the constraints and the magnitude of the task that falls to the specialists in the RIA, whose field of investigation is vast and whose responsiveness in making intelligence available is a key factor. This swiftness and precision require a strong capacity of anticipation, the permanent enlargement and diversification of a network of sources as well as a sustained dialogue between intelligence and the operations.

Parallel to the main effort in the fight against terrorism, the Air Intelligence Center has had to maintain a balance between the strategic intelligence effort and intelligence support to the permanent air security posture. This constant discrepancy is at the root of an overall dilution of intelligence resources, aggravated by budgetary restrictions, causing an inevitable impoverishment of the knowledge

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9. F. Parisot, "Le combat aérien à l'horizon 2035," *Les Cahiers de la Revue Défense Nationale*. (2020): 49-84.

10. Air-Intended Intelligence: "The AIR includes both the air force's own intelligence requirements and the intelligence gathered by the Air Force's sensors. Air-Intended Intelligence (RIA) É. Champeaux – General (2S), former commander of the Air Defence and Air Operations Command (ADOC) "knowledge and anticipation"; "Une présentation du renseignement d'intérêt air," *Revue de la Défense Nationale*, cahier du Bourget (2017).

base of state actors. The evolution of conflictuality in the third dimension has been accompanied by a permanent expansion of the field of use of the CRA. The growing instability in security amid a multipolar world has only accentuated the needs for air intelligence expressed by an ever-growing network of third-dimensional users. The CRA has thus considerably extended its areas of interest in order to monitor potential crisis areas, detect new threats and understand the intentions of the most complex strategic competitors. The triad of competition-contestation- confrontation has also modified the approach to intelligence. The need to appreciate the capabilities and intentions of each competitor is now indispensable.

Finally, the return of high-intensity conflicts at Europe's doorstep has considerably modified the AAE's intelligence ecosystem and brought it up against its limits. The conflict in Ukraine is generating an exponential need for information of air interest, which extends from the strategic to the tactical level, in order to irrigate an enlarged RIA community more and more rapidly, which is naturally part of the "short term"<sup>11</sup>.

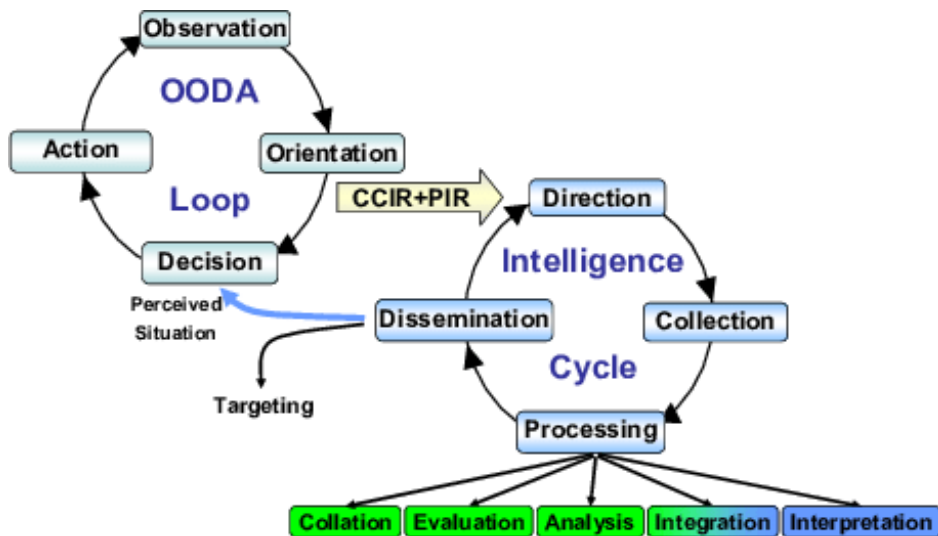


Figure 2: OODA loop synchronization and intelligence cycle

### Short and long term analysis, a balance to be struck

The multiple counterinsurgency operations conducted throughout the past twenty years have relied heavily on the use of airborne ISR assets. Moreover, the reduced size of armies operating over vast geographical areas has naturally led to a dependence on ISR platforms, whose range, depth of field and persistence compensate for a lack of manpower and, in general, an inability to occupy the terrain sustainably or to probe the enemy in depth.

<sup>11</sup>. During a parliamentary hearing in October 2015, General A. Lanata, Chief of Staff of the Air Force, stated thus: *"the French Air Force is the time-sensitive army"*.

Operations in Afghanistan, Libya and later the Sahel have brought to the forefront a swarm of sensors capable of detecting, locating and identifying the nature of the enemy to fuel a dynamic targeting cycle. The theses of the Revolution in Military Affairs (RMA) and the confrontations witnessed during the last decade of counter-terrorism in the Sahel have contributed to the emergence of surveillance and attack drones, the development of targeting pod and the SIGINT collection systems. A dynamic targeting maneuver based on a set of high-performance sensors networked in a “sensor to shooter”<sup>12</sup> logic has significantly increased the interest of military authorities in the collection and correlation of information in a constrained time frame, often to the detriment of multi-domain analysis carried out over the longer term. This sensor-centric approach has insidiously fostered a confusion between information and intelligence<sup>13</sup>. It has generated imbalances in the traditional intelligence cycle. For Joseph Henrotin, “the fascination with the sensor tends to reinforce the collection function over that of analysis and, by extension, to make information take priority over analysis. In fact, counter-terrorism operations require a global approach based on a proven knowledge of social, political and economic factors in order to contextualize the information gathered by the sensors and to determine the intentions of different actors in greater detail. If a drone crew can observe a mobile ambulance, it will be impossible to determine its actual use without the availability of other correlated and merged intelligence sources (HUMINT -OSINT- SIGINT-CYBER) which require a longer period of processing. There is an undeniable and indispensable complementarity between the different sources and domains of intelligence, whose exploitation nonetheless complies with different timetables.

The pertinence and coherence of an intelligence maneuver thus rests on the subtle balance between elaborate intelligence, which requires time, and the re-assembly of correlated information in a short loop by crews and analysts implementing the sensors. Informational superiority, in the sense of being able to locate enemy units, appears insufficient.

It is incumbent upon the CRA to find this balance in order to develop a base of knowledge about competitors and adversaries in order to determine their intentions precisely and to facilitate its dissemination to the tactical echelons in order to develop a true informational superiority.

## **The perspectives for evolution**

### *Broadening our base of knowledge about our opponents*

The changing nature of conflict in the 3rd dimension and the complexity of new threats require a comprehensive approach that focuses on a keen understanding of the enemy’s psychology and culture. CRA analysts must strive to overcome their own cognitive biases in order to better understand the adversary’s unique approach to air warfare. The risk of misunderstanding the adver-

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12. C. R. Davis. “[Airborne Reconnaissance: The Leveraging Tool For Our Future Strategy](#),” *Defense Technical Information center*, “Chapter 3: Sensor-to-Shooter Capability” (1995). The “sensor to shooter” logic aims to provide an armed aircraft with the location of an identified military target to enable it to rapidly engage a fleeting target.

13. J. Henrotin. *art. cit.*

sary's values or intentions is then avoided<sup>14</sup>. This makes it easier to determine the enemy's most likely or most dangerous intent.

This dynamic could emerge via the exploitation of adapted products made available by the CIAE<sup>15</sup> and the academic spheres dedicated to research.

*Developing the know-how acquired in the domain of intelligence support in the fight against terrorism*

The French strategic withdrawal from Africa in no way alters its engagement in the fight against terrorism, which remains a priority for military intelligence services. Thus, the first area of effort to be agreed upon concerns the strengthening of our post-mission analysis capabilities<sup>16</sup> of video streams from UAV sensors<sup>17</sup>. More generally, it will be up to the CRA to promote the use of airborne intelligence. The planned creation of a center in Cognac dedicated to the timely analysis of ISR flows will ensure, more particularly, the monitoring of techniques and procedures implemented by terrorist groups. The lessons learned will be disseminated to the military operations community. Correlation and fusion with other available sources will allow us to put into perspective the maneuvers observed by both MQ-9 Reaper and ALSR<sup>18</sup> crews and to construct an in-depth knowledge of terrorist groups.

This initiative must be accompanied by a consolidation of support processes for dynamic targeting and the development of the *Joint ISR*<sup>19</sup> function.

*Seizing the opportunities offered by the OSINT revolution*

According to Joseph Henrotin, while “*the aviation sector should remain the main supplier of the RIM*”<sup>20</sup>, *it is the cyber sector that is currently experiencing the strongest growth.*”

The massive dissemination of open source geographically located information and images on specialized and non-specialized sites gives a new dimension to Open Source Intelligence (OSINT). The conflict in Ukraine offers a very tangible illustration of the potential for everyone to be part of the fight. Anyone with a smartphone can participate in the collection of “first-hand” information.

Once limited to the exploitation of the press and major events (military parades and defense industry events), OSINT has expanded to the harnessing of the Internet's societal layer. News outlets (print, radio and television) have moved into the digital world while the development of social networks has made every individual a potential source of information. Initially considered an auxiliary

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14. R. Jervis. *Perception and Misperception in International Politics* (Princeton, NJ: Princeton University Press, 2017).

15. Joint Center for Environmental Actions

16. Beyond the real-time analysis performed by the crews, the aim is to analyze surveillance missions in depth to identify changes in the combat tactics and techniques used by armed terrorist groups.

17. [AAE 2022 Strategic Plan](#) - “*Linked to the DRM, creating a pole for analysis and cold exploitation of ISR Ops missions, under the operational supervision of the CRA*”.

18. Avion Léger de Surveillance et de Reconnaissance

19. NATO has established a permanent JISR system providing information and intelligence to key decision-makers, helping them make well-informed, timely and accurate decisions.

20. Intelligence of military interest

source, Internet research has become a discipline in its own right, governed by the same rules as IMINT or ELINT. Oriented in the same way, this source provides an opportunity to find information that will be correlated by the other disciplines, or vice versa.

In recent years, the CRA has adapted to make the best use of this aspect of intelligence originating from cyber space and will develop its skills in this domain.

*Succeeding in its digital transformation*

As with the civilian world, the military is going digital. Not only does OSINT generate massive amounts of data, but the documentation produced by the DRM and our partners is now digital. Sensors have also become digital over the past two decades. The IMINT, SIGINT and RADINT disciplines primarily produce computerized files that must be rendered intelligible.

This trend represents an extraordinary opportunity in terms of exploitation through GEOINT<sup>21</sup> tools (GEOINT being a corollary of the digital transformation of intelligence), but requires overcoming a certain number of obstacles, including:

- Have the IT infrastructure in place
- Have the necessary tools to capitalize on the data
- Have data specialists available
- Make the work methods evolve

Financial and human resource limitations accentuate the need for digital transformation to achieve gains at scale. The first challenge is acquiring the skills needed to exploit digital technology. It will be crucial to recruit and retain data experts, network architects and geomatics experts in order to create the necessary infrastructures for data and its availability for users having the need to know it. Data is now more than ever the Ministry of the Armed Forces' gold, and more particularly that of the Joint Intelligence Function (FIR). The capitalization of data in correctly structured databases that can be exploited by efficient algorithms are major challenges that the CRA will have to meet under the DRM's aegis. These databases will also have to be built with the memory and knowledge accumulated over the years about our competitors or adversaries. This collective memory, correctly structured and permanently available, will be a source of foresight of the actions of our adversaries.

*Taming data to make it interoperable and available to the greatest number of people*

The digital transformation is also characterized by an unprecedented and constantly growing amount of data needing to be processed. Algorithms must help handle this growing volume of data. It is not so much a question of replacing humans, but rather entrusting to the machine the tasks that require few cognitive resources, that are repetitive and prove to be very uninspiring over time. It is more so a question of reserving the most noble and complex tasks for humans, namely those of analysis and reflection.

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21. Geospatial Intelligence

For the time being, raw data processing automation tasks are being developed for the benefit of technical research disciplines. The first artificial intelligence solutions will be deployed in 2023 to facilitate mass imagery processing.

These artificial intelligence solutions will process a mass of data at speeds that humans could not handle, eliminating the risk of error. However, it is necessary to better train the intelligence operators who will concentrate on the most complex tasks.

The last significant change in the intelligence function will undoubtedly be in the area of forecasting. The CRA may need to focus less on past events, but it will need to be able to present the most potentially likely and most dangerous situations.

However, like its FIR partners, the CRA is faced with the problem of system and data interoperability. Most of the data is unusable because it cannot be circulated in the current architecture or because of its unsuitable format<sup>22</sup>. Air intelligence is only viable if it is shared by all the actors who need it in the necessary timeframe. Data structuring, capitalization and visualization tools are essential. In the AAE, the construction of an RIA memory involves the use of the Operational Intelligence Fusion and Electronic Warfare (FORGe) solution, whose databases would be interfaced to a range of AI tools designed to enhance them.

At the interface of the FORGe system, artificial intelligence tools offer great prospects for development, which can already be seen in the many projects carried out by the CRA and the Brigade aérienne de connaissance anticipation (BACA). The algorithms used already allow for the automation of multiple ancillary tasks and save precious time that can be reused for more in-depth analyses that only humans can perform at this stage. Thus, in a logic of rapid sharing of intelligence with combat units, the flow automated integration phases will instantly update the databases and ensure that combatants are aware of the latest events in their area of operation.

Over time, properly structured and sufficiently large databases will give all the expected efficiency to mass processing algorithms. The mass management of IMINT<sup>23</sup>, SIGINT<sup>24</sup> or RADINT<sup>25</sup> flows will discriminate against behaviors or aircraft kinematics deemed abnormal or suspicious. The analyst's attention will be drawn to events that can be used as warning indicators. This forecasting approach implies setting up a certain number of indicators while monitoring their occurrence to confirm a situation's emergence.

## Conclusion

Over the past two decades, the CRA has maintained a permanent restructuring effort to respond successfully to the evolution of conflict in the 3rd dimension. In a context of global reform, a refocusing of key competencies closer to the CD-AOA General Headquarters in 2008 facilitated the understanding of intelligence needs in support of decision-making. In addition, the *ad hoc* structures, DAIC

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22. A. Gary. "[Intelligence artificielle et armées françaises: une technologie du présent à mettre en oeuvre immédiatement](#)," *Revue de la Défense Nationale*, HS no. 4 (2021): 200-213.

23. Imagery Intelligence

24. Signal Intelligence

25. Radar Intelligence

and the CRA's level 2 analysis echelons have provided units as well as allied and national command structures with valuable threat assessment capabilities within the time frames required for modern air operations.

The multiple counter-terrorism operations carried out over the past twenty years have underlined the inherent limits of the imbalances generated between analysis and collection or the confusion between information and intelligence. The pertinence of analyses of intentions and the coherence of an intelligence maneuver depend on the balance between elaborate intelligence, which requires time to be produced, and the feedback of correlated information in a short loop by the crews and analysts who implement the sensors.

The latest National Strategic Review identifies a clear objective for the intelligence services, including the CRA and the DRM: *“One of the decisive challenges is to articulate the continuation of their action in the fight against terrorism and in support of military operations, with reinvestment in zones of strategic rivalry, particularly continental Europe and the Indopacific”*<sup>26</sup>.

In the fight against terrorism, the CRA, via its delegated center, will make a more specific effort to capitalize on, exploit and perform cold analysis of video streams from ISR assets operating in Africa. Correlation and fusion with other available sources will also allow us to contextualize the maneuvers observed by the crews and to build an in-depth knowledge of the capabilities and intentions of terrorist groups.

In the context of a high-intensity conflict, the CRA, as far as its responsibilities are concerned, must make an effort to develop the knowledge base of competitors and adversaries in order to determine their intentions as precisely as possible. This knowledge will have to be disseminated to the tactical echelons to spur the emergence of a true informational superiority. This superiority will be achieved by taking into account a broader base of knowledge; such as social, psychological, political and economic factors.

Finally, to achieve these objectives, the CRA will have to rely on structured databases enhanced by AI tools and served by interoperable networks. This resilient ecosystem, mastered by analysts, will provide fluid and permanent information to tactical units and general headquarters alike.

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26. [National Strategic Review](#), 2022.

# The Special Operations Air Forces Contribution to Intelligence Manoeuvring

Julie Bruscoli, Matthieu Lourenco

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With the 2013 White Paper on Defence and National Security, and the subsequent 2017 Strategic Review, the “knowledge and anticipation” coupling is defined as representing one of the five strategic functions that render it possible for France to guarantee its freedom of assessment and decision. This sole capability with its strategic scope is central for the implementation of operations conducted by the *Commandement des opérations spéciales* (“Special Operations Command” or SOC). Furthermore, it is a necessary prerequisite for France to carry out autonomous assessments on any capabilities that could achieve military effects on its own. Undeniably possessing exceptional assets, the French Air

and Space Forces (FASF) is able to contribute four units of distinct skills to the SOC – albeit without a specialisation in the intelligence field.

Since 1993, the *Special Operation Forces from Air component* designed as "*Special Operation Air Forces*" (SOAF) have been fully integrated into the SOC's manoeuvring. Similar to other SOC units, they comprise tactical echelons capable of collecting, analysing, and disseminating information to supply the national intelligence chain. Specialised in-depth manoeuvres and situated at the cutting edge of innovation, the SOAF units are of a unique standing. Its recent integration of the *Commando Parachutistes de l'Air 30* ("Commando Air Parachuters 30" or CPA30) into the SOC only confirms this trend. The CPA30, namely, specialises in intelligence, with additional missions of air support and the retrieval of isolated personnel.

A veritable melting pot for the development of French intelligence capabilities, these various units hence foreshadowed the FASF's intelligence manoeuvring as it is known today.

Nevertheless, there has been a change in paradigm with the arrival of new vectors and equipment (drones), along with the affirmation of new fields of confrontation (cyberspace, informational sphere, for instance.). The opportunities thus offered by said novel technologies are so overwhelming in their importance that the SOAF must reestablish its priorities. Likewise, this applies to other components and units as well, who are also investing in these new fields of conflictuality. Namely, these entities include the *Commandement Forces Spéciales Terre* ("Special Operation Land Force Component Command") and the *Commandement des fusiliers-marins et commandos* ("Special Operation Navy Forces component command"). As such, in this critical period, the question then rises on what orientations the SOAF should take within the intelligence field to ensure their efficiency, while providing the best capabilities in terms of information gathering for the national chain.

Since their integration into the SOC, the SOAF has progressively accumulated more power with their innovative equipment and concepts of use that contribute to intelligence manoeuvring. Currently, it possesses capabilities across the entire intelligence spectrum. Moreover, the SOAF is also developing capabilities in related assignments, such as influence, targeting, and more. In tandem, aviators from such units devote themselves, without abandon, to the pursuit of innovative capabilities that adapt to the emergence of different confrontation fields (i.e. multi-domain operations). This ultimately allows them to adequately respond to the French Armed Forces' potential scenarios of conflict.

### **Between Integrating Elite Air Units into the SOC and the Birth of Intelligence Support**

In 1993, only a year after its conception, a first unit of aviators joined the SOC. To be precise, it was in the aftermath of the Gulf War that French reflec-

tions took on a new turn. Notably, this focused on the contribution of units with an exceptionally high expertise level, required to carry out disruptive modes of action. At the time, the Air Force provided the SOC with three elite units:

- The CPA 10 (Air Commandos Unit N°10) was the first air commando unit to be integrated into the SOC. Its objective was to facilitate the in-depth engagement of aircrafts. Equipped with specific intelligence-gathering and transmission equipments, the capabilities of this unit have been considerably enhanced over the past thirty years.
- The 3/61 *Poitou* Transport Squadron, at its inception in 1993, delegated one of its squadrons to the SOC. This was the *Groupe opérations spéciales transport* (“Special Operations Transport Group”). With its *C-160 Transall*, *DHC-6 Twin Otter*, and *C-130H Hercules*, the squadron provided and supported the SOC units, once on the ground, with autonomous airborne projection and insertion capabilities. The regular integration of such new technologies into various aircrafts consequently expanded the squadron’s capabilities, particularly in terms of intelligence support.
- Finally, also created in 1993 was the *Escadrille spécialisée hélicoptères* (“Specialised Helicopter Squadron” or ESH). This squadron provided commandos with a helicopter transport capacity, most notably for night insertion. Initially equipped with the *AS332 Super Puma*, the ESH switched to *Puma* at the end of the 1990s, and then again to the *H225M Caracals* in 2006. The latter granted the squadron the means to develop their opportunity acquisition abilities. Originally based at Air Base 114 in Aix-Les-Milles, it was then transferred to Air Base 120 in Cazaux in 1998. In 2011, following the Air Participation of selected aviators from the 4th *Régiment Hélicoptères Forces Spéciales* (“Special Operations Helicopter Regiment”) in Pau, the ESH was consequently dissolved. As a result, its capabilities were transferred to the 1/67 *Pyrénées* squadron. Said squadron was integrated into the SOC before being declared to be in full operational capacity in 2018.

The routine deployment of the above three units as an advanced forward echelon into theatres of operations clearly demonstrated that operators can also be employed as sensors. All SOAF units – including both crews and commandos – are thus valued for their presence in these areas of interest. This is portrayed through the collection of data that is valuable for intelligence production.

Indeed, the integration of new technologies have fueled an ambition to take advantage of new opportunities offered by the air weaponry (overflight of points of interest, transmission of video streams, etc.). With the assisting feedback, the range of different means of intelligence manoeuvring offered by the SOAF becomes, as a result, considerably aggrandised.

*Adapting in the Field with the Use of Non-dedicated Equipment*

Unlike leading anglophone countries, intelligence gathering in France is not as of yet a matured practice across all of its spheres. A change of mindset within the SOAF in terms of approach and training became inevitably obligatory. This, in particular, applied to the full use of what warfighters or aircraft sensors could provide during demanding environments. In short, because the vision that “everyone on the ground is a sensor” was initially implemented empirically by the SOAF, it was in dire need of a heightened sophistication.

Importantly, it was CPA10 that paved the way for air units to collect “materials of interest” for the SOC’s intelligence manoeuvring. Through this, the first SOAF engagements in Bosnia (1993-1995) and in the confines of Rwanda during “Operation Turquoise” (1994) marked the starting point of a new manner of SOAF units’ contribution to intelligence-gathering efforts.

Meeting local authorities and engaging in regular contact with the population also brought about new opportunities to provide pertinent information. The observation, orientation, and transmission of information collected in these circumstances were initially conducted in an informal manner. Not long after, owing in part to the numerous courses offered in SOC units and by the *Direction du renseignement militaire* (“Military Intelligence Directorate” or MID), human intelligence (HUMINT) was granted specifically dedicated training for the purpose of optimising intelligence gathering.

*The Engagement in Afghanistan: The SOAF’s Significant Developments via Operation Heracles and Ares*

The engagement in Afghanistan – under the framework of Operation Pamir – marked an essential turning point in the role played by CPA10 on the ground in its contribution to intelligence manoeuvring. Importantly, observation and intelligence gathering became imperative in the detection of the Taliban’s positions, who took advantage of the country’s underground chambers to avoid detection. Thanks to these capabilities, Allied ground-attack aircrafts were able to strike rapidly at any target identified by the commando on the ground. Coined as the “Golden Age” of the skills executed by the Joint Terminal Air Controller (JTAC), these Strike Coordination and Reconnaissance (SCAR) missions required to efficiently operate in a short loop via the *Rover* or *Scarabée* systems (video transmission of the target between the JTAC and the aircraft pilot).

Further traditional reconnaissance capabilities were employed in addition to the above, such as rough terrain reconnaissance to land the *Poitou* aircraft or ESH helicopters. Both the integrator and coordinator of air weapon use, CPA10 played a decisive role in feeding the theatre’s intelligence chain.

From another angle, operations in Afghanistan also marked the advent of an extensive use of UAVs, in particular for reconnaissance missions. The integration

of Medium Altitude Long Endurance (MALE) and High Altitude Long Endurance (HALE) systems considerably improved the responsiveness and the manner in which forces on the ground were engaged. Nevertheless, unobtrusive observation from the ground carried out over a long period of time in a particularly complex environment with demanding geography, offered an indispensable and complementary perspective to the imagery intelligence acquired by all these airborne vectors.

Through the lens of this context, the SOAF, along with the *Poitou* and the ESH, was observed to have capitalised on most of their capabilities by carrying out reconnaissance, before opening routes that counter the risks of Improvised Explosive Devices (IEDs). The use of the *Caracal*'s on-board thermal imaging cameras was able to recognise parts of a road, where there were signs, hinting that an explosive device had been left behind (upturned earth, unusual human pattern near a point of passage, etc.).

Operations Barkhane and Chammal executed against armed terrorist groups only accelerated this practice of utilising SOAF units to significantly broaden the spectrum of skills. Born out of the determination to innovate, both the capabilities of Non-Traditional Intelligence Surveillance and Reconnaissance (NTISR), as well as Command, Control, Communication, Intelligence, Surveillance, Target Acquisition and Reconnaissance (C3ISTAR) emerged, thereby producing increasingly powerful equipment. With the use of aircrafts and helicopters, the limited aerial evolutions and flight profiles employed in these semi-permissive environments facilitated the transportation of equipment designated for intelligence support missions. Optronic pods, cameras, electromagnetic sensors, along with infrared binoculars are all tools used in addition to onboard resources. In terms of detection, aerial reconnaissance, or post-action assessment (Battle Damage Assessment), the use of these varied capabilities now effectively contributes to overall intelligence manoeuvring. The SOAF has henceforth become complementary actors, who are trained and employed by the J2<sup>1</sup> chain.

While the actions described above are most often carried out in a short loop and to the benefit of the tactical echelons, the SOAF also took great care to integrate themselves at both the operational and strategic levels. This is all to ultimately function within the overall military intelligence manoeuvring, led by the MID.

### *Optimisation and Integration into the Military Intelligence Chain*

For the intelligence chain to be effective, it is reliant on the speed and efficiency of the Observation-Oriented-Decision-Action (OODA) reflexive loop<sup>2</sup>. The feedback of information fuels this loop and ensures its proper functioning, be it in “real” time or in delayed “unreal” time. The intelligence chain (J2) – from the theatre to the mainland (MID) – is permanently linked with the SOAF units on the ground to optimise exchanges between both operational and strategic chains.

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1. Intelligence directorate within the joint command structure.

2. Theorised by John Boyd in the 1960s.

To this end, each unit consists of a local-level intelligence office, which centralises all intelligence materials produced that enter and leave the unit. Further, these offices partake in the brainstorming of how such materials may be put to use within the framework of an intelligence function. The personnel are thus trained, regardless of their rank, at the FASF intelligence training squadron, stationed in Creil from 2021. From there, they emerge as specialists in air or surface-to-air threats posed against the Air Force.

In addition to assisting their respective units with mission preparations, the SOAF's intelligence personnel can also be affixed to the operation centres of SOC Task Forces. With their expert knowledge on the use of various air vectors, they provide invaluable counsel to their superiors, as well as simultaneously enhancing the use of aviation in joint operations.

Attached in its integrality to the *Brigade Aérienne Connaissance et Anticipation* ("Knowledge and Anticipation Air Brigade"), these personnel, during operations, function as indispensable links, connecting the tactical level of SOAF units with the operational intelligence level of the Air Force – that which being the *Centre de renseignements avancé* ("Advanced Center of intelligence") and the Deployed Air Intelligence Center. In order to strengthen such channels between tactical, operational, and strategic (MID) levels, as well as to ensure coherence in project developments between units, the *Brigade des forces spéciales air* (Special operations Air Component Brigade or SOACB) is projected to eventually employ more specialised personnel. This new group would be delegated specifically to be responsible for ensuring the coordination, consistency, and management of intelligence capability projects for the Brigade.

#### *The SOAF's Contribution to Intelligence*

In today's times, the field of intelligence support has expanded considerably with the advent of new environments and fields of evolution, such as cyberspace, outer space, and electromagnetic. Moreover, these also represent, in themselves, new intelligence opportunities. This is notably the case for data collection at a particular large quantity. However, the traditional categories nonetheless persist in accordance with the different sources used to obtain information. Namely, these consist of human intelligence (HUMINT), electromagnetic intelligence (ELINT), imagery intelligence (IMINT), and finally, open-source intelligence (OSINT). The latter has, in recent years, seen an exceptional rise in their use with the increase in various communication and dissemination channels on the Internet.

Although such classic areas of intelligence are supported by well-defined, but at times, exclusive doctrines and practices, the SOAF is distinguished by their ability to appropriate each of them without being specialists. One of the choices adopted for the onboard units is to be able to aggregate on the same vector a sum of different sensors. Similarly, the intelligence personnel present in these

units – after completing specialised training and thereby acquiring considerable versatility – are also obligated to work on different intelligence fields as they are transferred. For instance, a SOAF intelligence officer who is selected and trained specifically for their unit's missions, is profiled for their adaptability. Such an aptitude allows the officer to plan operations within the operational centre, without failing to provide direct intelligence support to crews, commandos, and decision-makers alike.

### **Current SOAF Capabilities that Fuel the FRA Intelligence Chain**

Hailing from three decades spent at the SOC, the SOAF units are now of a magnitude that can unilaterally send ripples throughout the entire intelligence field. The synergies offered by the SOAF aviators are not only fine-tuned in operations on a daily basis, but also within the exercises organised by the SOACB, such as *Athena*. The intelligence component, in particular, occupies a major role in this symbiosis.

*The SOAF: A Key Contributor to the Intelligence Chain that Enhances Operations*

#### Intelligence Support

The SOAF's current core capabilities are used to support intelligence manoeuvring that are set to action. At the heart of this is the capacity to anticipate the needs of an operator, which requires establishing not only common procedures, but also permanent training. The linkage between Intelligence, Surveillance, Reconnaissance (ISR) support, and firing support must therefore be mastered. Importantly, intentions of the different actors must be made intelligible in order to anticipate their needs, before initiating appropriate measures. The objective is thus to deliver the right analysis or information to the right person.

To illustrate a case in point, one can turn their attention to the reconnaissance of an "aircraft landing area", which is a specific know-how skill set, unique to CPA10. Upon completing the preliminary verifications, this mission allows for the compilation of a complete file needed for the use of a runway or a landing zone. The capability for the *Observation et destruction de sites par l'arme aérienne* ("Site Observation and Destruction by Airborne weapons) maximises the use of air power to its widest spectrum (combat aviation, ground forces, etc.) with the objective of carrying out precision strikes. This, in essence, embodies the skills developed by CPA10 to employ air power against high-value targets.

Additionally, the SOAF can also take hold of their equipment (such as aircraft optronic pods, equipped with TV/FLIR sensors) to feed into the J2 chain. Since the enemy does not identify these aircrafts as participants in intelligence manoeuvring, liaison flights can be carried out without alerting the adversary to one's true intentions.

Lastly, operators in zones of action have also adopted Battle Damage Assessment missions. Specifically, these missions are carried out following an airstrike in order to compare the results obtained with the effects sought after. There is also a secondary use, which is observed more frequently in recent times. These missions have become a means to scrupulously scour the terrain and take advantage of anything the adversary may have left behind after being hit. Analysing, the recovery of documents, materials, and fingerprinting, as well as photography have hence been cultivated to a professional standard. Indeed, CPA10 and CPA30 commandos are now trained in these procedures, known as Site Sensitive Evaluation (SSE).

For the purpose of producing such actionable intelligence, the SOAF has developed and integrated within its structure, the substantial tools and means to do so. Consequently, this all but demonstrates FASF's unique ability to operate in an agile manner.

#### *Developing Innovative SOAF Intelligence Support Capacities*

The C3ISTAR Spearheads the SOAF's War Against Terrorism:

At its onset, objectives were established to offer the SOC an autonomous command and intelligence support system that would be integrated onto an assault and transport aircraft. The C3ISTAR concept was born from these aspirations. This became a veritable multi-purpose platform, made available to the SOC to directly support its operations. Its purpose was hence to combine mobility support, intelligence support, and command support into a single operation, featuring a wide range of action modes that can be implemented successively or simultaneously. In concrete terms, the C3ISTAR is based on the integration of a IMINT sensor (an *MX-20/15* optronic pos) onto an assault and transport aircraft.

Such an aircraft also possesses robust and diversified communication capabilities that allow the crew to fulfil the role of a command relay (C2 air) in a zone of action. This delegation of commands can be exercised in several fields. One is the ability to command an ISR module in an area of action (sensor warden). Another is the ability to relay or exercise a direct tactical-operational command function *via* either the boarding of a J3, a Chief of Mission in the holding compartment, or *via* an onboard JTAC support. These possibilities are combined with the standard capabilities of assault and transport aircrafts to increase the number of possible action modes. The intelligence personnel here arms the key function of tactical coordination and management of other ISR platforms.

Initial "Empirical" Development of a Rental Light Surveillance and Reconnaissance Aircraft (LSRA) to Support the SOC:

Conceived from an operational necessity, with inspiration taken from the United States, the SOC has expressed its interest in possessing the capability offered by light surveillance and reconnaissance aircrafts (LSRAs). Previously

employed by the MID until 2018 under a rental contract, the SOC sought to integrate these *Beechcraft*-type aircraft through a more progressive approach. This was mostly due to their decisive contributions to asymmetric warfare taking place within a permissive environment. It was naturally within the SOAF that the first crews responsible for conducting real-time intelligence gathering on these aircraft emerged. Less than a year after the use of its first rental aircraft, the SOAF was able to field the first LSRA to support the SOC. The LSRA is thus equipped with all SOC operation control systems. The SOAF also transferred this capability to the crews of the *Dunkerque* Airborne Electronics Squadron, as it provided the unit's personnel with the specific information and communication systems used by the SOC.

The *Caracal*: An On-site Approach to Equipment Integration:

To begin, the *Pyrénées* stood out amongst the intelligence field for its NTISR capability. Because helicopters continue to be a scarce and limited resource, the priority was therefore to refrain from developing an intelligence support function. However, the unit's capabilities (long-range mission, 20mm cannon, etc.) have undergone substantial progress in operational terms, with the transporting of multiple equipment that support intelligence manoeuvres. Nevertheless, helicopters remain a machine with constraining technical specificities (mainly due to vibrations and the rotor). Despite so, it continues to serve as a platform of interest for the development of electronic support capabilities through equipment implemented by SOC commando units (13th Parachute Dragoon Regiment, Commando Kieffer, 54th Transmission Regiment, CPA30).

The New Space Field to Offer New Opportunities for the SOAF:

Exo-atmospheric space, a new environment for conflict, is the subject of attention all across the globe. Indeed, the new field represents a significant challenge in the guarantee of not only communications security and freedom of movement (GPS), but also the autonomous assessment of a country's situation. With satellite resources that combine both IMINT and ELINT capabilities, the FASF – having added the word “Space” to its name in 2020 – has decisive capabilities to support its operations. In this context, CPA10, a SOAF unit, is a pioneer amongst its peers due its access and skills in space image processing via the MID. As a result, CPA10 personnel are able to use said imagery intelligence in the designing of an operation's action plan.

Including the *Poitou* and CPA30 into the Joint Intelligence Function and the Challenge of Further Integration with the MID:

In 2020, the 3/61 *Poitou* Transport Squadron and CPA30 units integrated with the *Fonction interarmées du renseignement* (“Joint Intelligence Function”). This integration, within the military intelligence sharing community, is organised by the SOACB and supported by the Knowledge and Anticipation Air Brigade. It enhances capabilities that benefit both the SOC and the FASF. The MID, in ad-

dition, is able to monitor the progress of innovation in these units and provide existing training in the areas of SOAF's skills acquisition.

Ultimately, this integration ensures that the FASF (via the SOAF units) can benefit from specific training within the MID. From the perspective of the MID, it represents the possibility of directly exploiting intelligence collection and production of the *Poitou* and CPA30 units. Such an integration will be of even higher value in the context of a high-intensity conflict, where resources will be scarce and coveted. The in-depth movements of SOAF units (*A400M Atlas*, *KC 130J*, *H225M Caracal*, Forces Commando Air) will also be developed with an intelligence component, and not solely an operational one.

*Specialised FASF Units: Decisive Support for the SOC and Intelligence Manoeuvring*

Operations that can rely on Special Forces units and *Modules d'actions opérations spéciales* ("Special operations action modules", being units that are in direct support of the Special Forces) employ specific skill sets needed for SOC operations. These include the *Groupeement Aérien d'Appui aux Opérations* ("Air Operations Support Group"), as well as the *Escadre Aérienne Commandement et de contrôle Projectable* ("Projectable Command and Control Air Wing"). Air operations for these types of special operations are not only contributory, but also serve as force multipliers. For instance, in the field of intelligence, the acquisition of the *Reaper* UAV is deployed by the 1/33 Belfort, which is the Special Operation Forces reference unit. This has contributed decisively to demonstrating the need for such means in the third dimension for special operations. In detail, this was achieved by the extent of its intelligence and kinetic capabilities, despite the current absence of an ELINT payload.

One of the most decisive advances for force employment has been the area permanence made possible by MALE and HALE UAVs, with its endurance of 12 to 24 flight hours in surveillance missions. Their integration into the existing lot of air units is undeniably for the purpose of supporting the SOC. The downside is that their placement among SOC units would be detrimental due to the (already) scarce resources of the FASF. Perhaps a worthwhile tradeoff, the synergetic developments and exchanges between the SOAF and SOC units are nevertheless enhanced during exercises in France or missions carried out jointly in the various theatres of operations.

Furthermore, such synergies are only made sustainable when they are propelled by the SOACB to serve the entire organisation of FASF units that contribute to SOC operations. Regardless, the SOAF is well aware that intelligence manoeuvres are also being carried out in units other than those of the FASF. They will thus capitalise on their networks to develop projects that can acquire new intelligence capabilities, particularly within CPA30. The

SOAF's ambition is thus deemed to be at an insurmountable level. Indeed, such an environment that cultivates synergy will only guarantee success as there is much at stake. As the number of personnel in each expertise area (aircrew, commandos, intelligence, staff) remain limited, it is thus necessary to prioritise unfulfilled needs and engage in a long-term global reflection on the effects sought after by the SOAF to meet future challenges.

## Perspectives

### *Developing Synergies*

With the integration of the *Poitou* and CPA30 into the Joint Intelligence Function, the SOAF has taken advantage of the opportunity to develop synergies between its units and the French Central Intelligence Directorate. This integration created new prospects that the FASF staff must also seize. To this end, it will be necessary to strengthen the intelligence function at the SOAF's most elementary level in order to be able to perfect the function's consistency within the SOAF in the long term. These synergies must first and foremost be developed between the SOAF units, by sophisticating their particularities and individual know-how. Concurrently, this must be carried out while ensuring the development of the competencies passed down by the SOC to its intelligence officers (specialised training courses). Hence, this approach ensures the constitution of a robust pool of Air personnel ready to take up positions within the J2s of various SOC Task Forces.

Additionally, these synergies must also be developed internally within the FASF, with the units supporting special operations, such as via Special operations action modules or reference units. They can, in turn, be fruitful in several ways.

The SOAF remains an invaluable laboratory for innovation and testing in the capability field. The FASF can benefit directly from positive feedback on certain equipment. A case in point is the rental LSRAs put into service by the FASF within the SOC, which revealed a crucial need to develop said air platforms.

Other FASF units (in particular, the SOC reference units, such as the 1/33 *Belfort* in terms of ISR expertise) also provide the SOAF with valuable feedback. This is necessary in order to enhance the Air Land Integration domain. Specifically, this domain is responsible for the coordination of air power with ground actions. Within it, procedures and intelligence capabilities absent in the SOAF can be shared, which would in turn, open up new realms of possibilities. For example, the integration of tactical UAVs or Medium Altitude Medium Endurance (MAMEs) systems within the SOAF must be based on the competencies developed conventionally by the FASF. Moreover, this must be carried out both in terms of the acquisition and processing of intelligence, as well as in terms of the operational use aspect. The same applies to certain ELINT segments, where the FASF's conventional units have developed their own skill sets (Airborne Electronic Squadron, Ground Electronic Squadron, LSRA). Furthermore, the

SOAF should continue to fine-tune their mastery over such skills in order to establish and develop new capabilities (Special Forces Electronic Support, tactical UAVs, ELINT pods, etc.).

Another aspect to note is that synergies with the air intelligence chain also need to be improved. To refine their situational assessment, the SOAF must use air intelligence (AIRINT) developed within the FASF to present all accurate details. Whether it is in the situational elaboration of airport platforms or the assessment of air and surface-to-air threats, the SOAF remains a unit of the FASF. Thus, it must develop the foundations of the intelligence cycles of their parent corps to convey the Air Situation to the MID, as well as the *Centre de Planification et de Conduite des Opérations* (“Centre of Operational Planning and Conduct”). Directly involved in threat assessment, the exchange of AIRINT to the FASF must be made more actively responsive, and free of any conflicts surrounding chains of command.

Indeed, the SOAF must ensure that they develop intelligence capabilities that are clearly identified and adapted to the specificities of the aerial environment, without seeking to conform to other SOC capabilities. Excessive acculturation or alignment with what already exists could jeopardise the ability of each SOAF unit to carry out its own missions. This would consequently diminish their contributions to intelligence manoeuvring.

Finally, the exploitation of either artificial intelligence, influence (psychological operations), or cyberspace is to be studied in detail. Regrettably, the lack of personnel dedicated to these tasks is glaring. The SOAF must further expand their involvement in the intelligence domain, by intersecting through cultures and other fields, as well as by mastering the stakes and interactions. This needs to be carried out without spreading themselves too thinly in the multi-domain spectrum.

#### *Innovation as a Priority to Providing Solutions for the Current Strategic Context*

Given the current geopolitical context in Europe, the lessons learnt from the SOAF operations in the Levant (Operations Chammal and Hamilton), as well as the evolution of “broad spectrum” threats (cyber, space, weapons of mass destruction) provide a framework for a new manner of training for war. SOAF units will be required to be integrated into large-scale conflict scenarios and may be commanded under hybrid arrangements between operation commands (Special Operations Center, Joint Force Air Component Command, etc.). In this context and in view of high-intensity warfare training, the SOAF must continue to share their innovative solutions not only within their own army during major exercises, but also with the SOC.

With the emergence of Anti-Access/Area Denial and the possibilities of large-scale conflicts breaking out, the SOAF faces the same challenges as with

any other unit. It is imperative that they ceaselessly innovate research and intelligence processing phases. Future digital tools are required to be interoperable with those developed within the SOAF. In regard to training, the implementation and testing of certain technical capabilities could be based on exercises proposed within the FASF. Should the SOAF function indeed as a laboratory for the FASF (namely in terms of Air Land Integration), the gap in performance in a counter-insurgency war and the war against terrorism must be narrowed. Notably, future wars will certainly require the SOAF to collaborate more with their army to prepare for possible large-scale conflicts.

To meet these challenges, the SOAF will have to continue to seize the technological opportunities and the speed of the innovation processes developed in the SOC to maintain a competitive edge in the intelligence field. Considering that tomorrow's wars will be fought as a coalition, the SOAF must therefore equip itself with tools that can be interoperable between Allies.

Indeed, since their birth, the SOAF has been keen to integrate into the SOC and dedicate their capabilities to its operations. The SOAF refined the specificities of their environment and promoted the integration of aerospace weaponry as the action modes of the Special Operation Forces. Having developed for almost 30 years their own singularity within their own army, the specific competencies in the SOAF's air support would benefit from an investment in any processes that have been thus far sidelined.

With expertise in target identification, Air Surface Integration, and intelligence (via a drone or a fighter plane), the SOAF may be best placed to test and develop the Strike Cells capabilities set up within the COS, which are most familiar to U.S. command structures. This Strike Cell is a dedicated cell working in a short loop with the famous "Find, Fix, Finish, and Evaluate". It centralises all the information necessary to mounting an air strike on its targets. All this is then executed by specialists and joint personnel in order to achieve ever greater efficiency.

The air environment imposed by the speed of such vectors requires both intelligence and their associated target development tools. Here, the SOAF is at the forefront of airborne weaponry innovation and integration into a joint environment, such as that of special operations. The SOAF intelligence personnel, having already been trained in targeting techniques, should capitalise on the synergies between the intelligence and targeting domains within the SOC. This would enable them to develop their skills further and effectively serve the Special Operation Forces, intelligence, as well as the French Air and Space Forces.

Raised with care by a dedicated brigade, in less than 30 years, the capability domain of SOAF units in support of intelligence manoeuvring has only grown at a steady pace. The development of key concepts adapted to the decades of the war against terrorism has only invigorated the willingness to innovate, as well as solidified their unique competencies. With selected, qualified and motivated

combatants, the SOAF has been able to water the field of intelligence with their invaluable forces, both by providing innovative onboard technical solutions, as well as specialised and qualified human resources.

Nonetheless, while the SOAF may put their exceptional skills at the disposal of the SOC, they cannot go without the obligatory interactions with the army in which they are housed. Synergies must continued to be made, be it in doctrinal studies, in the management of specific intelligence skills, in the integration of air intelligence resources outside the SOAF (such as UAVs or LSRAs), in training for high-intensity conflicts, or in organisational links with the national intelligence chain *via* the air intelligence chain. Indeed, the future will only witness the forging of closer bonds between the SOAF and its direct superiors, as it strives to propose never-ending innovative solutions to command.

# New Perspectives on Spatial Data Collection

Xavier Gallais<sup>1</sup>

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Strategic interest into space was conceived upon two crossroads: the one between two blocs, and those between the missile and the bomb<sup>2</sup>. At the end of 1945, in the context of the Cold War, the West and the Soviet Union brought in the German minds behind the design of the V1 and V2 to merge the power of nuclear weapons with the range of ballistic missiles. In October 1957, the Soviet Union made history as the first to enter space with the launch of its *Sputnik*. Taken aback by the U.S. population's astonishment, the Eisenhower administration did everything to undermine the significance of this event, albeit to little success<sup>3</sup>. A wave of anxiety suddenly washed over the United States: unlike the previous world wars, North America was now within the firing range of the enemy, and faced the possibility of becoming a battlefield.

On both sides of the Iron Curtain, nuclear deterrence entailed significant intelligence requirements. This comprised the ability to gauge the adversary; size up enemy forces; prepare a possible recourse; send a warning in time; and finally,

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1. I am deeply grateful to all those who have contributed to this article, either by taking the time to explain the space domain to me in rich, educational discussions, or by rigorous and enlightening proofreading.

2. Editor's translation of X. Pasco. *Le nouvel âge spatial : de la guerre froide au New Space* (Paris: CNRS Éditions, 2017). 22.

3. M. Brzezinski. *Red Moon Rising: Sputnik and the Hidden Rivalries that Ignited the Space Age*. (New York: Henry Holt and Company LLC., 2007). 44-59.

detect any signals of a power build-up or even a ballistic missile launch. In this context, the U.S. U2 reconnaissance aircrafts emerged as a new vector for information gathering. It was developed for the purpose of providing all necessary information with its missions carried out at considerably high altitudes. Yet, the adversary was quick to respond. On May 1, 1960, while flying its U2 over the Soviet Union, U.S. pilot Gary Powers was shot down by the Union's surface-to-air missile.

This event subsequently became a strategic landmark in military intelligence. Namely, it opened the realm of possibility to collecting information from space. This veritably fell beyond the reach of Soviet ground-to-air systems, while relishing in a permissive, if not, non-existent, legal framework at the time. This type of intelligence collection was carried out using remote sensors (for instance, electromagnetic interception and optical sensors) on board satellites at mostly low orbit.

France, which began developing its first rockets in 1948 at the Colomb-Bechar Air Base 145, located in Hammaguir in the Algerian desert<sup>4</sup>, stepped onto the stage as a nuclear and space power in the 1960s. In terms of intelligence gathering, the French military's Earth observation capabilities made its debut in 1986 with the launch of its *Helios I* programme. A point of emphasis on, during the first Gulf War, nearly every available image was of U.S origin. This only exposed France's lack of autonomy in terms of intelligence, which only underpinned the relevance of such a venture<sup>5</sup>. The first *Helios 1A* satellite was finally released into orbit in 1995. In short, *Helios I* not only strengthened France for space-based assessment capability, but also accompanied the evolution of Western armed forces into a professional expeditionary one<sup>6</sup>.

The militarisation of space has not been limited to solely spatial inventory. Piece by piece, military space architecture have traditionally been built around Earth observation; electronic eavesdropping capabilities at low orbit (less than 2 000 km); Positioning, Navigation and Timing systems (PNT) capabilities in medium orbit (20 000 km); as well as telecommunications capabilities in geostationary orbit (36 000 km). Such an architecture has made it possible to significantly increase the intensity of effects on the adversary, under the auspices of information gathering, targeting accuracy, and connectivity – all of which have grown to be essential in contemporary military operations.

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4. P. Varnoteaux. "Il y a 50 ans, la France quittait la base d'Hammaguir, en Algérie." *Air & Cosmos*. 03 July 2017. <https://air-cosmos.com/article/il-y-a-50-ans-la-france-quittait-la-base-dhammaguir-en-algerie-4521>.

5. J.-Y. Le Drian. 2015. "Déclaration de M. Jean-Yves Le Drian, ministre de la défense, sur le programme 'Helios' d'observation spatiale à des fins militaires et sur l'industrie spatiale, à Toulouse le 9 juillet 2015." Transcript of speech delivered at Toulouse, July 9, 2015. <https://www.vie-publique.fr/discours/195725-declaration-de-m-jean-yves-le-drian-ministre-de-la-defense-sur-le-pro>.

6. O. Schmitt, "La préparation de la prochaine loi de programmation militaire confond vitesse et précipitation." *Le Rubicon*. 19 August 2022. <https://lerubicon.org/publication/la-preparation-de-la-prochaine-loi-de-programmation-militaire-confond-vitesse-et-precipitation/>.

Today, space not only serves as a strategically vital environment for military operations, it is equally important to societies. Space exploration has gradually evolved into an intensive dual-use environment. Commercial services provided from space have become essential to the functioning of modern times. Earth observation and the interception of electromagnetic signals provide essential sources of information for meteorology, maritime traffic monitoring, agriculture, financial flows, and more.

The strategic interests regarding space, for both civilian and military sectors, have therefore never been more urgent. This situation spawned a new form of state-to-state competition, hence transforming space into an increasingly contested domain. Notably since 2019, both the U.S. and Europe witnessed the establishment of commands especially dedicated to the control of this new strategic environment. This only highlighted a mutual interest in the fact that space has henceforth become a new zone of competition.

In this rapidly changing context, new viewpoints are emerging to gain or maintain information superiority over the adversary. The architecture being developed, particularly in the form of multi-mission and interconnected platforms, will facilitate information gathering to be more accessible and obtainable at a higher refresh rate.

This article thus outlines the characteristics of how the space environment is transforming (I) and how it subsequently impacts the collection of information in the operational support carried out both on Earth (II) and for space control (III).

### **From *Old Space* to *Power Space*: A Brief History of Space**

Initially reserved for an exclusive circle of nuclear powers, privileged with the capacity to implement the technology needed to launch spacecrafts, the exploitation of the space domain is being democratised with new services in terms of data collection. This is due in part to the birth of more affordable, better connected, and more efficient architectures.

#### *The Emergence of New Space*

Architectural space evolution over the past ten years is often coined as “New Space”. This cryptic term is not only used to highlight the radical, twenty-first century transformation of the space ecosystem, but also associated with the cost reduction of space access and satellite manufacturing. Nonetheless, without contradicting the validity of this assertion, New Space is first and foremost a term epitomising U.S. industrial supremacy, cemented by a balance of private wealth and public expenditure. Indeed, for the U.S., this new balance constitutes a strategic capability and instrument of power<sup>7</sup>.

New Space was thus born of a political will pushed forth in the U.S. at the end of the Cold War. In the early 1990s, when the Clinton administration took

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7. X. Pasco. *op. cit.* 144-145 and 162-163.

over the White House, the U.S., lone superpower left standing after the fall of the Soviet Union, exercised unchallenged economic and military dominance on a global scale. Several initiatives aimed at better integrating U.S. space strategy with its political and strategic objectives were launched. The most significant of these were the commercialisation of space imagery and the commitment to render permanently available the Global Positioning System's (GPS) public signal<sup>8</sup>.

Like how Google Maps is built on GPS, the commercial applications resulting from these political decisions were numerous, bringing forth with it a wave of new companies and businesses. One of interest is the WorldView Imaging Corporation<sup>9</sup>, which had launched its first high-resolution (80 cm) satellite into orbit in 1999. Entry into the remote-sensing services market is usually achieved through a combination of private and public funding. The *WorldView-1* satellite launched in 2007, for example, was co-funded by DigitalGlobe and the National Geospatial-Intelligence Agency (NGA).

Thanks to this liberal policy approach, the U.S. profoundly transformed its industrial space fabric. Dual systems and new industrial dynamics are now complementing state capabilities in remote sensing with private assets, increasing the resilience of the country's spatial architecture. The multiplication and proliferation of commercial sensors with dual missions have ultimately densified U.S. remote-sensing assets.

In 2011, yet another political decision contributed to dramatically changing the value chain for spatial access. The cost of access to manned spaceflight was deemed much too exorbitant by U.S. policy-makers, who then decided to put a stop to the Space Shuttle programme. However, this subsequently caused quite severe short-term consequences. For ten years thereafter, the U.S. lost its sovereign capacity in the field of human spaceflight and relied on Russia to supply with its *Soyuz* rockets and engines<sup>10</sup>. NASA's sphere of influence and leadership were blunted, which gradually upset the balance of power in the U.S. space industry. This was all done for the purpose of reducing costs by shifting the burden of industrial risk onto new, emerging actors who were rewriting their own codes of the space ecosystem.

After selling his shares in PayPal, Elon Musk founded *SpaceX*, a company which is now the very symbol of New Space<sup>11</sup>. This move has proven to be a success: Europe's *Ariane* launcher, which had, until then, dominated the non-state market, is now gradually being supplanted by the SpaceX-developed *Falcon 9* rockets (namely, parts of their launchers are recovered after each launch, reducing their overall costs with greater profitability). Now the U.S. once again

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8. S. Pace. *The Regulation of Commercial Remote Sensing Systems* (Santa Monica: RAND Corporation, 1994). <https://www.rand.org/content/dam/rand/pubs/testimonies/2006/CT112.pdf>.

9. WorldView Imaging Corporation became DigitalGlobe in September 2001, then Maxar in 2017.

10. Beyond manned flight, the engines of some U.S. rockets are also of Russian origin.

11. A. Vance and J. Carrette. *Elon Musk. Tesla, PayPal, SpaceX - l'entrepreneur qui va changer le monde* (Paris: Eyrolles, 2016).

dominates space access, particularly in low-Earth orbits.

Pursuant to this liberal strategy, the Obama administration passed the 2015 Space Act, which, specifically, opened the doors to new possibilities for private companies to use low-Earth orbits. Emboldened by this policy and by more affordable access costs, U.S. manufacturers began developing constellation projects that offered new Earth observation and connectivity services at low orbit. These constellations use smaller satellites<sup>12</sup> (with miniaturised payloads) and greater numbers.

Originating from the U.S. political ambition to modify the management and financing of their space industry, New Space has accelerated the architectural evolution of space. This dynamic has encouraged the emergence of new private players, which has led to new partnerships. In 2010, the NGA awarded contracts to a number of commercial suppliers (Capella Space, Hawkeye 360, Planet Labs, Maxar, etc.). These allowed the U.S. Department of Defense (DoD) to build on its legacy of remote sensing resources with additional equipment, which, albeit offered limited resolutions, resulted in obtaining greater responsiveness, better coverage, multi-sensored information collection capacities, and finally, enhanced resilience.

### *The New Space is behind us*

The disruption in space, as exemplified by New Space, is only intensifying with time. For one, the number of launches is drastically increasing: 79 in 2012, 114 in 2020, and 148 in 2021. Namely, the year of 2021 broke the record – dating back to 1967 – for the number of launches in a single year<sup>13</sup>. The increase in the number of satellites placed in orbit is becoming exponential, with 1,800 operational satellites recorded in 2018 and almost 5,000 in 2021. If space operators' forecasts indeed ring true, by 2031, several tens of thousands of satellites are expected to be placed in already-congested, low earth orbit.

Yet, the acceleration of this evolution does not only concern the number of satellites. Specifically, the space ecosystem is developing new solutions to bring its architecture to the next level. As New Space continues to facilitate space access and an improved connectivity, this would subsequently pave the way to improve the processing and circulation of information as well. Indeed, the neologic term, “Next Space”, has been gaining traction within the space technology community since 2015, as conversations about the characters of New Space's evolution churned on. Today, the term is used to designate an architecture that capitalises on technical advances made in New Space's significantly more efficient services.

In the field of information processing, development projects assigned to

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12. Referring to microsatellites or even nanosatellites whose weight varies from a hundred to a dozen kilograms.

13. V. Cimino. “La Chine est en tête des lancements spatiaux en 2021.” *Siècle Digital*. 05 January 2022. <https://siecledigital.fr/2022/01/05/chine-lancements-spatiaux2021/>.

Next Space focused on greater autonomy for space segments, which is achieved through more powerful onboard softwares. The aim of this autonomy is to improve refresh rates and the relevance of the information transmitted to users.

For the flow of information, two non-mutually exclusive solutions can be adopted. The first is to significantly populate the number of ground stations around the globe in order to increase the possibilities of downloading information to users. The second is to have the information flow between satellites within the same constellation, or even between different constellations, so that the satellite closest to a ground station can perform the download.

Indeed, optimising information processing and circulation offers new operational prospects for space-based data collection. The combination of exploitations carried out, at least partially, by space segments and interconnections between sensors will, in the long run, make it possible to automate the access for information.

One could then, for instance, envisage a satellite with the ability to detect (i.e. with radar imagery) what may perhaps be a tank, without being able to confirm the information with its own capabilities. The position of this entity of interest would subsequently be immediately transmitted, accompanied by a request to capture images, to another space sensor capable of flying over said target in a matter of minutes. The complementary imagery collected would consequently confirm the tank's presence (via a different resolution, wavelength, or angle). This information would finally be transmitted in successive bursts between satellites, before being downloaded to its respective users.

At the heart of numerous projects, Next Space has already been fielded. By the end of 2022, the DoD will release into orbit the first phase of the National Defense Space Architecture (NDSA) project, which consists of seven functional layers, one of which is called the "Transport Layer". Specifically, these seven layers implement interconnected sensors to collect information, which is then transmitted in a seamless, secure, and resilient manner with a latency less than or equal to "terrestrial" optical fibres<sup>14</sup>. In addition, the Commission's secure connectivity constellation project could, by 2030, serve as a stepping stone for Europe's own sovereign Next Space.

#### *"Power Space": A Solution to the Limitations of Next Space*

As it generates more energy consumption, Next Space has naturally led industry experts to study the energy output and endurance of future satellites. Moreover, the mining of celestial bodies, promoted by the U.S.<sup>15</sup>, is leading space powers to consider the conquest of new orbits. Several projects are already under

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14. D. Vergun. "Space Development Agency Transitioning to U.S. Space Force." *U.S. Department of Defense*. 26 April 2021. <https://www.defense.gov/News/News-Stories/Article/Article/2747675/space-development-agency-transitioning-to-us-space-force/>.

15. NASA. "Principles for a Safe, Peaceful, and Prosperous Future." *NASA*. Consulted in November 2022. <https://www.nasa.gov/specials/artemis-accords/index.html>.

way. A case in point is the construction of refuelling stations placed in cis-lunar orbit, which would increase the endurance of space vehicles. Other studies also explore the possibility of equipping satellites with nuclear propulsion<sup>16</sup>. These projects constitute what is now known as “Power Space”<sup>17</sup>.

In detail, Power Space will make it possible to envisage space-based remote sensing and telecommunication services, which would be geared not only towards the Earth but also towards monitoring celestial bodies and the orbits that provide access to them. The connectivity established between constellations and relay stations will allow information transmission from sensors to end users, be it on or off Earth.

The transition from New Space to Power Space is therefore accompanied by an evolution of a multi-mission, multi-orbit, and connected space architecture. This gives birth to new possibilities of space information gathering.

### **The Contribution of Future Space Architecture to “Land” Operations**

All in all, the space architecture of the future opens doors to new opportunities for operational support. As a result, it becomes possible to envisage multi-spectral information collection<sup>18</sup>, carried out in a quasi-permanent manner on zones of interest. This would then be rapidly disseminated to the highest political and military authorities, as well as to the tactical elements deployed in a theatre.

#### *France’s Space Architecture*

To better understand the future space architecture of France, it is first necessary to review the country’s current capabilities.

To explain, France’s state-of-art space architecture is built on three concentric circles: (i) a “sovereign” core, bringing together the most essential capabilities for military operations; (ii) an “extended” circle that reinforces such sovereign means via international partnerships; and (iii) a “complementary capability”, contracted to commercial actors.

These resources have been developed from an ecosystem created after the Second World War, and maintained ever since. This ecosystem comprises the *Centre National d’Études Spatiales* (CNES; or “National Centre of Space Studies”), the *Direction Générale de l’Armement* (state defence procurement and technology agency; or “DGA”), the armed forces, as well as France’s national industrial sector. The ecosystem has gradually forged a dual expertise, which is essential for the development of military remote sensing capabilities. For exa-

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16. L. David. “Military interest in the moon is ramping up.” *Space.com*. 06 December 2021. <https://www.space.com/military-interest-moon-cislunar-space>.

17. E. Howell. “US military wants to demonstrate new nuclear power systems in space by 2027.” *Space.com*. 29 May 2022. <https://www.space.com/nuclear-power-propulsion-space-defense-innovation-unit-contracts>.

18. Infrared, electro-optical, radar, electromagnetic interception, etc.

ample, the architecture of *Helios I* was based on the civilian *Spot* satellite. As a result, France can now access extremely high-resolution images with the *Composante Spatiale Optique* (CSO; or “Optical Space Component”)<sup>19</sup>, owing to the technological advances developed for the *Pleiades* system<sup>20</sup>.

To summarize, France possesses a range of high-performance systems, supported by an architecture comprising telecommunications systems in geostationary orbit, and sensors at low-earth orbit. Moreover, through international partnerships, this architecture is completed with access to essential PNT capabilities provided by GALILEO and GPS. With military space capabilities at the vanguard of its kind, France is able to envisage what their operational use could be in present day contexts, such as the armed conflict in Ukraine.

### *Operation Space Support in the Theatre of the Ukrainian-Russian Conflict*<sup>21</sup>

On February 26, 2022, 48 hours after the onset of the Russian invasion, Ukraine’s Deputy Prime Minister and Minister of Digital Transformation, Mykhailo Fedorov, directly called on Elon Musk through Twitter<sup>22</sup>. His appeal was to be granted by *SpaceX*’s commercial Internet services via its *Starlink* constellation<sup>23</sup>. This was following the attack launched by Russia that deprived the Ukrainian government of a portion of their satellite and ground communication resources. Barely ten hours later, *Starlink* was made accessible in Ukraine and receiving stations were sent by *SpaceX*.

On March 1, 2022, Mykhailo Fedorov, again, made another request – this time to additional U.S. remote-sensing companies<sup>24</sup>. Upon the authorisation of the country’s policy-makers, these companies stepped forward. The U.S. delivered space-based information to Ukraine, targeting the activity of Russian forces daily.

By relying on a dual space architecture that has been in place since the 1990s, the U.S. was therefore able to provide support to Ukraine. This subsequently became a factor of operational superiority, notably in the context of a high-intensity conflict against the opposing competitor, Russia.

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19. French military satellite carrying optical Earth observation sensors.

20. P. Steininger. “Le Cnes, acteur historique du spatial militaire.” *Revue Défense Nationale* 10, no. 835, (2020): 31-35. <https://www.cairn.info/revue-defense-nationale-2020-10-page-31.htm>.

21. S. Erwin. “Report: Industry has to face reality that commercial satellites will be targets in war.” *Space News*. 23 August 2022. <https://spacenews.com/report-industry-has-to-face-reality-that-commercial-satellites-will-be-targets-in-war/>.

22. M. Fedorov. “@elonmusk, while you try to colonize Mars...” *Twitter*. 26 February 2022, 13:06. <https://twitter.com/fedorovmykhailo/status/1497543633293266944>.

23. L. Minisini. “Mykhailo Fedorov, chef de guerre numérique en Ukraine.” *Le Monde*. 09 March 2022. [https://www.lemonde.fr/m-le-mag/article/2022/03/09/acces-a-internet-cyberattaques-boycott-de-la-russie-mykhailo-fedorov-chef-de-guerre-numerique-en-ukraine\\_6116749\\_4500055.html](https://www.lemonde.fr/m-le-mag/article/2022/03/09/acces-a-internet-cyberattaques-boycott-de-la-russie-mykhailo-fedorov-chef-de-guerre-numerique-en-ukraine_6116749_4500055.html).

24. Planet, Maxar, Airbus, SI Imaging Services, Capella Space, Blacksky Global, Iceye and SpaceView.

Indeed, the commercialisation of space-based imagery is not at all groundbreaking. However, the sheer volume of imagery produced, along with the performance achieved in terms of coverage and the refresh rate of information is a feat in itself<sup>25</sup>. The Ukrainian government and its armed forces both benefit from such multi-source, remote-sensing support, which is used, in particular, by units employing drones or by the *Kropyva* application – the latter of which allows tactical units to request artillery support via smartphones<sup>26</sup>.

Furthermore, dozens of images from these commercial services are published daily on social networks. These photographs and videos not only capture select moments of combat phases, but also contribute directly or indirectly to influence operations. For example, the *New York Times* published an investigation, using a combination of social network videos and satellite imagery, to expose possible human rights crimes committed by the Russian armed forces in the Ukrainian town of Bucha<sup>27</sup>.

Despite its particular strategic context, the Ukrainian-Russian conflict nonetheless marks a significant step forward in terms of the support provided by evolving space architectures. This equally applies to commercial actors making use of their assets in a foreign conflict where their home state is not engaged in.

#### *New Opportunities to Support Operations*

The image resolution achieved by commercial space services remain, to date, lower than those achieved by sovereign core equipment. Nevertheless, they do offer other advantages. In Ukraine's case, for example, certain constellations can perform up to 15 flyovers a day over the same point in a theatre to offer continuous monitoring of enemy activity. The time it takes to obtain the information collected by such services is therefore reduced by the large number of ground stations able to download this data. The combination of multi-source data collection not only provides detailed and consolidated information, but also information that is regularly updated, no matter the weather condition.

Furthermore, the performance gap between state legacy systems and private assets could narrow in the medium term. The company, Maxar, has announced that it is able to improve the resolution of its next-generation satellites by a factor of two. It is also proposing a new tactical ground station<sup>28</sup>, capable of obtaining requested images in less than 15 minutes. By 2030, such future remote-sensing

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25. Digital Eye. "Ukraine: The New Satellite War." 18 June 2022, video, 49m 00s. <https://www3.nhk.or.jp/nhkworld/en/ondemand/video/3004855/>.

26. L. Neveu. "Guerre en Ukraine : Kropyva, l'application Android utilisée par les artilleurs ukrainiens." *Futura Sciences*. 16 June 2022. <https://www.futura-sciences.com/tech/actualites/guerre-futur-guerre-ukraine-kropyva-application-android-utilisee-artilleurs-ukrainiens-99045/>.

27. M. Browne et al. "Satellite images show bodies lay in Bucha for weeks, despite Russian claims." *New York Times*. 04 April 2022. <https://www.nytimes.com/2022/04/04/world/europe/bucha-ukraine-bodies.html>.

28. TANGO (*Tactical Architecture for Near-Real-Time Global Operations*).

constellations could provide near-permanent observation of a theatre area from space. The transmission speed of the gathered information would also be substantially reduced to less than an hour.

Such breakthroughs have not escaped China's eyes, as the competitor also begins preparing a card of its own. Noting the operational advantages offered by *Starlink* in the Ukrainian theatre, a recent article in China deliberated the options at hand that either exist or need to be developed to neutralise such a capability from its side<sup>29</sup>.

### **Collecting Information to Have a Better Command of Space**

As the importance of space both within societies and military operations rises in significance, it only becomes increasingly complex in parallel, to fully grasp how to make use of this new field of conflict. This, in turn, then generates ever more specific needs in terms of information gathering.

#### *Risks and Threats*

An interesting challenge that has emerged is the astounding increase in the number of satellites, particularly those at low-earth orbit, this has mechanically produced debris, and poses a heightening risk to existing space architectures. Multiple causes can be attributed to the creation of such debris: satellite fragmentation, a stage of a rocket left in orbit after a launch, collisions, voluntary destruction made by anti-satellite systems (ASAT<sup>30</sup>), etc. Indeed, both China's Direct-Ascent ASAT (DA-ASAT) demonstrative launches in 2007 and Russia's in 2021 have generated more than 2 000 and 1 500 pieces of debris, respectively, thereby "polluting" quite a few orbits. Today, the number of pieces of debris in space is estimated at more than 36 500 for those larger than 10 cm and more than one million for those smaller than 1 cm<sup>31</sup>.

In consideration of further threats, certain countries have already resolved to strengthen their command of this environment, while others are exploring the option of contesting its use by envisioning a confrontation, should it be necessary. In France, this consideration was included in its 2019 Space Defence Strategy<sup>32</sup>. This followed the emergence of new threats observed in the three types of orbits. These were catalogued according to their, more or less, reversible modes

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29. D. de Schaepmeester. "La Chine menace de détruire des satellites Starlink." *Air&Cosmos*. 01 June 2022. <https://air-cosmos.com/article/la-chine-menace-de-detruire-des-satellites-starlink-37842>.

30. *Anti-Satellite*.

31. Space Debris Office, European Space Agency. "Space debris by the numbers." *The European Space Agency*. 11 August 2022. [https://www.esa.int/Space\\_Safety/Space\\_Debris/Space\\_debris\\_by\\_the\\_numbers](https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers).

32. The United States announced in April 2022 that it would no longer conduct ASAT tests, in part to curb an arms race; W. J. Hennigan. "To Slow an Anti-Satellite Arms Race, White House Bans U.S. Tests of Space Weapons." *Time*. 18 April 2022. <https://time.com/6168148/space-weapons-ban-harris/>.

of action: cyber, espionage, jamming, directed energy weapons, sabotaging and/or de-orbiting satellites, satellites equipped with armed components, and finally, the threat most widely known to the public, ASAT. Four countries have so far demonstrated its ability to destroy a satellite with a missile: China (2007), the United States (2008), India (2019), and Russia (2021)<sup>33</sup>.

To explain further in the space domain, a threat can be characterised by three complementary criteria: the acquisition of a capability, the demonstration of command of said capability, as well as the intention to put it to use. With the launch of the *Luch Olymp* into orbit in 2014, Russia's forces deployed an espionage capability in geostationary orbit, which concurrently showcased its ability to approach any non-cooperating satellites and position itself at close proximity to it<sup>34</sup>.

In the same vein, after its launch into orbit in November 2019, Russia's *Kosmos 2542* satellite became oddly threatening as it subsequently released yet another satellite, the *Kosmos 2543*. The latter was described by the U.S. as an "inspector satellite." It was reported to have approached one of the country's satellites<sup>35</sup>, which was forced to manoeuvre away from this potential threat posed by its uninvited neighbour. Later, in July 2020, *Kosmos 2543* released a new object, described as a "space shotgun" that could be viewed as an ASAT weapon<sup>36</sup>. This is but a testament to Russia's mastery of closing-in manoeuvres, not only in geostationary orbit, but also in low-earth orbit. In relation, this also raises questions about the potentially malicious intentions of releasing daughter satellites from parent satellites (fittingly coined as "Russian Dolls"). Furthermore, it viscerally ascertains the legitimacy of ASAT threats from space with the firing of objects.

Consequently, in the face of such threats, it will further be necessary to develop tactics with means that can respond to the particularities of the space environment.

### *Understanding but a Prerequisite to Taking Action*

To protect France's interests, its Defence Space Strategy declaratively seeks to acquire, by 2030, the capability to take action in space. This would render it feasible – in compliance with international law and self-defence principles – to respond to any orbital threats hereafter. Implementing this strategy in space therefore requires a level of knowledge and command of the space environment that the French armed forces can amass through space intelligence.

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33. *Ibid.*

34. Le Monde and AFP. "La France accuse la Russie de tentative d'espionnage par satellite." *Le Monde*. 08 Septembre 2018. [https://www.lemonde.fr/international/article/2018/09/07/paris-revele-une-tentative-d-espionnage-russe-sur-un-satellite-franco-italien-en-2017\\_5351908\\_3210.html](https://www.lemonde.fr/international/article/2018/09/07/paris-revele-une-tentative-d-espionnage-russe-sur-un-satellite-franco-italien-en-2017_5351908_3210.html).

35. Earth observation satellite operated by the *National Reconnaissance Office* (NRO).

36. M. Evans and L. Fisher. "Russia tests secret 'space shotgun' that can target satellites." *The Times*. 25 July 2020. <https://www.thetimes.co.uk/article/russia-tests-secret-space-shotgun-that-can-target-satellites-h5m6t5f3f>.

Indeed, space intelligence contributes, in particular, to establishing a reference situation, the Recognised Space Picture (RSP), that is not only controlled, but also actively maintained. This RSP is the synthesis of a vast amount of various types of information and sources that come from the aforementioned three concentric circles: state legacy sensors (sovereign core), international agreements (extended circle), and space services (complementary capabilities).

Mirroring aerial surveillance, the objective of space surveillance is to detect, track, identify, and then characterise objects of military interest amongst those exhibiting a “predictable” behaviour in a peaceful manner. To successfully complete such a mission, it is firstly essential to have a solid understanding of the space environment.

### *Responding to the Complexity of the Space Domain*

Due to the multitude of objects needed to be monitored, the inherent risks that exist, along with any emerging threats to come, the space environment is becoming ever more complex to grasp. Such challenges are only increasing in number, as future space architecture is faced with the responsibility to not only be oriented towards Earth, but also towards space itself.

To begin with, projects in the field of space surveillance are currently being developed to improve the performance of traditional Earth-based sensors and to implement new capabilities in space. These space-based sensors will be able to collect information from both dedicated<sup>37</sup> and non-dedicated constellations. In the latter case, collection would be from additional payloads, thereby conferring a multi-mission role to their host constellations.

The culminating goal then is to connect space surveillance sensors (ground- and space-based, commercial and state legacy systems) with one another, as well as with a ground control and command (C2) centre. This distributed data collection would hence be able to track, in near-real time, a previously detected object of interest, as well as to ultimately operate in space and target a potential aggressor<sup>38</sup>.

In addition to improving the responsiveness in military space operations, information collection in, from, and to space will have to be partially self-managed to keep up with the increasing complexity of this environment. Beyond being distributed, collection must also be flexible to adapt to any given circumstances with a substantial degree of autonomy. In order for this to be achieved, it is thus necessary to develop dynamic capacities that merge various information to not only analyse the behaviours observed, but also to isolate any deemed “abnor-

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37. T. Hitchens. “North Star plans blanket coverage of near Earth orbits with up to 30 satellites.” *Breaking Defense*. 15 August 2022. <https://breakingdefense.com/2022/08/north-star-plans-blanket-coverage-of-near-earth-orbits-with-up-to-30-satellites/>.

38. L. Rigal and N. Sauvage. “Donnée et temporalité : facteur clé de succès.” *Revue Défense Nationale* 20, no. 835 (2020): 85-92. <https://www.cairn.info/revue-defense-nationale-2020-10-page-85.htm>.

mal”. To reiterate, this processing could be carried out both directly at the sensor level and on Earth within C2.

Born in the context of the Cold War, information collection from space served as one of the catalysts that led to the militarisation of this environment. Since then, the strategic importance of said data collection type has continued to proliferate in tandem with the evolution of armed forces, growing to serve as a pillar of strategic autonomy for space powers.

Sensor integrated architecture, as a result, has matured at an explosive speed throughout the past decade. This progression provided new outlooks as space segments are now capable of carrying out several different missions thanks to sensors collecting information in, from, and towards space. In the years to come, space architectures will be based on dual constellations, comprising small, interconnected satellites that will operate in a distributed and self-run manner. These prospects will evolve into a quasi-permanent information collection capacity, carried out on a specific area. Finally, it will enable a better understanding of the environment to operate in space and defend one’s interests.



# SIGINT and Electromagnetic Operations: All But Forgotten in Future MDOs

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Exalted as the keystone of operational superiority in the wars of tomorrow, the capabilities of engaging multi-domain operations (MDO) intrinsically necessitates a holistic approach. Undoubtedly, efforts in one particular environment or field may well be deemed as more important than in others. However, none must be neglected. The war in Ukraine, in particular, has been a sharp admonition of the need to exploit each and every environment for there to be victory. Deliveries of weapons from land, air, and sea, as well as the attempts to prevent the use of resources from space, all but stress the incontestable importance of physical environments<sup>1</sup>. Likewise, both the informational sphere and cyberspace are also emerging as recurring fields on which battles are waged.

Notwithstanding, the electromagnetic field still seems to garner very little attention. Such neglect only raises questions about the interest given to it as an arena of conflict. As they are rarely highlighted, poorly understood, and all too often reserved for a limited circle, electromagnetic operations regrettably depend on heavy structures and complex processes. These then hinder the exploitation of its potential and the understanding of its importance in military operations. Within this context, it is thus worth questioning whether the electromagnetic field and its operations have indeed become the forgotten middle child of future MDOs.

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1. M. Untersinger. "Guerre en Ukraine : les utilisateurs du réseau satellitaire Viasat victimes d'une cyberattaque." *Le Monde*. 8 March 2022. [https://www.lemonde.fr/pixels/article/2022/03/08/guerre-en-ukraine-les-utilisateurs-du-reseau-satellitaire-viasat-victim-t-d-une-cyberattaque\\_6116600\\_4408996.html](https://www.lemonde.fr/pixels/article/2022/03/08/guerre-en-ukraine-les-utilisateurs-du-reseau-satellitaire-viasat-victim-t-d-une-cyberattaque_6116600_4408996.html).

In detail, this article will illustrate that, while the importance of the electromagnetic field is growing amongst modern societies and armed forces (1), choosing between exploitation, intelligence, and action in this field seems to remain impossible (2). This, therefore, requires a change of model (3) for it to obtain a better operational credibility within MDOs.

### **1) Towards an Unbridled Contestation of the Electromagnetic Environment**

Electromagnetic environment analysis has grown to be a paradox. Despite being one of the common goods on which society and armed forces are increasingly dependent, its increasing weaponisation by competitors has so far only triggered moderate responses to defend it.

*The Electromagnetic Spectrum: A Hyper-dependent Common Good in Modern Digital Societies, Including Armed Forces*

To begin, a truism must be stated. If 99% of the world's internet data travels through undersea cables<sup>2</sup>, 100% of the data from connected objects not linked to a wired system – be it a phone, a sensor, a soldier, or a weapons system – travels through the electromagnetic space. The digital revolution is permeating through societies around the world. Combined with the need for mobility and communication, it has rendered the electromagnetic spectrum as a common good for all. Indeed, the electromagnetic spectrum not only serves as the oxygen for phones (either as WiFi, 4G, 5G, or the imminent 6G), and the compass of future self-driving cars, but also the scene where digital social relations thrive. This hyper-dependence must thus be explored further. In many aspects, it mirrors the dependence of world trade on maritime transport, which remains the backbone of supply chains, accounting for 90% of trade volume and 80% of value in 2021<sup>3</sup>. Yet, caught between hyper-dependence and contestation, such a cornerstone of everyday lives can quickly transform into an Achilles heel.

The electromagnetic field is, in essence, transversal, as it resides on the cross-roads of all military activities. According to the definition of the French doctrinal corpus, the electromagnetic field is an immaterial operational field “devoid of borders, which transcends and interacts with all environments, as well as with the informational field [...] where freedom of action is essential for the conduct of operations in other environments, even if it can only be local and temporary”<sup>4</sup>. If interactions are evident in material domains, they are also present in

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2. G. Poncet. “Pourquoi le spectre d’une attaque sous-marine contre internet inquiète.” *Le Point*. 30 September 2022. [https://www.lepoint.fr/high-tech-internet/pourquoi-le-spectre-d-une-attaque-sous-marine-contre-internet-inquiete-30-09-2022-2491887\\_47.php](https://www.lepoint.fr/high-tech-internet/pourquoi-le-spectre-d-une-attaque-sous-marine-contre-internet-inquiete-30-09-2022-2491887_47.php).

3. World Trade Organization. “Maritime Transport.” *World Trade Organization*. Accessed 01 December 2022. [http://www.wto.org/french/tratop\\_f/serv\\_f/transport\\_f/transport\\_maritime\\_f.htm](http://www.wto.org/french/tratop_f/serv_f/transport_f/transport_maritime_f.htm).

4. Editor's translation of Central Intelligence Agency. *CIA Concept 0.1.1.-M2MC Multimilieux et multichamps (M2MC), la vision française interarmées* (Langley, VA: Central Intelligence Agency, 06 September 2021).

the immaterial domain (cyberspace and information). Moreover, as stressed by Jean-Baptiste Florant, associate researcher at the *Institut français des relations internationales* (“French Institute for International Relations”), the prelude to cyber weapon deployment is information superiority. Importantly, he states that “there is no information superiority without prior control of the electromagnetic field, that is to say without electronic warfare.”<sup>5</sup> This all but emphasises, once again, the electromagnetic continuum, along with the continuum between fields and environments.

In correlation, the doctrine of the United States also does not deny the singular importance of the electromagnetic field. It goes so far as to infer that the maritime, air, and space domains are common goods. Specifically, their primary shared characteristic is that they are all connected by the electromagnetic field, which glues everything together<sup>6</sup>. Hence, there will be active competition and contestation as opposing adversaries seek to maintain their superiority within the electromagnetic spectrum, while denying its use to others<sup>7</sup>. This consideration of the electromagnetic field as a space of conflict in its own right only challenges the MDO’s engagement framework. Particularly, it questions whether MDO’s operational superiority is really achievable should one of these environments or fields be neglected.

### *Operationalising the Electromagnetic Field Ventures Beyond Sovereign Monopoly*

This questioning is ever more pertinent at a time when both signal intelligence (SIGINT), in particular, and electromagnetic activities, in general, are being democratised. Similar to space and cyberspace but contrary to land, sea, and air environments, the potential operationalisation of the electromagnetic field escapes sovereign monopoly. Today, many signals intelligence capabilities are readily available for any entity to use, without being subjected to government control<sup>8</sup>. For example, open-source information is available on maritime situations, mappings of the radio frequency spectrum, demodulation systems, wiretapping, jamming, satellite piracy, as well as cybernetic surveillance.

To summarize, three different categories of capacities coexist:

- Sovereign capacity: generated and operated either by the government or by a commercial provider, but accessible only to the government;

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5. Editor’s translation of J.-B. Florant. “Cyberarmes : la lutte informatique offensive dans la manœuvre future.” *Études de l’Ifri, Focus stratégique*, no. 100 (January 2021): [https://www.ifri.org/sites/default/files/atoms/files/cyberarmes\\_florant.pdf](https://www.ifri.org/sites/default/files/atoms/files/cyberarmes_florant.pdf).

6. Joint Chiefs of Staff. “The Joint Force in a Contested and Disordered World.” *Joint Operating Environment 2035* (14 July 2016): 32. [https://www.jcs.mil/Portals/36/Documents/Doctrine/concepts/joe\\_2035\\_july16.pdf](https://www.jcs.mil/Portals/36/Documents/Doctrine/concepts/joe_2035_july16.pdf).

7. *Ibid.*

8. C. Weinbaum et al. *SIGINT for Anyone: The Growing Availability of Signals Intelligence in the Public Domain* (Santa Monica, CA: RAND Corporation, 2017). <https://www.rand.org/pubs/perspectives/PE273.html>.

- Commercial capacity: available for purchase on a legal market; and
- Democratised capacity: available legally or illegally, and either for purchase or for free to anyone who seeks it, but may require upgrades or adjustments.

Of interest is the second category, which is currently booming, much like “New Space” itself. Admittedly, commercial capacity is an opportunity that militaries operating in the electromagnetic field do not always take advantage of (i.e. off-the-shelf purchases, lower costs, diversification of capabilities, etc.). On a global scale, the legal commercial market for electronic warfare is expected to grow by 5% per year to reach nearly 30 billion dollars in 2030<sup>9</sup>. Meanwhile, the democratised capacity in the third category may be growing rapidly but is nonetheless significantly fuelling proliferation and threat levels. A case in point is satellite wiretapping, which long being the prerogative of government entities, can now be carried out by individuals for just a small investment. Namely, in 2009, insurgents in Iraq intercepted the video feed of U.S. *Predator* drones using Russia’s *SkyGrabber* programme, which costs only \$26 a piece. Similarly, in 2015, a U.S. researcher demonstrated that with solely \$1,000, it was possible to construct an equipment that could broadcast spoofed data to a *GlobalStar* satellite<sup>10</sup>.

The expansion of grey areas and hybrid modes of action in the electromagnetic field may also lead to the local paralysis of both societies and armed forces. Several examples can include: jamming GPS signals to stop air traffic; disabling either a mobile phone network<sup>11</sup> or co-orbital operations to jam military satellites; rendering Blue Force Tracking unavailable; harassing pilots and their families with phone calls<sup>12</sup>; sending viruses to airbase WIFI networks; depleting PR4G batteries through electronic harassment<sup>13</sup>, targeting Airborne Warning and Control Systems (AWACS); blinding E-2Cs or frigates by *Krasukha-2s* or an *SU-24* equipped with a *Khibiny* pod<sup>14</sup>.

While not every single one of these events would occur at the same time, each has already happened once or even several times in the past. Such scenarios

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9. The Press Free. “Marché mondial de la guerre électronique et prévisions technologiques de 27,8 milliards de dollars jusqu’en 2030 – ResearchAndMarkets.com.” *The Press Free*. 12 August 2022. <https://thepressfree.com/marche-mondial-de-la-guerre-electronique-et-previsions-technologiques-de-278-milliards-de-dollars-jusquen-2030-researchandmarkets-com/>.

10. C. Weinbaum et al. *op. cit.* 6.

11. O. Letertre. “Regards croisés sur la guerre électronique”. *Études de l’Ifri, Focus stratégique*, no. 90 (July 2019): 22. [https://www.ifri.org/sites/default/files/atoms/files/letertre\\_justel\\_lechable\\_dosse\\_guerre\\_electronique\\_2019.pdf](https://www.ifri.org/sites/default/files/atoms/files/letertre_justel_lechable_dosse_guerre_electronique_2019.pdf).

12. L. Lagneau. “Des proches d’aviateurs néerlandais déployés dans les pays baltes ont été harcelés par téléphone.” *OPEX360*. 04 September 2019. <http://www.opex360.com/2019/09/04/des-proches-daviateurs-neerlandais-deployes-dans-les-pays-baltes-ont-ete-harceles-par-telephone/>.

13. P. Gros. “Les opérations en environnement électromagnétique dégradé.” *Note no. 357/Consortium CONFLITS-2035*, no. 1 (May 2018): 23-25. <https://www.frstrategie.org/sites/default/files/documents/programmes/observatoire-des-conflits-futurs/publications/2018/1.pdf>.

14. O. Letertre et al. *art. cit.*

demonstrate not only the insidious and hybrid nature of electromagnetic operations, but also current difficulties in defending against them. Consequently, a credible scenario of an electromagnetic pandemic could emerge, affecting all parts of society, including armed forces. Yet, considering the low probability of these occurring, and whose seriousness is somewhat exaggerated should they occur, France shows a relatively lack of interest in the electromagnetic field.

*The Electromagnetic Field: Still in the Blindspot of Priorities for the French Armed Forces*

Despite the above, confronted with the massive (re)investments in this field by Russia and China, the importance of effects in said field is bound to increase. Human nature possesses a propensity to grasp the tangible and invest in what they know, while being able to easily abandon the invisible and undetectable. Electromagnetics, unfortunately, fall into the latter category: it is all at once everywhere and nowhere. To the layperson, its language is abstruse and technical, as its field of application has unlimited or near-unlimited boundaries. Explaining the stakes involved in electromagnetic operations is inevitably a journey fraught with obstacles.

Cyberspace, on the other hand, although partly immaterial, is not met with the same antipathy. While the average user may not possess complete mastery of all the logical and physical intricacies, cyberspace is nonetheless part of their everyday lives. While nearly everyone has a computer, very few have a spectrum analyser or a GPS jammer. Even though political discourse on strategic foresight has now adopted the military language of the MDO's engagement framework, there remains little to no mention of the electromagnetic field as a space of conflict to be invested in. Namely, in France's latest *Revue Nationale Stratégique* ("National Strategic Review")<sup>15</sup>, the term "electromagnetic" and its derivatives are only mentioned once throughout the whole document, whereas "cyber" is mentioned 48 times.

Despite its growing civilian and military importance, electromagnetics is still, paradoxically, a field unfrequented by discourse. This lies in stark contrast with both Russia and China, who have made the domain a strategic priority. Due to its nature of being difficult to perceive, combined with its unavoidable budgetary arbitrations, the electromagnetic field is relegated to the background on the spectrum of conflict. What fails to be taken into account in these circumstances is that anything left undefended will therefore be contested<sup>16</sup>.

15. Secrétariat général de la défense et de la sécurité nationale, *Revue Nationale Stratégique* 2022 (Paris: République Française, 9 November 2022). <http://www.sgdsn.gouv.fr/uploads/2022/11/revue-nationale-strategique-07112022.pdf>.

16. Commission de la défense nationale et des forces armées, *Audition, à huis clos, du général de corps aérien Frédéric Parisot, major général de l'armée de l'Air et de l'Espace*. Presidency of T. Gassilloud, Compte rendu no. 7, Assemblée nationale: Session extraordinaire de 2021-2022. 20 July 2022. [https://www.assemblee-nationale.fr/dyn/16/comptes-rendus/cion\\_def/116cion\\_def2122007\\_compte-rendu.pdf](https://www.assemblee-nationale.fr/dyn/16/comptes-rendus/cion_def/116cion_def2122007_compte-rendu.pdf).

## **2) The Nonsensical Dilemma between Sword, Armour, and Choosing to Listen**

Notwithstanding its lack of visibility, fighting in the electromagnetic environment is well conceptualised in France. French doctrinal texts<sup>17</sup> define electromagnetic operations into three categories of activities. The first relates to SIGINT, which exploits activity in the electromagnetic spectrum to develop intelligence either immediately or at a later time post-deliberation. The second is the exploitation of the electromagnetic spectrum, which includes telecommunications, active or passive remote sensing (optical, infrared, or radar, all of which allows for target designation as well as weapons system guidance), and finally, positioning, navigation and timing (PNT) synchronisation capabilities. Finally, the last category corresponds to electromagnetic combat, better known as electronic warfare. This is defined as a military activity that harnesses electromagnetic energy to provide situational awareness and achieve offensive and defensive effects<sup>18</sup>.

This categorisation ultimately brings together three classic operational purposes: obtaining information, exploiting the environment, and fighting by either attacking or defending. SIGINT is a sub-segment of the operational environment it structures.

### *Respecting the Continuum*

The shortcomings of translating these texts by the French Armed Forces into organisational and operational implementation is that they tend to erode the original continuum between exploitation, intelligence, and electronic warfare activities. This continuum is born from the dependence of these activities on each other. For example, no electronic countermeasure could produce the desired effect without the exploitation of electromagnetic spectrum and the capitalisation of SIGINT being mastered first.

History also highlights the importance of this continuum as seen with the emergence of electronic warfare. After military wireless telegraphs were operationalised, its first successful use was achieved during the Russian-Japanese conflict between 1904 and 1905. Notably, Russia was able to jam the communications of the Japanese navy<sup>19</sup>. A decade later, German generals, Paul von Hindenburg and Erich Ludendorff, obtained a transcription of Russia's war intentions through the interception of their wireless telegraph messages. This subsequently led to their victory over Alexander Samsonov's Second Imperial Russian Army at Tannenberg in August 1914<sup>20</sup>. As for the French, the exploitation of SIGINT

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17. Publication interarmées, *PIA 3.6.1. Maîtrise de l'environnement électromagnétique* (Paris, CICDE, 6 April 2016).

18. *Ibid.* 20.

19. P. Smith. "Russian Electronic Warfare: A Growing Threat to U.S. Battlefield Supremacy." *American Security Project - Perspective* (April 2020): <https://www.americansecurityproject.org/wp-content/uploads/2020/04/Ref-0236-Russian-Electronic-Warfare.pdf>.

20. B. Crochet. *Tannenberg 26-29 August 1914* (Louviers: Ysec, 2007).

and electronic warfare allowed the *Grand Quartier Général* (general headquarters of the French Army) to break wireless codes and anticipate the offensive on Verdun in February 1916<sup>21</sup>. Moving forwards, from the onset and until the end of the Cold War, progress in one category of activity fuelled research in another, gradually establishing a fruitful circle combining exploitation, intelligence, and combat in the electromagnetic spectrum.

This continuum also reinforces coordination issues. To detail, all electronic warfare actions must be known to SIGINT operators and electromagnetic spectrum operators. Even more so than in other environments and fields, endogenous attrition in the electromagnetic field is symptomatic of an increased requirement for coordination. In 2015 alone, while commanding the future U.S. Space Force, General John Hyten conceded the existence of 261 cases of telecommunications jamming *via* U.S. military satellites. He considered that all of them were accidental “self-interference”, therefore explicitly acknowledging the difficulties of knowing and coordinating the actions of U.S. forces in the electronic field<sup>22</sup>. Finally, beyond issues of operational efficiency, this need for coordination underpins a nation’s military credibility, especially within a Joint Allied framework.

In order to maintain a beneficial and coordinated circle between all activities in the electromagnetic spectrum, their logical structuring around a field must prevail over any other organisational logic for three main reasons. Firstly, this approach constitutes the doctrinal backbone of the French Armed Forces as declared in its Joint Concept publication of September 2021. Specifically, the publication details how France now envisions MDO as the new general framework that structures the employment of its forces<sup>23</sup>. Such an approach holds the purpose of protecting the institution from a purely organisational approach. The appropriation of environments and fields defines the organisation and not the other way around. To date, this remains the only identified and recognised approach towards integrating the notion of conflictuality in all its dimensions. Yesterday, war was a state of affairs defined by a clear legal framework. It evoked a situation that could be understood by all. Today, the use of the term “conflict” expresses the transformation of conflictual forms and spaces in which violence – material or immaterial, above or below the armed conflict threshold – spreads and becomes normalised<sup>24</sup>.

The exploitation of the spectrum, SIGINT, and electronic warfare therefore form a vast and coherent whole in the electromagnetic field, albeit being one that is finely intricate by nature. Its actors are spread across disparate directorates,

21. J.-M. Degoulange. *Les Écoutes de la Victoire. L’histoire secrète des services d’écoute français (1914-1918)* (Paris: Pierre de Taillac, 2019).

22. S. Freedberg Jr. “US Jammed Own Satellites 261 Times; What If Enemy Did?” *Breaking Defense*. 02 December 2015. <https://breakingdefense.com/2015/12/us-jammed-own-satellites-261-times-in-2015-what-if-an-enemy-tried/>.

23. Central Intelligence Agency. *op. cit.*

24. C-P. David and A. Rapin. “Quantifier l’inquantifiable : de la mesure de la guerre.” in B. Pelopidas and F. Ramel (eds.) *Guerres et conflits armés au XXI<sup>e</sup> siècle* (Paris: Presses de Sciences Po, 2018).

services, armies, and units – a situation that calls for the development of true governance. Operators, analysts, defenders, and combatants of the electromagnetic spectrum often ignore and operate in isolation of each other, except at certain tactical and local levels. If such diverse players are not interconnectedly coordinated, the transposition of this anomaly to the air environment would lead to an ubiquitous scenario. Hence, responsibilities would have to be spread across different organisations: from the air traffic controller (the operator or guarantor of the environment's safe conduct), the air defence fighter pilot (the defender), the fighter pilot carrying out interdiction missions (the attacker), to the intelligence officer (the analyst). Upon failure to do so, coherence in the environment – which guarantees operational efficiency – would be shattered.

*To Flood the Consciousness with Specialised Thinking Is To Lose Sight of the Whole*<sup>25</sup>

The lack of structured governance is not the only cause that weakens this continuum between electromagnetic activities. As it is innately highly demanding in terms of know-how, technicality, and discretion, the electromagnetic ecosystem suffers from the adverse effects of a hyperspecialisation<sup>26</sup> of its actors with the development of fragmented and poorly integrated organisations. French philosophical and sociological literature provides pathways to better understand the risks that come with hyperspecialisation. In his criticism of contemporary hyperspecialisation, sociologist Edgar Morin observes that general blindness envelops the specialised lucidity in the expert<sup>27</sup>. The purpose is evidently not to castigate signal analysts, telecommunications experts, or any other electronic warfare operators in the military – quite the contrary. The objective is rather to caution against the recurrent inability of overly specialised minds to reason about the whole<sup>28</sup>, as well as to grasp the issues that take hold of the tenuous borders between one activity and another.

In the context of this article, the whole here refers to the electromagnetic field and its interactions with other fields and environments. Inward-looking attitudes are, in short, especially fuelled by hyperspecialisation. This is due to its rigid rules of confidentiality and a lack of convergence of information and communication systems between particularly compartmentalised, deficient, and outdated professions. Not only does this isolate the actors and their activities, it also prevents any form of synergy of resources, knowledge, and mutual understanding from taking place.

This observation of compartmentalisation is not, however, a fatality. In fact,

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25. H. Amir. *L'Écologie Philosophique : Un remède aux effets pervers de l'hyperspécialisation contemporaine* (Centre International de Recherches et Études Transdisciplinaires, October 2015).

26. *Ibid.*

27. Editor's translation of E. Morin. *Sortir du XXème siècle* (Paris: Fernand Nathan, 1981): 337.

28. *Ibid.*

the structuring of the cyber environment gives cause for optimism. While the baggage brought on by history is certainly lighter for cyberspace, its operators have still been unable to separate intelligence and combat activities. Rather, they continue to associate them in a single governance structure, the COMCYBER (French cyber defence command). The doctrine associated with cyber threat intelligence (CTI) details that offensive operations for intelligence purposes (in French: *la lutte informatique offensive à des fins de renseignement*) is indeed one of its components<sup>29</sup>, thereby formalising the close linkage between these two activities.

Successive renunciations of capabilities in terms of SIGINT and electronic warfare within the French Armed Forces have undoubtedly impacted the continuum of electromagnetic activities. The French Air and Space Forces (FASF) most notably illustrate this trend during the past 60 years. The military history of the air component is indeed an unrelenting one, where the rationale for developing electronic warfare capabilities based on robust SIGINT analysis has been an operational constant. From 1964, with the birth of the French nuclear component of its Strategic Air Forces<sup>30</sup> to the current war in Ukraine, as well as throughout the wars in Vietnam<sup>31</sup>, the Gulf<sup>32</sup>, and Kosovo<sup>33</sup>, one of the major lessons learnt has always been to have combined SIGINT-electronic warfare capabilities to obtain air superiority, in particular, and operational superiority, more generally<sup>34</sup>.

However, since 1999, the FASF no longer possesses suppression of enemy air defence (SEAD) capabilities with the withdrawal from service of its *AS-37 Martel*. In addition, with the withdrawal of the *CI60 Gabriel* in 2022, it also no longer holds any strategic airborne SIGINT capabilities either. Abandoning a portion of military electromagnetic activities is not a new phenomenon, neither in Europe nor in the U.S. As early as 1969, Richard C. Raymond, a member of the U.S. National Security Agency's scientific committee, presented in his then-classified report the imperative need to invest in SIGINT<sup>35</sup>. Forty-five years later, and after more than a decade of counterinsurgency warfare, former Prin-

29. Doctrine Interarmées. *DI 2.2. Renseignement d'Origine Cyber* (Paris: CICDE, 11 May 2022).

30. The need for electronic intelligence led the French Army Staff to acquire an intelligence aircraft capable of satisfying the needs of their Strategic Air Forces, giving rise first to the *DC-8 Sarigue*, and then to the first electronic countermeasure systems on the *Mirage IV*.

31. In 1967, the U.S. lost 326 aircraft, 85% of which were due to ground-to-air systems. Five years later, these losses were ten times lower after the implementation of squadrons specialised in attacking *Wild Weasel* radars equipped with *Shrike* anti-radar missiles.

32. The attrition rate of the French *Jaguar* would have been higher without the crucial support of the U.S. offensive electronic warfare.

33. U.S. Air Force General Michael Short, commander of the U.S. troops during the Kosovo crisis, commented that the French Air Force, while a coherent and effective army, lacked suppression of enemy air defences (SEAD) capabilities.

34. M. Gorget. "La guerre électronique dans les unités de combat de l'armée de l'Air, 1950-1980." in Comité pour l'histoire de l'armement, Association Guerrelec, *La Guerre électronique en France au XXe siècle* (Paris: Centre d'études d'histoire de la Défense, 2000). 73-83.

35. R. Raymond. "Challenge to Sigint: Change or Die." *Cryptologic Spectrum* 1, no. 13 (1969) in M. Aid, *The Secret Sentry* (National Security Archive Electronic Briefing Book No. 278, 2009).

cial Deputy Assistant Secretary of Defense for Research and Engineering Alan Shaffer expressed his concerns in 2014 for the rise of Russian and Chinese military capabilities in the electromagnetic spectrum: “We have lost our dominance in the electromagnetic spectrum”<sup>36</sup>. The development of ground-air defence systems by competitors is proportional to the de-investment and chronic downgrading of Western militaries in the suppression and destruction of enemy air defences (SEAD/DEAD).

This (again) highlights, the important *continuum* of electromagnetic activities and their intricacy despite its lack of perfection in governance. It also highlights the operational nonsense of being faced with the dilemma of choosing between the sword (offensive electronic warfare), the armour (defensive electronic warfare, exploitation, and protection of transmissions), and listening (SIGINT) for an army that nurtures global ambitions in the face of unabashed competitors. Indeed, abandoning certain capabilities may be rationalised from a budgetary point of view. However, it will be less so from the point of view of operational coherence. Thus, it is crucial to remain cognisant that progress in one field benefits another. Conversely, relinquishing or having gaps in knowledge in one area will automatically undermine the efficiency of others as it erodes this continuum. The structuring of the electromagnetic field is therefore the main challenge in the face of an increasingly unbridled environment of conflict.

### **3) Despite Its Inexorable Character, Cyber-electromagnetic Convergence Remains Timorous**

#### *Cyber-electronic Warfare: An Arlesian Within Reach*

Considering the disjointed nature of electromagnetic operations, along with the electromagnetic field’s lack of weight in influencing the MDO discourse, a change of approach to explore new ways forward is thus warranted. Namely, some voices seek to advocate for a rapprochement with the cyber environment. From it, a novel term is circulating and gradually taking hold amongst the armed forces: “cyber-electronic combat”. Nevertheless, its advent is still far from becoming an operational and organisational reality.

On the contrary, from the lens of society itself, its digitalisation (administration, finance, commerce, leisure) and perpetual renewal of telecommunications techniques and infrastructures (Internet of Things, 4G, 5G, 6G, space constellations) are inexorably melding electromagnetics ever more with cyberspace. The former is often the input and/or output vehicle for a signal processed by the latter. Every notification from a smartphone is but a prime example. In com-

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36. S. Freedberg Jr. “US Has Lost ‘Dominance In Electromagnetic Spectrum’: Shaffer.” *Breaking Defense*. 03 September 2014. <https://breakingdefense.com/2014/09/us-has-lost-dominance-in-electromagnetic-spectrum-shaffer/>.

bination with manned electromagnetic sensors and effectors, the development of autonomous vehicles – whether civilian or military – increases the need for interconnection between two wired relays, via the electromagnetic spectrum. Hence, the transmission of data from any connected object represents an electromagnetic access route to its corresponding information system, and thereby to its software and physical layers. The proliferation of nomadic and airborne data links is accelerating the convergence between the cyber world and that of electronic warfare<sup>37</sup>.

*SIGINT the Gap, Electronic Warfare the Cleaver, and Cyber the Exploiter*

The electromagnetic-cyber diptych broadens the modes of action, while outlining the complementarity and substitutability needed to be explored further. To explain, the main function of SIGINT is to investigate the signal it intercepts to decipher, if possible, its author, content, function, and location. It is only after this analysis that vulnerabilities may be identified. SIGINT, electronic warfare, and cyber, thus all interact in an incremental and complementary action pattern. SIGINT characterises the signal breaches, whereas electronic warfare cleaves them open to be exploited by cyber. Beyond the immediate tactical gains, the impact of this association at the operational level should be questioned according to its target and scope. If the objective is to destabilise or paralyse an adversary by directly altering the mechanisms needed for them to understand the real world and make proper decisions<sup>38</sup>, then it can be reasonably deduced that cognitive warfare has found itself an effective vector in the electromagnetic-cyber binarity.

To illustrate the potential substitutability between cyber and electronic warfare, Florant, specifically, analyses the Israeli Air Force's Operation Orchard against a Syrian nuclear site by discussing the earlier neutralisations of its air defences. He proposes three hypotheses on how the air defence system came to be infected with a virus, which subsequently was able to mask the arrival of Israeli fighters: (1) a malicious code that is installed by a human source; (2) special forces that connect itself to the information system; or (3) an airborne signal (radar, radio or other) that transmits a wave packet with codes that could infiltrate the information system.

*Envisioning a Fourth Army for the Immaterial?*

While synergy is mostly spoken of as being operational, it is not an end in itself but rather the result of a process that optimises both resources and effects. In other words, the result of a synergy is better than the expected sum of results from each individual part. To begin, limitations in both human and budgetary resources should be taken into account. Secondly, it would be preferable to unify

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37. J.-B. Florant. *art. cit.* 32.

38. D. Pappalardo. "La guerre cognitive : agir sur le cerveau de l'adversaire." *Le Rubicon*. 09 December 2021. <https://lerubicon.org/publication/la-guerre-cognitive/>.

and merge the chains of command and governance. Today, cyber, intelligence, and electronic warfare are managed at different levels of responsibility, within different structures, and under separate commands. Lastly, any form of organisational obesity and unnecessary expansion must be avoided.

In more concrete terms, the electromagnetic-cyber convergence must bring clarity to its organisation, and not complexity or density. For France, recreating the U.S. model of establishing new agencies or services would be counterproductive and would exhaust its existing resources. Rather, the country would find a more suitable answer with competitor states. While this by no means translates to following Russia's approach with the creation of a single functional electronic warfare command<sup>39</sup>, it does refer to China, whose MDOs are seemingly more advanced – if not at least on the organisational level. Their Integrated Network Electronic Warfare concept seeks to achieve informational dominance based on the combined use of computer, electronic, and kinetic attacks against enemy C4ISR<sup>40</sup> nodes.

Closer to France's shores, Israel is implementing quite the appealing structure. Its Joint Cyberdefense Directorate integrates all components of cyber, electronic warfare, SIGINT, and frequency management. This organisation not only ensures continuity between electromagnetic activities but also electromagnetic-cyber synergy as a whole. Considering all these case studies, perhaps it is time to bring forth the question of whether a "fourth army" for the immaterial should be formed. Said army would integrate cyber with all electromagnetic activities and their influence, together around the backbone of COMCYBER (whose name, in this regard, would require a change).

### *Stakes for the French Air and Space Forces*

The aerospace environment is innately perhaps the closest to intangible environments and fields due to its ability to easily interact with others. In the electromagnetic field, the range of FASF's actions today is limited to what could be seen as electromagnetic "self-defence". However, as effective as they are, defensive electronic warfare capabilities, such as jamming and decoy, can only thwart an imminent threat, as opposed to neutralising a potential threat.

The FASF must therefore seize two opportunities. The first lies with the airborne nuclear component. Since maintaining nuclear credibility clearly hinges on the renewal of the missile-vector-transmissions triangle, it would thus be pertinent to also apprehend new threats from the immaterial fields. As mentioned previously, the need for a strategic air force is what has driven technological and

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39. R. McDermott, *Russia's Electronic Warfare Capabilities to 2025: Challenging NATO in the Electromagnetic Spectrum* (Tallinn: International Centre for Defence and Security, 2017). [https://icds.ee/wp-content/uploads/2018/ICDS\\_Report\\_Russias\\_Electronic\\_Warfare\\_to\\_2025.pdf](https://icds.ee/wp-content/uploads/2018/ICDS_Report_Russias_Electronic_Warfare_to_2025.pdf).

40. D. Sharma. "Integrated Network Electronic Warfare: China's New Concept of Information Warfare." *Indian Journal of Defence Studies* 4, no. 2 (April 2010). [https://idsa.in/system/files/jds\\_4\\_2\\_dsharma.pdf](https://idsa.in/system/files/jds_4_2_dsharma.pdf).

operational advances in conventional air forces since their creation. As such, recovering an air defence neutralisation capability (SEAD/DEAD) will be one of the crucial challenges in the decades to come, as A2AD systems proliferate even more. The second opportunity is offered by the decades of experience in airborne SIGINT, as well as the recent years of experience in the more intrusive electromagnetic operations that extend into cyberspace. All in all, this only stresses that air forces should continue to expand their scope of action, including as a provider for modes of actions to the benefit of other sponsors.

Today, electromagnetic operations hold only limited prospects. Despite its importance in military operations, the exploitation of the electromagnetic field is seemingly either too shallow or feeble to weigh in on the MDO debate by itself. A double dynamic thus warrants engagement. An internal rapprochement of exploitation, intelligence, and combat activities is first necessary to restore the electromagnetic continuum. Further, its perimeters must be widened *via* an electromagnetic-cyber convergence in which the influence function would also find its place and group together immaterial effects into a coherent governance. Without this becoming a dogma, such a development would be invaluable in strengthening credibility in the face of MDO commitments to which today's armed forces are committed.



***VARIA***



# Russia's Long-Range Aviation: The Spoiled Child of Impoverished Parents

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Starting from 24 February 2022, bombers of Russia's Long-Range Aviation, the *Dal'nyaya Aviatsiya* (DA), have been engaged in the conflict with Ukraine at an unprecedented scale. Indeed, most of Russia's airstrikes targeting Ukraine's infrastructures have been long-ranged, and launched from either the Belarusian territory, southwest Russia, the Black Sea, or the Caspian Sea. Furthermore, nearly a quarter of the strikes penetrating deep into Ukrainian territory were reportedly carried out by long-range bombers, equipped with cruise missiles. Concurrently, in parallel, the conspicuous deployment of several strategic bombers from their assigned air bases were done so in tangent with President Vladimir Putin's declaratory strategies.

The DA, notably from the moment of its conception, has been both the spearhead and symbol of Russian air power. While it may have undergone a critical period between 1991 and 2010, it nonetheless remains an operational air force, embodying the integration of both conventional and nuclear means in Russia's defence strategy. The purpose of this article – beyond a brief introduction of such an essential component of the *Vozdushno-kosmicheskiye sily* (VKS) – is thus to highlight the variety of uses of strategic bombers at the tactical, operational, and strategic levels. After hitting its targets on the frontline, the use of bombers

is concentrated to gradually induce theatre-wide effects that eventually lead to strategic-level strikes. The *DA*'s observed actions during the conflict in Ukraine is evidence of the singularity of this *VKS* component. For one, they seem to be forced to produce military effects on the battlefield with targets imposed from the political level. The *DA*, a stand-alone symbol of Russian air power, illustrates, through this duality of tactical and strategic use, the articulation of conventional and deterrent capabilities that are part of Russia's overall strategic signalling posture.

### The *DA*: An Embodiment of Russian Strategic Air Power From 1914 to the Intervention in Syria

As vectors of the Federation's air diplomacy during peacetimes, strategic bombers were born as the heirs of tsarist "bombing" aviation. It then grew up to become Soviet and, soon after, Russian "long-range" aviation (LRA). The origins of the LRA date back to 23 December 1914<sup>1</sup>, when Tsar Nicholas II approved the creation of the first *Ilya Muromets* heavy bomber squadron. Although the aircraft was initially designed by Igor Sikorsky for civilian transport<sup>2</sup>, upon its inception, the air force became affixed to Russia's highest level of command<sup>3</sup>.

The modern history of Soviet long-range aviation, as it is known<sup>4</sup>, only took off with the *Tu-4 Bull* long-range bomber, which was equipped with propeller-driven turboprops. Notably, its design closely echoed that of the U.S. *B-29* bomber, after four had been lost in the Far East of the USSR in 1944. Two years later in 1946, the *Tu-4* entered into service and was operational until 1951. Its main mission then was originally constrained to conventional strategic bombing. However, from 1952 and onwards, it became capable of carrying *RDS-3* nuclear bombs. Several versions were subsequently developed to be used for reconnaissance and electronic warfare, along with both nuclear and conventional strike missions (*Tu-4R*, *Tu-4REP*, *Tu-4A*<sup>5</sup>, and *Tu-4K*).

As the Cold War settled in, these bombers came to provide nuclear deterrence, before being used to pose a threat to Western fleets and NATO reinforcement operations. Indeed, *Tu-22s* and *Tu-16s* in their anti-ship models served as an unquestionable threat to NATO's carrier battle groups. Later, during the war in Afghanistan, *DA* bombers (*Tu-16* and *Tu-22M2/M3*) – alongside the 40th Army's

1. Музей Дальней Авиации. "23 декабря - День дальней авиации ВВС России." *Музей Дальней Авиации*. Accessed 01 December 2022. <https://www.avia-ryazan.ru/index.php/prazdniki/den-dalnej-aviacii.html>.

2. Rostec. "Дальней авиации России - 105 лет." *Rostec.ru*. 23 December 2019. <https://rostec.ru/news/dalney-aviatsii-rossii-105-let/>.

3. Previously known as *Stavka* or *SVG* (*Stavka Verkhovnogo Glavnokomandouiochtshego*), and currently as *VGK* (*Verkhovnoye glavnokomandovaniye*).

4. The *TB-3*, *Pe-4* and *Il-8* are 'heavy' bombers that entered service from the 1930s and 1940s.

5. Entering service in 1949, the *Tu-4A* for '*athtomnyy*', like its successors *Tu-16* and *Tu-95*, contributed to the testing of the Soviet atomic programme and eventually became a nuclear delivery vehicle.

tactical and artillery aviation (helicopters) – contributed to carrying out strikes on the *mujahideen*. In addition, the *Tu-16* and *Tu-22M2/M3* of the 30th and 46th Air Forces carried out more than 1,150 sorties in the Afghan theatre. Assigned for the most part to the Belaya Air Base (*Amur Oblast*), they were deployed from airfields in Central Asia, notably from Mary in Turkmenistan and Karchi in Uzbekistan. Finally, their last mission in Afghanistan took place in January 1989. In sum, throughout this conflict, the *DA* bombers operated at high altitudes, uninhibited by ground-to-air threats<sup>6</sup>.

While the *DA* only delegated one chief of staff<sup>7</sup> to the Russian Air Force – or *Voyenno-vozdushnye sily* (*VVS*), it was nevertheless considered as a prestigious branch within the *VKS*<sup>8</sup>. In particular, heavy bombers epitomised both military and technological confrontation within the Western world throughout the Cold War. Numerous strategic bomber programs<sup>9</sup> were developed to counter U.S. initiatives and elevate Russia to the same parity of capabilities. Notwithstanding such achievements, the fall of the Soviet Union brought about a widespread deflation and dismantling of resources. During this period, the *DA* was fortunate to escape relatively unscathed from this demise. This, in particular, was its duty as a nuclear deterrent. It subsequently continued to play a discreet international role throughout the 1990s and 2000s.

Today, the *DA* is a full-fledged component of the *VVS* within the *VKS*, albeit being directly subordinate to the Supreme Command (*VGK*<sup>10</sup>) – the institution responsible for the preparation and conduct of military campaigns and strategic operations<sup>11</sup>. The *DA* notably retains all heavy, long-range bombers in service within the *VVS*. It is in charge of any mission that bombs strategic targets with either cruise missiles or bombs, both conventional and nuclear. From Russian nomenclature, a dichotomy can be observed, separating *Tu-95MS* and *Tu-160* strategic bombers<sup>12</sup> from *Tu-22M3* long-range bombers<sup>13</sup>. The latter is now being exclusively used for tactical bombing missions on the ground and at sea. The former two, on the contrary, contribute to both nuclear deterrence and the additional role of carrying out conventional missions. To encapsulate, *DA* strategic bombers represent the airborne component of Russia's nuclear deterrent.

In consequence, the majority of bomber fleets deployed between Engels and Ukraïka is positioned facing the southern borders of the Russian Federation. It

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6. The *mujahideen* were equipped with very short-range *Stinger* ground-to-air systems. It should be noted that the 326th heavy bomber division engaged in these operations is still operational.

7. General Piotr Deinekin was successively the Air Force Chief of Staff for the USSR, then the Commonwealth of Independent States (CIS), and finally, the Russian Federation.

8. Of interest to note, several strategic bombers (*Tu-16*, *Tu-22*) have also been in service in the Russian naval aviation.

9. *Tu-16 Badger*; *M-4 Bison*, *3M Bison B*, *Tu-22 Blinder*.

10. *Verkhovnoye glavnokomandovaniye*.

11. The President of the Russian Federation is the Supreme Commander-in-Chief.

12. *Strategicheskiy bombardirovshchik-raketonosets*.

13. *Dalniy raketonosets-bombardirovshchik*.

is also expected for there to be dispersed operating bases running in the Russian North. These airfields permanently host air command posts (AvK<sup>14</sup>) subordinate to the DA command<sup>15</sup>. Posts located in the Arctic consist of Tiksi (200 Avk), Vorkuta (40 Avk), and Anadir (182 Avk). Kamensk Uralsky (*Sverdlovsk Oblast*) is home to 199 AvK, which serves as a stopover for aircrafts flying from one end of Russia to the other. The Soltsy Air Base (52 AvK), the Rogachevo airfield<sup>16</sup>, the island of New Zealand (*Arkhangelsk Oblast*), and the Temp airfield on the island of Kotelný (Sakha Republic) all complete this territorial network of the DA. These air command posts hold fuel reserves and maintain runways to accommodate transiting bombers.

The VKS operates around twenty *Il-78/M Midas*, which are intrinsically dependent on the DA. They perform air-to-air refuelling missions for DA strategic bombers, as well as for both VKS and MA-VMF<sup>17</sup> aircrafts. In addition, they are employed to provide support for the heavily occupied tactical transport fleets. The 203rd tanker regiment (OAP SZ<sup>18</sup>) stationed in Dyagilevo comprises the entire VKS tanker fleet. Their first wave of upgrades is anticipated to raise all *Il-78* and *Il-78M* aircrafts up to the *Il-78-2* standard. These aircrafts' lifespan would then be extended, while ten previously-ordered *Il-78M-90A* aircrafts are progressively delivered. This variant of the *Il-76MD-90A* is produced in Ulyanovsk by the *Aviastar-SP* factory and offers significantly enhanced capabilities<sup>19</sup>. It is essentially a modernised version of the *Il-76MD Candid* but converted into a tanker. To date, only one *Il-78M-90A* prototype has reportedly been produced. The resumption of long-range patrols by strategic bombers and the forthcoming entry into service of the air-to-air refuelling *Tu-22M3M* aircrafts have undoubtedly accelerated this programme.

Indeed, the DA, since 2007, has resumed its long patrols in the Arctic, as well as along the coasts of Europe, the United States, and Japan. It was also deployed occasionally in Indonesia in 2017 and later in Venezuela in 2018<sup>20</sup>. Yet, it is within Russia's own vicinity that the bombers have been making their mark. Specifically, the *Tu-22M3s* were employed from 1995 in Chechnya, then in 2008 in Georgia, and finally, in Syria after 2015. At the height of its engagement in Syria, Russia mobilised twenty-five *Tu-22M3s*, accounting to about one third of its fleet. Moreover, six of them were deployed to the Nojeh Air Base in Iran after August 2016.

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14. *Aviatsyonnaya kommandatura*.

15. *Aerodrom podskoka*.

16. Also known as *Amderma-2*.

17. *Morskaya aviatsiya voenno-morskogo flota*: Naval Aviation of the Russian Military Navy.

18. *Otdelnyi aviatsionnyi pol samolotov zapravshchikov*.

19. Red Samovar. "The Ilyushin IL-78 Midas." *Red Samovar*. 18 June 2019. <https://redsamovar.com/2021/06/18/actu-lilyushin-il-78-midas/>.

20. Russian Federation, Ministry of Defense. "Командующий Дальней авиацией доложил главному ВКС о выполнении полетов Ту-160 в Карибском море." *Mil.ru*. 14 December 2018. [https://structure.mil.ru/structure/okruga/east/news/more.htm?id=12208059@egNews\\_](https://structure.mil.ru/structure/okruga/east/news/more.htm?id=12208059@egNews_).



Figure 1: *Tu-22M3* taking off from the Mozdok Air Base to carry out a bombing raid in northeastern Syria, February 2016.

In parallel, *Tu-95MS*s were used in Syria for the first time between November 2015 and November 2016, 59 years after they entered into service. *Kh-555* cruise missiles mounted in pairs upon four pylons under the wings were launched<sup>21</sup>. *Tu-160*s, from Engels, also participated in their first operations, firing both *Kh-101* and *Kh-555* cruise missiles, while being escorted by *Su-30SM*s. The military effects obtained by these strikes remain difficult to assess, particularly because the list of targets presented does not correspond with the targets reported to be hit, especially in eastern Syria. While official statements were quick to sensationalise the fight against terrorism, it was the opponents to the Syrian regime in the west of the country that took the brunt of Russia's attacks. The media impact thus seemed to have been greater than the operational achievements.

Moreover, the intervention in Syria had fanned the flames of competition between different *VSRF*<sup>22</sup> branches, as all sought to become the sole, primary means of power projection for both political and military staffs. This was most notably the case between the *Voyenno-Morskoy Flot* (Russian Navy or “*VMF*”) and the *VKS*. However, judging from all the modernisation programmes that the *DA* bomber fleet were able to secure, the relative operational success of Russian aviators in Syria<sup>23</sup> must have likely enticed quite the allocation of added resources. Namely, not only was the *Tu-160M*'s serial production revived, the

21. T. Cooper. *Moscow's Game Of Power - Russian Military Intervention In Syria, 2015-2017* (Carwick: Helion & Company Ltd., 2018).

22. *Vooroujionnye sily Rossijskoj Federatsii*.

23. X. Rival and M. Pinel. “Qualitative Aspects of Russian Intervention in Syria.” *Vortex*, no. 2 (December 2021): 135-151. <https://en.calameo.com/cesa/read/006940288a005dec830d6>.

*Tu-95MSMs* and *Tu-22M3Ms* were also upgraded<sup>24</sup>. Nevertheless, considering the systemic delays in Russia's aeronautics industry and the consequences of the conflict in Ukraine on both the country's production and maintenance lines, trade-offs will most likely be made<sup>25</sup>.

The final point to note is that the *MiG-31P*<sup>26</sup>, while carrying the *Kh-47M2 Kinzhal* missile, is now attached to the *DA*<sup>27</sup>. These *MiG-31*s are currently assigned to Savasleika Air Base No. 3958 (*Nijni Novgorod Oblast*). These subsequently formed the core of the first independent fighter regiment (*OIAP*<sup>28</sup>) to integrate the *DA*, which, until then, had been composed exclusively of heavy bombers<sup>29</sup>.

### The *DA* in the Ukrainian Conflict: From Tactical to Strategic, between Military Effects and Political Decisions



Figure 2: The presence of Russian aircraft on Ukrainian borders on 18 February 2022<sup>30</sup>. © Wing.com.ua

24. A. Lavrov. "Russian Aerial Operation" in R. Hamilton et al (eds). *Russia's War in Syria: Assessing Russian Military Capabilities and Lessons Learned* (Philadelphia, PA: Foreign Policy Research Institute, September 2020). <https://www.fpri.org/wp-content/uploads/2020/09/russias-war-in-syria.pdf>.

25. P. Luzin. "Russia's Defense Industry Growing Increasingly Turbulent." *Eurasia Daily Monitor* 19 (17 November 2022).

26. At times, referred to as *Mig-31K*.

27. Izvestia. "Полет "Кинжала": гиперзвуковые ракеты пополнили дальнюю авиацию." *Izvestia*. 17 February 2022. <https://iz.ru/1292447/anton-lavrov-bogdan-stepovoi/polet-kinzhala-giperzvu-kovye-rakety-popolnili-dalniuiu-aviaciiu?ysclid=I92er2ti7579103635>.

28. *Otdelnyi istebitelnyi aviatsionnyi polk*.

29. Военное Обозрение. "Первый авиаполк с гиперзвуковым комплексом "Кинжал" вошел в состав Дальней авиации ВКС РФ." *Voennoe Obozrenie*. 17 February 2022. <https://topwar.ru/192410-pervyj-aviapolk-s-giperzvukovym-kompleksom-kinzhal-voshel-v-sostav-dalnej-avii-vks-rf.html>.

30. Black Sea News. "ROCHAN CONSULTING показала российскую военную авиацию у границ Украины / Фото, карта." *Black Sea News*. 20 February 2022. <https://www.blackseanews.net/read/184939>.

Prior to the invasion, there were no specific reports made regarding *DA* bombers. While the *VKS* concentrated a large share of its air assets on the borders of Ukraine, the *DA* bombers remained stationed at their respective bases. Nevertheless, they played a prominent role right from the conflict's onset. At 5 a.m. on 24 February 2022, immediately after the speech announcing the initiation of Russia's "special military operation"<sup>31</sup>, the first salvo of cruise missiles were launched from the air, ground, and sea, to hit C2 centres, air defence sites, air bases, and port infrastructures, as well as other vital points of interest. The aim was to reduce the capabilities of the Ukrainian Armed Forces (UAF). These air strikes were reportedly carried out by approximately 75 bombers<sup>32</sup>. In the following days, the *DA* further continued their launch of cruise missile strikes<sup>33</sup>. Firing in such a manner – that was simultaneously both operational and strategic – during this first stage of the campaign seems to have been greatly acknowledged by the Russian authorities. Notably, on 7 April 2022, the 121st *Sevastopolskiy* regiment of *Tu-160* heavy bombers was awarded the honorary title of "Guards" as per presidential decree.

Despite the above, Russian authorities remained relatively silent on any commentary made over these attacks. Moreover, the way these missiles were fired made it barely possible for cameras to capture and broadcast across various networks. As such, the only evidence to prove that such bombings took place often lied in the destruction left in their wake, along with the identification of the type of munitions used (*Kh-101*, *Kh-555*, and *Kh-22*). The media coverage of the *DA* strikes was therefore limited at first. However, from 12 March 2022 onwards, a satellite image provided by Israeli company ImageSat International (ISI) captured the presence of *Tu-160*s and *Tu-95MS*s at Engels Air Base. This, consequently, snapped media attention back towards strategic strikes. Specifically, a close monitoring of their activities shows that there was a gradual shift in the nature of how *DA* bombers were employed between April and November 2022.

31. First occurrence of the phrase "Spetsialnoy voyennoy operatsii - SVO" was in a speech by the President of the Russian Federation: "Обращение Президента Российской Федерации." *Kremlin.ru*. 24 February 2022. <http://kremlin.ru/events/president/news/67843>.

32. T. Newdick. "We May Have Our First Sight Of A Russian Bomber Launching Missiles At Ukraine." *TheWARZone*. 11 May 2022. <https://www.thedrive.com/the-war-zone/we-may-have-our-first-sight-of-a-russian-bomber-launching-missiles-at-ukraine>.

33. T. Newdick. "These Are The Standoff Missiles Russia Used To Open Its War Against Ukraine." *TheWARZone*. 24 February 2022. <https://www.thedrive.com/the-war-zone/44443/these-are-the-standoff-missiles-russia-used-to-open-its-war-against-ukraine>.



Figure 3: Satellite imaging disclosing the presence of the *Tu-160* and *Tu-95MS* on the parking strip of Engels Air Base. © ISI

### The *DA*'s initial mission was tactical and limited to the front lines...

Up until mid-March 2022, the initial operational strike campaign had mobilised both *Tu-95MS* and *Tu-160* aircrafts. After this first phase, *Tu-22M3* aircrafts entered the scene and carried out tactical bombings with free-fall bombs. An image taken at Shaykovka Air Base on 4 April 2022 shows a *Tu-22M3* about to be fitted with a *FAB-3000M-46* bomb<sup>34</sup>. Designed in 1946 with its relatively thin walls, it was particularly suitable for bombers flying at subsonic speeds. When this bomb was dropped from a *Tu-22M3*, it caused a powerful ground detonation and significant blast effect, albeit only against a lightly-buried structure. The last recorded use of free-fall bombs by *Tu-22M3*s was in 2016, during the raids from Mozdok Air Base into northeastern Syria.

<sup>34</sup>. Developed in 1946, it contains 1,400 kg of explosive charge.



Figure 4 and 5: On the parking strip of Shaykovka Air Base on 4 April 2022 of a *FAB-3000* bomb that may have been carried by the *Tu-22M3* in the background.

From 14 April 2022, the Russian Armed Forces (RAF) surrounded Mariupol. *Tu-22M3*s executed a medium-altitude barrage<sup>35</sup> over the city, which had been deprived of a ground-to-air defence<sup>36</sup>. *Tu-22M3*s dropped their free-fall bombs on the Azovstal factory in Mariupol for the first time in the conflict<sup>37</sup>. Nevertheless, the RAF faced an entrenched opposition for several days. Meanwhile, Mariupol became an international symbol of Ukrainian resistance. For Russia, they sought to push the UAF to surrender at the earliest instance possible. Hence, the use of long-range bombers at very low altitudes became the preferred choice. Beyond their large payload, these bombers were the most optimal vector for creating a tactical situation in Russia's favour<sup>38</sup>. The *Tu-22M3*s then continued to strike the factory until mid-May.

35. J. Bronk et al. "The Russian Air War and Ukrainian Requirement for Air Defence." *RUSI*. 07 November 2022. <https://rusi.org/explore-our-research/publications/special-resources/russian-air-war-and-ukrainian-requirements-air-defence>.

36. M. Evans. "Supersonic Russian jets drop dumb bombs on Mariupol steel plant." *The Times*. 18 April 2022. <https://www.thetimes.co.uk/article/supersonic-russian-jets-drop-dumb-bombs-on-mariupol-steel-plant-fddsd2bb5>.

37. Новое Издание. "РФ сбросила мощную авиабомбу..." *Telegram*. 19 April 2022, 15:55. <https://t.me/Novoeizdanie/10920>.

38. Very short-range ground-to-air.



Figure 6: A *Tu-22M3* taking off to bomb Mariupol on 14 April 2022.

**... but then, gradually advanced up to the operational level...**

Concurrently on another plane, Russia began an interdiction campaign to disrupt the logistical flow to the front, as ground offensives began in the Donbass. On 25 April 2022, both *Tu-160*s and *Tu-95MS*s launched twelve *Kh-101* and *Kh-555* cruise missiles from the Caspian Sea, hitting railway infrastructures in central and western Ukraine. These strikes reportedly caused a temporary interruption of railway traffic, according to the Ukrainian government. On 21 May 2022, *Tu-22M3*s carried out strikes on a bridge over the Dnieper River in the vicinity of Zaporizhzhia, as well as on a railway station in Vilnyansk. However, both missiles were reported to have missed their mark. The *Tu-22M3*s were also allegedly mobilised in a campaign to strike lines of communication, specifically, Ukraine's railway network. This type of strike was initially carried out by the *Kh-101*, *Kh-555*, and *Kalibr*<sup>39</sup>.

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39. T. Cooper. "Ukraine War, 12 May 2022." *Medium*. 12 May 2022. [https://medium.com/@xTomCooper\\_x/ukraine-12-may-2020-6fe4a31959b9](https://medium.com/@xTomCooper_x/ukraine-12-may-2020-6fe4a31959b9).



Figure 7: A *Tu-160* delivering a *Kh-101*.



Figure 8: Loading a *Kh-101* into the ammunition bay's hold.

Nevertheless, this campaign was said to have failed in achieving its desired result due to a lack of ammunition. Indeed, on 11 May 2022, it was revealed that the *Tu-22M3*s were using *Kh-22*s, which were produced in the 1970s<sup>40</sup>. This evidently raised doubts regarding Russia's cruise missile inventory. Indeed, several studies underline that many of their weapons systems are dependent on imported components<sup>41</sup>, including certain cruise missiles. However, a study conducted by the Conflict Armament Research (CAR) reveals a different pic-

40. ZOKA. "Launch of two supersonic cruise missiles..." *Twitter*. 11 May 2022, 11:51. [https://twitter.com/200\\_zoka/status/1524326248092164096](https://twitter.com/200_zoka/status/1524326248092164096).

41. J. Watling and N. Reynolds. "Ukraine at War - Paving the Road from Survival to Victory." *RUSI*. 4 July 2022. [https://static.rusi.org/special-report-202207-ukraine-final-web\\_0.pdf](https://static.rusi.org/special-report-202207-ukraine-final-web_0.pdf).

ture: satellite guidance systems now are equipping *Kh-59* and *Kh-101* missiles with the same electronic components by making use of partially damaged or unexploded munitions<sup>42</sup>.



Figure 9 and 10: Wreckage of a *Kh-101* and the *9E-2648* warhead found in a field in Ukraine in March 2022. © Ministry of Defense of Ukraine

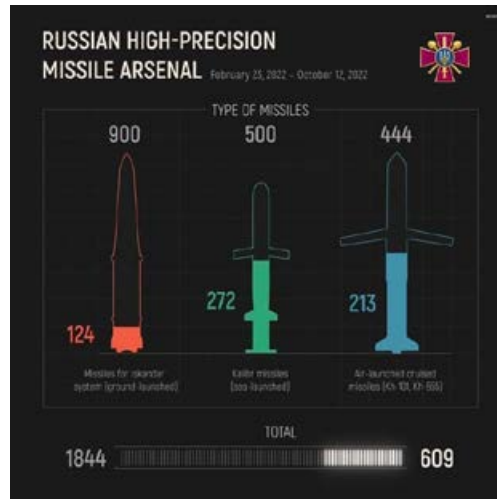


Figure 11: Infographic showing Russia's consumption of its precision strike missile stockpile from 23 February 2022 to 12 October 2022. © Ukrainian Ministry of Defence

Indeed, at a rate of 4-to-8 *Kh-101* missiles assembled per month, Russia will continue to toil in replenishing their stockpile of precision-guided weapons<sup>43</sup>.

42. Ukraine Field Dispatch. "Component commonalities in advanced Russian weapon systems." *Conflict Armament Research*. September 2022. <https://storymaps.arcgis.com/stories/239f756e2e-6b49a5bec78f5c5248bf3d>.

43. T. Cooper. "Ukraine War, early August 2022, Part 1." *Medium*. 10 August 2022. [https://medium.com/@x\\_TomCooper\\_x/ukraine-war-early-august-2022-part-1-1da764a30863](https://medium.com/@x_TomCooper_x/ukraine-war-early-august-2022-part-1-1da764a30863).

The VKS will be forced to use older ammunition, such as the *Kh-22M* or *Kh-59M*. Eventually, stockpile replenishment would be significantly obstructed by economic sanctions<sup>44</sup>. However, Russia seems to be currently circumventing these difficulties<sup>45</sup> by outsourcing from other partners<sup>46</sup>. Nevertheless, the production capacity of the country's defence industry is likely to remain limited due to their chronic shortage of qualified workers<sup>47</sup>.

### ... before finally extending into the strategic level.

This lack of new-generation missiles will not, however, prevent the gradual shift to these strikes taking on strategic objectives that target infrastructures pivotal to Ukraine's war efforts. Several large-scale strategic raids have already been carried out on 25 June 2022 from the Belarusian territory<sup>48</sup>. Twelve bombers divided into four separate groups – three of which were composed of *DA* aircrafts – were reported to have fired at least 15 cruise missiles in three different waves<sup>49</sup>. The first wave was composed of *Tu-22M3s* that had taken off from the Shaykovka Air Base where the 52 *TBAP*<sup>50</sup> was stationed. The second wave had been launched from Shesha, where *Su-34s* were temporarily deployed. These cruise missiles were believed to have been launched from within Russian airspace over Mazyr (*Gomel Oblast*). Finally, the third wave consisted of *Tu-22M3s*, which most likely flew in from another axis. It struck industrial buildings in Konstantinovka within the Donetsk region<sup>51</sup>.

In addition to these strikes, *Iskander* and *Onyx* ballistic missiles were also reportedly fired from Belarusian territory at the same time<sup>52</sup>. They are said to have hit their targets in the Zhytomyr and Yavoriv regions that border Poland, where a training centre for foreigner volunteers was located. Finally, *Kalibr* cruise missiles were also noted to have been launched from sea<sup>53</sup>.

44. Ukraine Field Dispatch. "Dating newly produced Russian missiles used in Kyiv attacks." *Conflict Armament Research*. December 2022. <https://storymaps.arcgis.com/stories/81bc6b71fd-c64361a05a21020c3d6d5e>.

45. D. Ivanov. "В Китае заговорили о разгроме гегемонии США." *Voennoe Delo*. 6 December 2022. <https://voennoedelo.com/posts/id35185-ny1cr2l6nnahegk9yd3q>.

46. Dambiev. "Тяжелый транспортный самолет Ан-124-100..." *Telegram*. 04 December 2022, 16:55. <https://t.me/ChDambiev/20991>.

47. The State Duma. "Комитет по обороне обсудил поправки к проекту бюджета на 2023-2025 годы." *Duma.gov.ru*. 10 November 2022. <http://duma.gov.ru/news/55716/>.

48. T. Cooper. "Ukraine War, 25-26-26 and 28 June." *Medium*. 29 June 2022. [https://medium.com/@x\\_TomCooper\\_x/ukraine-war-25-26-27-and-28-june-2022-a8cbb1c9266b](https://medium.com/@x_TomCooper_x/ukraine-war-25-26-27-and-28-june-2022-a8cbb1c9266b).

49. "Перехват переговоров: Маскированный ракетный удар по территории Украины 25 июня 2022 года." *Youtube*. 28 June 2022. <https://www.youtube.com/watch?v=kKCoN2hlS6w>.

50. *Tyazholyi bombardirovochnyi aviatsionnyi polk*.

51. Deleted Tweet and Account. <https://twitter.com/talsalihiy3/status/1540565659859419136>.

52. Censor.net. "Russia resumed launches of "Iskanders" from territory of Belarus and for first time used long-range Tu-22M3 bombers from airspace of Belarus, - Air Force." *Censor.net*. 26 June 2022. [https://censor.net/en/news/3350140/russia\\_resumed\\_launches\\_of\\_iskanders\\_from\\_territory\\_of\\_belarus\\_and\\_for\\_first\\_time\\_used\\_longrange\\_tu22m3](https://censor.net/en/news/3350140/russia_resumed_launches_of_iskanders_from_territory_of_belarus_and_for_first_time_used_longrange_tu22m3).

53. T. Cooper. "Supplement: Of Backfires and Kitchens." *Medium*. 26 June 2022. [https://medium.com/@x\\_TomCooper\\_x/supplement-of-backfires-and-kitchens-ef0088f33722](https://medium.com/@x_TomCooper_x/supplement-of-backfires-and-kitchens-ef0088f33722).

Beyond these attacks, technical incidents were also recorded. During the first phase, one *Tu-22M3* (designator O1) reportedly failed to launch its second missile. During the third phase, two out of the four *Tu-22M3s* (the 3rd and the 4th) failed to launch their *Kh-22s*. Yet, despite being let down by the malfunctioning of their missiles, the *VKS* demonstrated their ability to plan and carry out several raids in one day along different axes of attacks from the north. Specifically, Russia strove to outflank Ukraine's ground-to-air defence systems, which were mainly positioned to intercept missiles coming from the east and the south. Russian forces also sought to take advantage of Ukraine's difficulties in recharging their batteries. Regardless, Ukraine's ground-to-air defence (GAD) nevertheless intercepted about ten of such missiles.

### The sequence of raids were as follows:

Kinematics of <i>VKS</i> Strikes Carried Out on 25 June 2022			
Time	Aircraft	Actions	Comments, radio transmission
Phase 1: Two Groups of 3 <i>Tu-22M3s</i>			
03h31m21	Group 1: 3 <i>Tu-22M3s</i>	Take-off from Shaykovka Air Base	Indicators : O1, O2, O3
Undetermined	Group 2: 3 <i>Tu-22M3s</i>	Take-off from Shaykovka Air Base	Indicators : 21, 22, 23
03h46m34s	O1	1 shot	"O1, ready with one"
03h46m52s	O2	2 shots	"O2, ready with two"
03h47m01s	O3	2 shots	"O3, ready with two"
03h56m53	O1	1 shot	"O1, one performing task"
03h56m59s	O3		"O3, accepted"
03h58m49s	O3	1 shot	"O3, one performing task"
04h07m15s	O1		"O1, 620 km/h, ready"; "I can't anymore".
04h07m15s	22	1 shot	"22 tasks done"
04h09m07s	21 and 23	2 shots	
04h19m52s	Group 1	Return transit to Shaykovka Air Base	
04h19m57s	Group 1	Return transit to Shaykovka Air Base	"Scale: 230, 235, 240"
04h30m51s	Group 2	Return transit to Shaykovka Air Base	
04h34m52s	Group 2	Approaching Shaykovka Air Base	

Phase 2: Two <i>VKS</i> fighter-bombers			
05h15m42s	Likely <i>Su-34</i>	Take-off from Shesha Air Base	Call sign: 53482
05h23m04s	Likely <i>Su-34</i>	Take-off from Shesha Air Base	Call sign: 53422
05h34m13s	482	1 shot	
05h42m21s	422	Joining launch area	
05h42m25s	482	1 shot	
05h46m28s	422	1 shot	
05h48m18s	482	Return transit to Shesha Air Base	
05h55m38s	422	1 shot	
Phase 3: One Group of 4 <i>Tu-22M3s</i>			
18h49m49s	Group 3: 4 <i>Tu-22M3s</i>	Take-off from Shaykovka Air Base	1st, 2nd, 3rd, 4th <sup>54</sup>
19h08m26s	Group 3	Joining launch area	"8100, 8250, 8400, 8550"
19h20m40s	Group 3		"Increase speed to 650 km/h"
19h21m00s	1st and 2nd	2 shots	"1st and 2nd tasks done"
19h26m10s	Group 3	Return transit to Shaykovka Air Base	"Group work completed, end of task".
19h48m26s	Group 3	Approaching Shaykovka Air Base	"Approaching turn, leaving Republic of Belarus, right turn on course at 85°"

The day after, a group of six *Tu-22M3s* followed by a second group of two *Tu-22M3s* had reportedly approached the Ukrainian border from Belarus to launch their *Kh-22s* at Kyiv, which resulted in numerous casualties<sup>55</sup>. It may be concluded that these bombings were a response to the strikes fired by Ukraine on 24 and 25 June 2022 by *MI42* HIMARS<sup>56</sup> at the 20th Army (20 *Gv OA*<sup>57</sup>) field headquarters and at the Svatovo (*Luhansk oblast*) ammunition depot. The retaliation was meant to communicate Moscow's unfaltering determination as outpourings of statements from European leaders were made in support of Ukraine. It was also in defiance to the possible beginnings of very close ties being built

54. Indeterminate real indicators, referred to here as 1st, 2nd, 3rd, and 4th.

55. T. Cooper. "Supplement: Russian Missile Strike, 25 June 2022." *Medium*. 25 June 2022. [https://medium.com/@x\\_TomCooper\\_x/supplement-russian-missile-strike-25-june-2022-65325532b8d](https://medium.com/@x_TomCooper_x/supplement-russian-missile-strike-25-june-2022-65325532b8d).

56. The *MI42* HIMARS (High Mobility Artillery Rocket System) is a multiple rocket launcher (MRL) system.

57. *Gvardeyskaya Krasnoznamonnaya Obshchevoyskovaya Armiya*. The headquarters of the 20th Combined Army is located in Voronezh (Voronezh oblast).

between the EU and Ukraine. In any case, they only contributed to fueling the conflict's escalation.

Ukraine's arms factories were also targeted. In particular is the company Artem<sup>58</sup> in Kyiv, which specialises in the production of aeronautics equipment for the country's defence industry<sup>59</sup>. However, on 27 June 2022, two *Kh-22s* fired by a *Tu-22M3* flying out of Shaykovka seemed to have missed this target. As a result, the deadly airstrikes hit the Kremenchuk shopping centre instead, which drew severe ire from the Ukrainian government.



Figure 12: A *Kh-22* in terminal phase over Kremenchuk on 27 June 2022.  
© Ukrainian Ministry of Defence

From evidenced reporting, the Israeli agency ImageSat International (ISI) released satellite images<sup>60</sup>, showing the deployment of four *Tu-160s* on 21 August 2022 and three *Tu-95MSs* on 25 September 2022 to the Olenegorsk Air Base – which initially hosted a squadron of *Tu-22M3s*<sup>61</sup>. These bombers were believed to have come from the Engels Air Base. This deployment occurred immediately after 21 September 2022, when a partial military mobilisation was declared in Russia, while veiled threats to use nuclear weapons were made<sup>62</sup>.

58. Global Security. “Zavod Artem Artyom Rocket-Building Corporation Artem Holding.” *GlobalSecurity.org*. 27 June 2022. <https://www.globalsecurity.org/military/world/ukraine/artem.htm>.

59. GeoConfirmed. “Zavod Artem’...” *Twitter*. 26 June 2022, 16:55. <https://twitter.com/GeoConfirmed/status/1541072781433077761>.

60. (Little) Think Tank. “[RUSSIE]...” *Twitter*. 30 September 2022, 20:01. [https://mobile.twitter.com/L\\_ThinkTank/status/1575908713927524365](https://mobile.twitter.com/L_ThinkTank/status/1575908713927524365).

61. A. Ahronheim. “Russian bombers capable of carrying nukes detected near Finland.” *The Jerusalem Post*. 30 September 2022. <https://www.jpost.com/international/article-718618>.

62. President of Russia. “Обращение Президента Российской Федерации.” *Kremlin.ru*. 21 September 2022. <http://www.kremlin.ru/events/president/news/69390>.



Figure 13: Infographic, issued by the ISI, illustrating the presence of strategic bombers in Olenegorsk.

After a break from strategic bombing (perhaps brought on by a lack of missiles or the ongoing reorganisation of the Russian command with the arrival of General Surovikin), several *Tu-22M3*s struck the Khmelnytskyi region of Ukraine from Belarusian airspace on 6 October 2022<sup>63</sup>.

As a side note of interest, Ukraine carried out its first attempt to attack the Shaykovka Air Base that was hosting *Tu-22M3* bombers from the 52nd Heavy Bomber Regiment (152 *TBAP*)<sup>64</sup>. This attack was done with remotely-operated ammunition and was the farthest ever carried out onto the territory of the Russian Federation<sup>65</sup>. However, it appears that no damage was inflicted<sup>66</sup>. Previously, the UAF's use of remotely-operated munitions was also observed in strikes launched at a refinery at Novoshakhtinsk (*Rostov Oblast*) in June

63. LiveUAMap. "Russian Tu-22 M3 bombers launched Kh-22 missiles..." *LiveUAMap*. 06 October 2022. <https://liveuamap.com/en/2022/6-october-russian-tu22-m3-bombers-launched-kh22-missiles>.

64. Kommersant. "В Калужскую область залетели беспилотники." *Kommersant*. 13 October 2022. <https://www.kommersant.ru/doc/5608721>.

65. Other long-range strikes took place in Belgorod in April and August, as well as in Crimea on the Saki Air Base in Novofedorivka and on an ammunition depot in Dzhankoi. See H. Altman. "Russia Increasingly Feeling Sting Of War Behind The Lines." *TheWARZone*. 18 August 2022. <https://www.thedrive.com/the-war-zone/russia-increasingly-feeling-sting-of-war-behind-the-lines>.

66. T. Rogoway. "Ukrainian Kamikaze Drone Attacks Bomber Base Deep In Russia (Updated)." *TheWARZone*. 07 October 2022. <https://www.thedrive.com/the-war-zone/ukrainian-kamikaze-drone-attacks-bomber-base-deep-in-russia>.

2022<sup>67</sup>, then at the Black Sea Fleet headquarters<sup>68</sup> in Sevastopol a month later in August<sup>69</sup>.



Figure 14: Satellite image comparing the Shaykovka Air Base on 7 October 2022 and 8 October 2022.  
© The WAR Zone

To continue, Russia also complemented their strategic strikes in early October 2022 with the use of drones made of Iranian origin. In the morning of 10 October 2022, cruise missiles (including *Kh-101s* and *Kh-55s*), ballistic missiles, as well as *Shahed-136* drones<sup>70</sup>, were fired at a number of Ukrainian cities. According to official statements, this was Russia's retaliation to the partial destruction of the Kerch Bridge by Ukrainian forces on 8 October 2022<sup>71</sup>. This was, in turn, refuted by Ukraine, who claimed that Russia's plans for these strikes predated the bridge's destruction. Moreover, said strikes were accused of having targeted Ukraine's command centres, critical energy infrastructure, factories, as well as the country's densely populated urban areas.

67. T. Newdick. "Kamikaze' Drones Strike Russian Oil Refinery, Looks Like Model Sold On Alibaba." *TheWARZone*. 22 June 2022. <https://www.thedrive.com/the-war-zone/kamikaze-drones-strike-russian-oil-refinery-looks-like-model-sold-on-alibaba>.

68. *Chernomorski flot - Voenno-morskoy flot* (ChF-VMF).

69. T. Rogoway. "Ukraine Situation Report: Shadowy Long-Range Kamikaze Drone Strikes Again." *TheWARZone*. 20 August 2022. <https://www.thedrive.com/the-war-zone/ukraine-situation-report-shadowy-long-range-kamikaze-drone-strikes-again>.

70. The Russian name is *Geran-2*.

71. *Izvestia*. "Путин сообщил о нанесении ударов по объектам украинской инфраструктуры." *Izvestia*. 10 October 2022. <https://iz.ru/1407924/2022-10-10/putin-soobshchil-o-nanesenii-udarov-po-obektam-ukrainskoi-infrastruktury>.

In a likely attempt to maintain the estimated stock at around one hundred<sup>72</sup>, Russia's most modern *Kh-101* missiles were used in moderation up until this point. When they were indeed used in large numbers, it was as much as a matter of operational constraints (due to the need to strike deeply into Ukrainian territory), as it was a matter of symbolic importance. A case in point can be observed after 11 to 12 October 2022. The intensity of the new wave of attacks since then had decreased significantly. Mostly carried out by the remotely-operated ammunition of Iranian design, they were subjected to numerous interceptions by Ukraine's ground-to-air defence systems.

Moreover, in November 2022, a heavy number of strikes were carried out on Ukraine's energy infrastructure<sup>73</sup>. On 15 November<sup>74</sup>, the Ukrainian GAD system announced that it had intercepted seventy *Kalibr*<sup>75</sup>, *Kh-101*<sup>76</sup>, and *Kh-555* cruise<sup>77</sup> missiles<sup>78</sup>. This suggested that Russia maintained a low-intensity strike pattern, that was also punctuated regularly by a day of high intensity. *Tu-95MS* of the 121st and 182nd *TBAPs* and *Tu-160s* of the 121st *TBAP* were believed to have fired their cruise missiles from the Caspian Sea. The routes followed by these missiles (i.e. along the Polish and Moldovan border) can be concluded as attempts to bypass Ukraine's GAD system and increase the destructive impact on the country's energy infrastructure<sup>79</sup>. During these attacks, the *VKS* also concurrently engaged the *MiG-31BM*s stationed in Belarus and the *Su-35S*s carrying long-range air-to-air *R-37M* missiles<sup>80</sup>, in order to neutralise any possible Ukrainian fighter jets taking off to shoot down these missiles.

72. P. Butkowski. "Russia's Secretive Long-Range Bomber Operations Against Ukraine." *TheWARZone*. 14 September 2022. <https://www.thedrive.com/the-war-zone/russias-secretive-long-range-bomber-operations-against-ukraine>.

73. Reuters. "NASAMS air defense system have 100% success rate in Ukraine - Pentagon chief." *Reuters*. 16 November 2022. <https://www.reuters.com/world/europe/nasams-air-defense-system-have-100-success-rate-ukraine-pentagon-chief-2022-11-16/>.

74. M. Santora and T. Gibbons-Neff. "Russian Missile Barrage Cuts Power and Water Across Ukraine." *The New York Times*. 23 November 2022. <https://www.nytimes.com/2022/11/23/world/europe/russia-ukraine-missiles-power.html>.

75. Euan MacDonald. "Spectacular footage: Two Russian Kalibr cruise missiles shot down..." *Twitter*. 17 November 2022, 09:27. [https://mobile.twitter.com/Euan\\_MacDonald/status/1593158987800641536](https://mobile.twitter.com/Euan_MacDonald/status/1593158987800641536).

76. Ukrainian Front. "The first recorded video of the downing..." *Twitter*. 17 November 2022, 08:48. <https://mobile.twitter.com/UkraineRussia2/status/1593149005978292224>.

77. Reuters. "NASAMS air defense system have 100% success rate in Ukraine – Pentagon chief." *Reuters*. 16 November 2022. <https://www.reuters.com/world/europe/nasams-air-defense-system-have-100-success-rate-ukraine-pentagon-chief-2022-11-16/>.

78. Ukrainian Air Force. "Today, delivered a massive blow to energy..." *Twitter*. <https://twitter.com/KpsZSU/status/159265323276981248?ext=HHwWgMDQva3rmpoAAAA>.

79. T. Cooper. "Ukraine War, 17 November 2022: Surovikin's Billion-Dollar Strikes." *Medium*. 17 November 2022. [https://medium.com/@x\\_TomCooper\\_x/ukraine-war-17-november-2022-surovikins-billion-dollar-strikes-c5c91e781d0f](https://medium.com/@x_TomCooper_x/ukraine-war-17-november-2022-surovikins-billion-dollar-strikes-c5c91e781d0f).

80. Range announced by the manufacturer of 390 km delivered at high altitude.

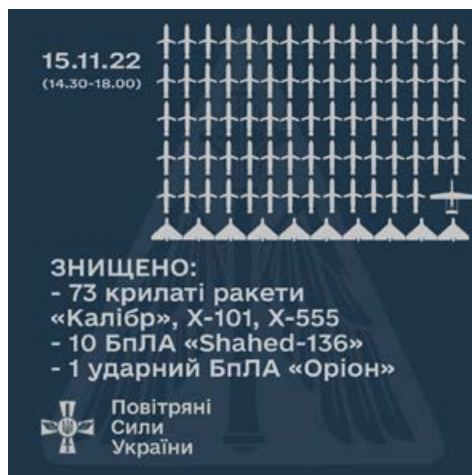


Figure 15: Computer graphics illustrating the aircraft destroyed by the Ukrainian Air Force on 15 November October 2022 between 14:30 and 18:00. © Ukrainian Ministry of Defence

In early December 2022, Ukraine resolved to leave their defensive posture and strike Russian bomber bases for a second time. During the night between 4 and 5 December, *Tu-141* drones with explosive charges hit both the Engels and Ryazan Air Bases<sup>81</sup>. Two impacts can be visibly detected in open-source images from Russia<sup>82</sup>. Ukrainian sources, on the other hand, indicate that two *Tu-95MS*s were hit at Engels<sup>83</sup>, while a *Tu-22M3* was damaged at Ryazan. Although, Ukraine regularly attacked Crimea and Taganrog with remotely-operated ammunition, the partially successful strikes on such distant targets housing the 22nd *TBAD* headquarters<sup>84</sup> (*Tu-160* and *Tu-95MS*<sup>85</sup>) and *Il-78* tankers is a first. Yet, in the hours that followed, the Ukrainian GAD was hit with 70 cruise missiles fired by *DA* bombers in a new wave of strikes<sup>86</sup>.

81. The New York Times. "Russia-Ukraine War: Ukrainian Drones Hit 2 Bases Deep in Russia." *The New York Times*. 06 December 2022. <https://www.nytimes.com/live/2022/12/05/world/russia-ukraine-war-news>.

82. D. Mosolkina et al. "ЧП на аэродромах в Саратовской и Рязанской областях. Что о них известно." *Vedomosti*. 05 December 2022. <https://www.vedomosti.ru/society/articles/2022/12/05/953785-aerodromah-saratovskoi-ryazanskoi>.

83. Avia. "Спутники зафиксировали на авиабазе ВКС России в Саратове стратегический бомбардировщик Ту-95 без части крыльев." *Avia.pro*. 07 December 2022. <https://avia.pro/news/sputniki-zafiksirovali-na-aviabaze-vks-rossii-v-saratove-strategicheskii-bombardirovshchik-tu>.

84. *Tyazholaya bombardirovochnaya aviatsionnaya diviziya*.

85. Forces.net. "Airbase attacks 'some of most strategically significant failures' since Russian invasion." *Forces.net*. 06 December 2022. <https://www.forces.net/russia/russian-airbase-attacks-some-most-strategically-significant-failures-force-protection>.

86. The New York Times. *art. cit.*



Figure 16: Satellite view of a *T-95MS* on the aircraft parking strip at Engels Air Base, taken on 5 December 2022. © SarahHa42, CNES 2022, Distribution AIRBUS DS<sup>87</sup>.



Figure 17: Satellite view of *Tu-22M3* at the Ryazan Air Base parking strip, taken on 5 December 2022 at 11:31 UTC. © ISI<sup>88</sup>

## The DA: Russia's Strategic Signalling Tool and the Armed Wing of Its Air Campaign

*The situation in war is extremely difficult to predict. For every war, it is necessary to develop a specific line of strategic behaviour, as each war is a specific case that requires a construction of its own specific logic, rather than a generalised application of a single model*<sup>89</sup>.

— Alexandre Svechin

87. Ukraine Weapons Tracker. "The aftermath of the recent Ukrainian long-range strike..." *Twitter*. 06 December 2022, 15:22. <https://twitter.com/UAWeapons/status/1600133489294118914>.

88. ImageSat Intl. "New Imagery of the aftermath..." *Twitter*. 05 December 2022, 20:54. <https://twitter.com/ImageSatIntl/status/1599854824127807488/photo/1>.

89. Editor's translation of a passage quoted by V. Gerasimov. "Ценность науки в предвидении." *Voenno-Promyshlennyyi Kurier*. 26 February 2013. [https://vpk.name/news/85159\\_cennost\\_nauki\\_v\\_predvidenii.html](https://vpk.name/news/85159_cennost_nauki_v_predvidenii.html).

From the first day of Russia's intervention into Ukraine, various types of bombers (*Tu-160*, *Tu-95MS*, *Tu-22M3*, *Mig-31I*) under the service of the *DA* have been mobilised to take down Ukraine's infrastructure in both its central and western regions<sup>90</sup>. During the earlier days of the conflict, the *DA* launched attacks with the aim of destroying infrastructures critical to the Ukrainian Armed Forces, including air defence systems (air platforms, aircrafts, ground-to-air systems, radars). However, Russia was unable to obtain air superiority due to the lack of a substantial SEAD<sup>91</sup> campaign. As a result, this conflict all but proves that the quest to secure air superiority must be pursued, not solely due to it being a dogma of air power, but rather, because of its capacity to induce an amplification effect of one's forces.

Moreover, the conflict demonstrates a clear application of cruise missiles. Namely, their use is limited to hitting fixed targets, whose coordinates are made known ahead of time during ground mission preparations. This does not include, however, any *de facto* mobile targets, such as equipment convoys. Contrary to the claims projected at the onset of the conflict, these cruise missiles have proven to be quite accurate<sup>92</sup>. The strike campaign during the opening phase of the conflict specifically targeted fixed ground-to-air sites (*SA-3*), *S-300* ground-to-air systems, command centres, air bases, and storage sites. The identification and selection of targets were carried out based on human intelligence that was either acquired by operators on the ground or by the Russian services in charge of collecting foreign intelligence (*SVR*<sup>93</sup>, *FSB*<sup>94</sup>, *GRU*<sup>95</sup>)<sup>96</sup>. Nevertheless, the Ukrainian forces' remarkably short response times, along with sufficiently advanced warnings, considerably reduced the effectiveness of Russia's first round of salvos launched at Ukraine's Integrated Air Defense System (IADS) architecture.

As the conflict raged on, Russia then redirected the focus of their operations to Donbass. With a more streamlined organisation of the material aid provided to the UAF, *DA* strikes also shifted their priorities to impeding the transfer of material equipment. In particular, they sought to damage communication routes. These targets mainly comprised arms production and maintenance factories, petrol depots, as well as roads and railways. From 10 October onwards, Russia shifted the basis of their target selection to energy infrastructures. Their strikes – whether they were carried out by cruise missiles (*Kh-101* or *Kh-555* and *Kalibr*), ballistic missiles (*Iskander*), or via remotely-operated munitions (*Shaheed-136* and *Shaheed-131*) – hit energy production buildings, such as coal or gas thermal

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90. G. Coulombel et al. "Russia's Use of Air Power: Early Lessons Learned from the First Month of the Conflict in Ukraine (24 February -24 March 2022)." *Vortex*, no. 3 (July 2022): 131-146. <https://en.calameo.com/cesa/read/006940288d34d5c710fcc>.

91. Suppression of Enemy Air Defense.

92. Between 3 to 10 metres.

93. *Sluzhba Vneshnei razvedki*.

94. *Federalnaya sluzhba bezopasnosti*.

95. *Glavnoe Razvedyvatelnoe Upravlenie*.

96. J. Bronk et al. *art. cit*.

power stations, hydroelectric plants, as well as electricity transmission networks with transformers and distribution substations.

This recent change in tactics came at the same time as Army General Sergei Surovikin's appointment (then commander of the *VKS* overseeing operations in southern Ukraine) on 8 October 2022 as the new commander of this "special military operation". The new wave of strikes brought forth sought to reduce – if not put to an end to – the Ukrainian war effort. However, it has yet to make a dent on Ukraine's morale (notably, the support of its population and the ability to federate internationally), nor the effectiveness of the Ukrainian troops.

Regardless, these strikes have nevertheless forced a complete mobilisation of Ukraine's air defence. According to the country's Ministry of Defence communiqués, fighter aircrafts (*MiG-29* and *Su-27*) and ground-to-air systems have reportedly intercepted a significant proportion of such missiles<sup>97</sup>. Despite so, for the Ukrainian Air Force aircrafts<sup>98</sup> to carry out these missions, they have had to fly into the range of Russian ground-to-air defence and interceptors (*MiG-31* or *Su-35S*) that were equipped with the latest *R-37M* long-range air-to-air missile. This inevitably resulted in quite the number of casualties<sup>99</sup>.

Conversely, Russia was also confronted with their own downfall, due to their insufficient ISR<sup>100</sup> capabilities, as well as the rigidity in their target selection and identification process<sup>101</sup>. Indeed a veritable challenge, Ukrainian systems were not only widely dispersed, but they also changed positions promptly after firing (known as "shoot and scoot")<sup>102</sup>. As such, the process leading to target designation could take up to more than 48 hours at a time. It was therefore more often than not that Russia's strategic bombers found themselves firing their cruise missiles with high precision, but at empty locations<sup>103</sup>.

The final point to be remarked on is the observation that *DA* bombers were occasionally redeployed several times from within Russia and abroad. This cannot simply be explained by the constraints of their engagement in Ukraine. For instance, *MiG-31*s seen in Syria at the Hmeimim Air Base and in Kaliningrad at the Chkalovsk Air Base<sup>104</sup> have been contributing to maintaining a strategic deterrent posture since February 2022.

97. OSINTtechnical. "Downed Russian Kh-101 cruise missile, Kyiv Oblast." *Twitter*. 22 October 2022, 18:49. <https://twitter.com/Osinttechnical/status/1583863209663950850>.

98. *Povitryani Syly Ukrayiny*.

99. T. Cooper. "Ukraine War, 22 October 2022." *Medium*. 22 October 2022. [https://medium.com/@x\\_TomCooper\\_x/ukraine-war-22-october-2022-7c2460746a7a](https://medium.com/@x_TomCooper_x/ukraine-war-22-october-2022-7c2460746a7a).

100. Intelligence, Surveillance, Reconnaissance.

101. T. Martin. "Russia's air campaign hampered by poor ISR based strikes and target processing: NATO official." *Breaking Defense*. 04 November 2022. <https://breakingdefense.com/2022/11/russias-air-campaign-hampered-by-poor-isr-based-strikes-and-target-processing-nato-official/>.

102. J. Bronk et al. *art. cit.*

103. *Ibid.*

104. T. Newdick. "Russian MiG-31s Armed With Air-Launched Ballistic Missiles Have Arrived In Kaliningrad." *TheWarZone*. 08 February 2022. <https://www.thedrive.com/the-war-zone/44205/russian-mig-31s-armed-with-air-launched-ballistic-missiles-have-arrived-in-kaliningrad>.

Yet, on 18 August 2022, the Russian General Staff announced that the *MiG-31*s being deployed in Kaliningrad were part of the implementation of additional strategic deterrence measures<sup>105</sup>. Said “additional strategic deterrence” was subsequently confirmed by a recent report of several *MiG-31*s landing in Mashulishchi in Belarus on 16 October 2022. Furthermore, these movements coincided with statements, announcing the deployment of four *Tu-160*s to the Olenegorsk Air Base along the Belarusian border on 21 August 2022<sup>106</sup>. They also harmonised with the publicity calling attention to two *Tu-95*MSs patrolling over the Pacific, the Bering Sea, and the Sea of Okhotsk on 18 October 2022<sup>107</sup>.

In conclusion, while the *DA* strategic bombers have indeed been mobilised in the war against Ukraine<sup>108</sup> – becoming thus the armed wing of the *VKS*, their original mission has not been abandoned. With various deployments that continue without fail, they are but a blatant reminder that Russia, nonetheless, remains a nuclear force to be reckoned with.

105. Tass. “Три истребителя с гиперзвуковыми “Кинжалами” перебазировали под Калининград.” *Tass*. 18 August 2022. <https://tass.ru/armiya-i-opk/15503715>.

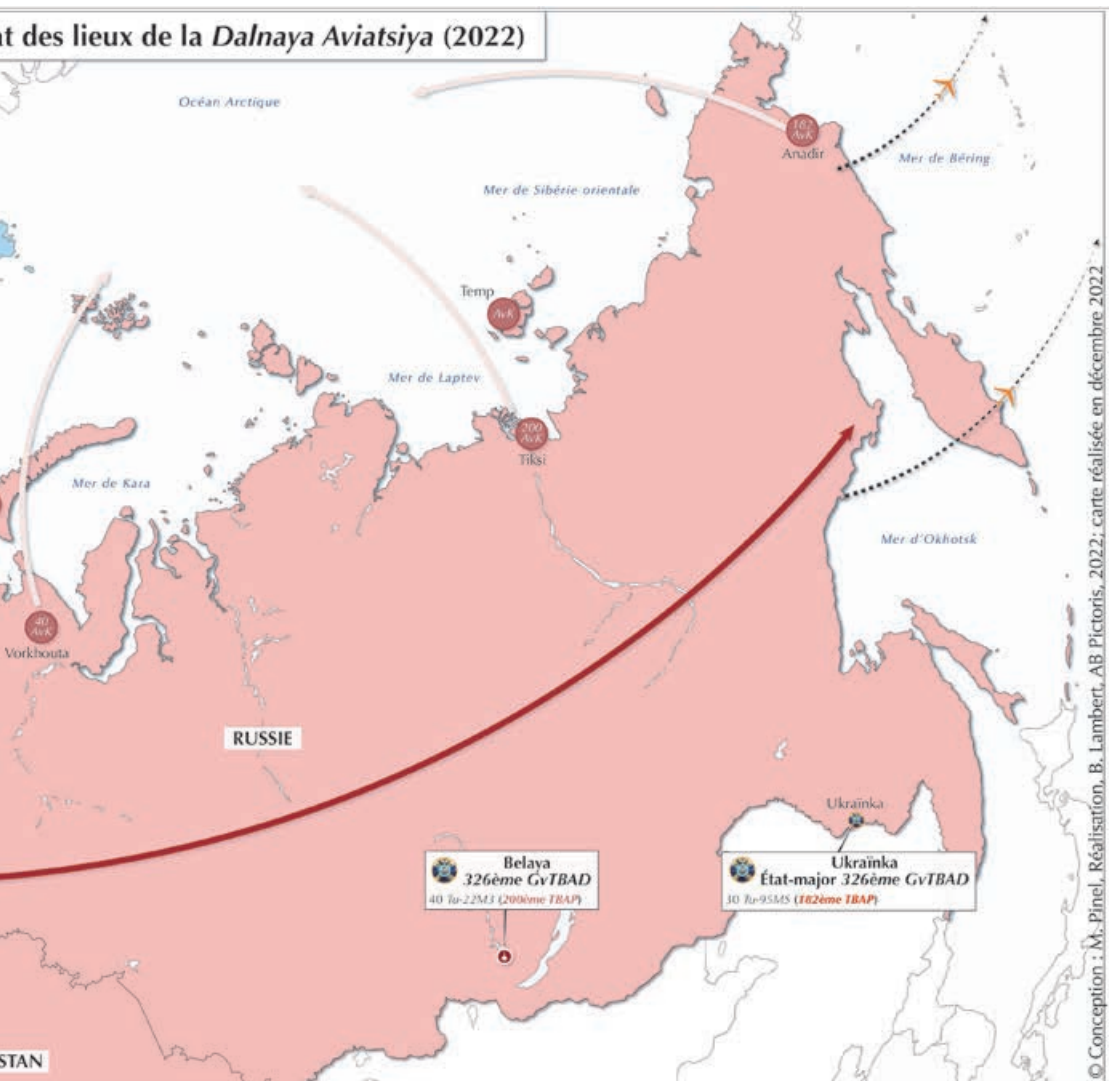
106. Avia. “Под Минском приземлились истребители МиГ-31.” *Avia.pro*. 16 October 2022. <https://avia.pro/news/pod-minskom-prizemlilis-istrebiteli-mig-31>.

107. Russian Federation, Ministry of Defense. “Два стратегических ракетоносца Ту-95МС ВКС России выполнили плановый полет над нейтральными водами Тихого океана, Берингова и Охотского морей.” *Mil.ru*. 18 October 2022. [https://contract.mil.ru/sel\\_contract/news/more.htm?id=12442089@egNews](https://contract.mil.ru/sel_contract/news/more.htm?id=12442089@egNews).

108. J. Trevithick and S. Tack. “Surge In Russian Bombers At Air Base Not As Unusual As Reports Claim.” *TheWARZone*. 01 December 2022. <https://www.thedrive.com/the-war-zone/surge-in-bombers-at-russian-base-not-as-ominous-as-media-claims>.



# et des lieux de la *Dalnaya Aviatsiya* (2022)



## Un maillage d'aérodromes permettant un déploiement sur tout le territoire russe

Des aérodromes de desserrement qui permettent le déploiement dans tout le pays

- Principale base aérienne
- Postes de commandement aérien (*Aviatsionnaya Kommandatura*, AvK) et aérodromes de desserrement

### Déploiement :

- Vers le Nord
- En longitude (d'un extrême à l'autre du territoire russe)

## La *Dalnaya Aviatsiya* à l'épreuve de la guerre en Ukraine

- Pays-membre de l'OTSC (+ Kirghizistan et Tadjikistan, hors cadre)
- Territoire ukrainien contrôlé et annexé par la Russie (annexion fin septembre 2022\*)
- Pays-membre de l'OTAN
- Déploiement de MiG-31 I en février 2022 à Kaliningrad
- Déploiement de Tu-160 et de Tu-95MS à Olenegorsk en septembre 2022, concomitant à l'emploi de la grammaire nucléaire russe
- Attaque ukrainienne par munition maraudeuse sur les bases aériennes de la DA en septembre et décembre 2022
- Déploiement de MiG-31 I en octobre et décembre 2022 à Machulishchy (Biélorussie)
- Patrouille de deux Tu-95MS au dessus du Pacifique le 18 octobre et le 14 décembre 2022

\*Oblast de Louhansk, Donetsk, Zaporijjia et Kherson; la péninsule de Crimée a été annexée en 2014



# Selecting Pilots of the French Air and Space Force

Frederic Choisy

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The French Air and Space Force (FASF) is composed of more than 40,000 air staff, fulfilling over forty or so professions throughout the force. As its objective, it seeks to "Discourage-Defend-Defeat: Succeed in 3D"<sup>1</sup>. In short, the FASF's *raison d'être* is to take action in the air while relying, to a large extent, on air operations. Amongst the many professions, the most well-known to the public are pilots – be it those of fighters, transport aircraft, helicopters, or remotely piloted aircraft. In order to ensure the diversity of FASF's missions, substantial institutional and individual investment is required to successfully train pilots with the necessary skill set. Indeed, the FASF spends around 400,000 euros alone to finance fighter pilot education programs<sup>2</sup>. This is without calculating the additional high costs incurred for training and instruction on actual aircrafts. Moreover, FASF pilot instructors are mainly employed internally, after being assigned from combat units. Many thus must undergo specific training to take on these new instructor positions. This is in stark contrast to the civil aeronautic

1. General S. Mille, Chief of Staff of the French Air and Space Force, "Discourage-Defend-Defeat: Succeed in 3D," *Æther: A Journal of Strategic Airpower & Spacepower* 1, no. 3: (Fall 2022), [https://www.airuniversity.af.edu/Portals/10/AEtherJournal/Journals/Volume-1\\_Issue-3/Mille.pdf](https://www.airuniversity.af.edu/Portals/10/AEtherJournal/Journals/Volume-1_Issue-3/Mille.pdf).

2. J.-J. Ferrara, "Avis fait au nom de la commission de la défense nationale et des forces armées sur le projet de loi de finances pour 2020 (no. 2272)," *Assemblée nationale*, 10 October 2019, [https://www.assemblee-nationale.fr/dyn/15/rapports/cion\\_def/115b2305-tvi\\_rapport-avis](https://www.assemblee-nationale.fr/dyn/15/rapports/cion_def/115b2305-tvi_rapport-avis).

industry, where companies hire qualified pilots, who have been trained mostly in private establishments. Hence, should pilots be considered as essential resources for FASF to complete their operational contracts, pilot recruitment then takes on a strategic nature. In essence, it is a question of choosing the candidate with the highest chance of success.

To highlight the importance of this issue, one needs to simply observe the fact that the practice of pilot candidate selection dates back to more than a century. Today, the stakes are precisely defined. This article will thus define these challenges, the qualities sought after in a pilot, as well as the methods used for pilot selection. Regulatory and ethical concerns will also be discussed, before finally presenting the prospects on how the selection process could continue to evolve.

### **The History of Pilot Selection**

In the early days of military aviation during the First World War, many countries developed their own pilot selection examinations. The first medical standards then appeared, defining successful candidates of having not only “very good eyesight and a robust constitution”, but also good sensory skills (e.g. tests were carried out under blindfolds)<sup>3</sup>. Progressively, new emphasis was also placed on psychological aptitude. From there, Italy became the first country to develop a set of tests that measured the perceptual speed, attention, and psychomotor coordination.

Nevertheless, it was only at the turn of the Second World War when studies enriching pilot selection practices began to flourish in numbers. Military leaders were becoming more cognisant of the operational reality and their challenges, which not only called for high-performing pilots, but also subsequent high costs in training them. In parallel, technological advances in the 1940s led to the development of precise and sophisticated aptitude measurement devices, which began to supplement the traditional “paper and pencil” exams. The first electro-mechanical devices for measuring psychomotor abilities (e.g. precision and reaction time) henceforth came into use. In addition, scientific research in psychology also highlighted the importance of assessing multiple abilities, inevitably extending selection processes considerably.

In France, although its Air Force’s research into psychology studies began in 1939, it was subsequently interrupted by the war. It did not resume until 1943 in Algiers, following the rise of a series of issues in candidate selection and recruitment for pilot training in the United States. Soon after in 1946, the *Service de sélection et d’orientation du personnel de l’armée de l’Air* (“Air Force Personnel Selection and Orientation”) was created. It then became the *Centre d’études et d’instruction psychologique de l’armée de l’Air* (“Air Force Centre of Instruc-

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3. Regarding this subject, see the comprehensive article by S. Champonnois, “Voler pour la patrie. Recrutement et formation des pilotes français entre 1914 et 1918,” *Nacelles, La Grande Guerre*, 28 November 2017, <https://revues.univ-tlse2.fr:443/pum/nacelles/index.php?id=332>.

tion and Studies in Psychology”) in 1953, before splitting in 1966 into the two following separate services:

- The *Service de sélection du personnel de l’armée de l’Air* (“Air Force Personnel Selection Service”): Responsible for carrying out methods for psycho-technical selection. From 2008 and onwards, it took on the name of *Centre de sélection spécifique Air* (“Specific Air Selection Centre” – hereafter “CSSA”), and reported to the recruitment office of the *Direction des ressources humaines de l’AAE* (“FASF’s Human Resources Directorate” – or “HRD”);
- The *Centre d’études et de recherches psychologiques Air* (“Centre for Studies and Research in Air force Psychology” – otherwise referred to “CERP’Air”): Develops testing and selection procedures to be implemented at the aforementioned CSSA above. Attached as an expertise centre to the FASF’s HRD in 2008, it then moved to the Tours Air Base 705 in 2012 following the rest of the CSSA, with which it continues to work in complementarity.

### **The Challenges in Military Pilot Selection**

The issues encountered by military aviation are complex and ever-evolving. Pilot recruitment, selection, training, and retention all pose serious challenges for several reasons. Firstly, the demand for FASF pilots remains high, yet the Air Force is projected to be understaffed in operational squadrons in a few years time. To recount, the FASF recruits each year on average of 70 to 80 *élèves-officiers du personnel navigant* (“aircrew officer-cadets” – hereafter “EOPN”) that are specifically designated to be pilots, as well as around fifty air officers recruited through the *École de l’Air et de l’Espace* (“Air and Space Academy” – or “EAE”). This is not to overlook that most military pilots are men. The appeal, it seems, to pursue a pilot specialisation remains low for women, who amount to only 8% of the EOPN selection. Proceedingly, the candidate pool is then again automatically reduced by 50%. Indeed, this gender ratio is unfortunately not a statistic unique to the FASF: professional female pilots in the civilian aviation sector make up only 5% in the entire world.

Beyond such, the profession’s practice has also evolved considerably. The advent of automation also took over the glass cockpits with digital displays replacing analog dials. Navigation and management of major failures are now handled by increasingly sophisticated flight management systems. This ultimately allows for greater manoeuvrability to develop more non-technical skills not directly related to piloting, including higher resilience, which is a military pilot’s most important asset. Such resilience is characterised by patterns of positive coping and adaptive behaviours upon or after critical confrontations with either an adversity or a risk. It also includes the ability to move beyond one’s normal, default state of calm.

A case in point are the recent geopolitical upheavals that have, again, brought to light for armed forces worldwide the need to remain prepared for high-in-

tensity conflicts. Specifically, the latter is inevitably forcing pilots to operate in more constraining and riskier environments than ever before. Increasingly more aware of these new elements at play, Command is also demanding higher psychological health standards for its pilots. As a result, the pilot selection process must also adapt its psychological assessment component, accordingly, to cover, on the one hand, a candidate's level of resilience, and on the other hand, their motivation level to enlist in the military. The FASF's pilots are therefore not only selected for their piloting skills, but also for their ability to integrate into military institutions.

Needless to say, efficient and thorough pilot selection (and training) plays a fundamental role in aviation safety, operational efficiency, and training costs. All in all, it contributes more broadly to maintaining the FASF's reputation in terms of its values of respect, integrity, commitment to service, and excellence.

### **Qualities Expected in a Future Military Pilot**

The main challenges in military pilot selection directly correlate with the diversity of areas requiring specific skill sets or qualities. A large number of scientific studies on selecting pilots in general, as well as military pilots in particular, have already been published<sup>4</sup>. All major air forces have a comprehensive selection process where candidates are assessed in many areas through a multi-stage process, of which most include eliminations. While some institutions use contractors (e.g., the Royal Air Force [RAF] with Babcock), others have military experts developing the tests and selection procedures (e.g., FASF, United States Air Force [USAF], and the Luftwaffe). Comparing the selection practices of the various different air forces reveal many similarities in the cognitive skills measured.

Nevertheless, there still exists differences in the methods used or in the personal qualities examined during group tests or individual interviews. For instance, the USAF and the RAF have a fixed system to assess psychomotor skills using a computer equipped with a keyboard, mouse, joystick, and rudder controls. In contrast, the FASF uses its *Système d'évaluation des candidats pilote* ("Pilot Candidate Assessment System" – or SECPIL), which is a mobile evaluation device with two axes (pitching and rolling). Despite the differences across the three countries, the focal point of the evaluation is not a question of simulating flight. Rather, it is measuring specific aptitudes while candidates follow precise instructions through several sequences of visual or sound stimuli. The qualities sought

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4. M. Martinussen, "[Psychological measures as predictors of pilot performance: A meta-analysis](#)," *The International Journal of Aviation Psychology* 6, no. 1 (1996): 1-20; J. S. Campbell et al., "[Meta-analysis of personality assessments as predictors of military aviation training success](#)," *The International Journal of Aviation Psychology* 20, no.1 (2009): 92-109; and D. L. Damos et al., "[Knowledge, skills, abilities, and other characteristics for military pilot selection: a review of the literature](#)," *Technical report AFCAPS-FR-2011-0003* (Randolph AFB, TX: Air Force Research Center, 2011).

after are divided into two main assessment categories – cognitive and psychomotor skills on the one hand, and soft skills and motivation levels on the other. An extensive study on expert opinions (i.e., qualified pilots) and statistical analyses that tie EOPN selection results to training scores were carried out to identify the exact qualities to look for during assessments. This eventually led to an overhaul in the EOPN selection process in May 2018.

### *Cognitive and Psychomotor Skills*

As detailed previously, the study of cognitive and psychomotor skills has been a mainstay of pilot selection since World War II. The relationship between these skills and pilot performance has been verified through extensive research studies. A meta-analysis<sup>5</sup> carried out in 2011 highlighted the skills considered to be the most important to pilots. These are spatial orientation, perceptual speed, numerical reasoning, time sharing, selective attention, precise control of movements, and coordination of limb movements (see glossary of terms in Table 1).

Beyond these main skills, subject-matter experts unanimously include other mental processes required for success, such as decision-making (speed and relevance) and situational awareness. These processes, according to the scientific literature, are sequences of operations that call for a set of transverse skills. In addition, pilots have agreed that these qualities are considered less important as a selection criteria because they can be developed during training, which is again confirmed by the literature (e.g., a study carried out on F-15 pilots<sup>6</sup>). In short, as important as these may be, it is rather unrealistic to attempt to assess the situational awareness or decision-making abilities of pilot candidates, who have just graduated the academy without the opportunity to hone such skills.

In addition to these newer elements, other additional skills specific to FASF pilots were also identified. A 2017 CERP<sup>7</sup> Air study of more than 500 flight crew members highlighted the importance of possessing high speed of closure, prioritisation skills, and cognitive flexibility (see Table 1). Without divulging too much information, it can be assumed that such cognitive abilities are or will be incorporated into the first two stages of the EOPN selection process (see Figure 1). Experimental tests for these skills are currently being approved and finalised, including but not limited to attention tests, speed of closure tests (the ability to quickly organise information or objects that have no apparent order), and prioritisation-mental flexibility tests.

Pilot candidates, who attend the EAE competitive examinations to apply for the pilot specialisation, do not need to go through the selection process like other EOPNs must do. Regardless, during their first year at the EAE, they would ne-

5. Meta-analysis is a compilation and synthesis of various studies that already exist on a given subject. It consolidates and clarifies the conclusions drawn from various studies.

6. T. S. Carretta et al., “[Prediction of situational awareness in F-15 pilots.](#)” *The International Journal of Aviation Psychology* 6, no. 1 (1996): 21-41.

vertheless undergo the same tests from both Stage 1 and 2 of the EOPN selection process. The results are analysed qualitatively by the CERP'Air and are reviewed during the pre-orientation commission<sup>7</sup>, which is held during the EAE program's third year. Should training results hint at a high chance of failure, students are given the option to transfer to another corps (i.e., mechanics or bases).

### *Soft Skills and Motivation Levels*

To reiterate, the highly technical nature of a pilot's occupation forces the pilot selection process to also focus on assessing cognitive and psychomotor skills. Such tests have proven to have high predictive validity, warranting the confidence placed in them. Yet specifically, it can also be said that pilots operate in a social setting since they always work in a team. Pilot cadets, similarly, also endure long, complex training periods under various high-stress constraints. It is thus unsurprising that recent studies have come to highlight the importance of non-cognitive qualities in a pilot's performance – in other words, their soft skills. Individual characteristics such as personality, social skills, values, and interests shown towards the profession have been identified to be equally pertinent in candidate selections. Indeed, once piloting skills have been acquired, any gaps in performance levels between individuals can then be narrowed down to their non-technical skills, which are highly influential in ensuring safe and efficient flight operations.

To explain, soft skills are underpinned by personality, such as one's behaviours and attitudes. As a result, a substantial number of studies affirm the importance of taking soft skills into account in both pilot and military personnel selection (e.g. communication, stress management, and self-confidence)<sup>8</sup>. A comprehensive meta-analysis on the personality traits related to military aviation training success reveals that extroverted and emotionally stable individuals are more resilient to the program's high-level of stress. Specifically, they are more energetic, experience more positive emotions, and tend to seek stimulation and companionship from others. On the contrary, low emotional stability reflects a tendency to easily experience unpleasant emotions, such as anger, concern, or depression, coupled with low self-esteem and a pessimistic attitude.

These observations can be further expanded on with more specific personality traits, such as self-achievement, grit, or psychological capital. Self-achievement – or commitment and a sense of control and challenge – allows the individual to learn from stressful events by setting new goals to overcome one's obstacles.

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7. The pre-orientation commission is chaired by the Commander of the Air Staff Training School; it bases its decisions on the student's aptitudes (the CERP'Air tests), their performance at the EAE and during the glider training course.

8. F. Choisy, "Le capital psychologique des militaires, une ressource personnelle majeure dans le contexte de l'armée de l'Air et de l'Espace" (PhD dissertation, Université de Tours, 14 December 2020); and K. J. Reivich et al., "[Master resilience training in the US Army](#)," *American psychologist* 66, no. 1 (2011): 25.

Grit involves working diligently towards success over long periods of time despite any failure, adversity, and stagnation encountered along the way. Psychological capital refers to an individual's positive psychological state of development, which is characterised by high levels of optimism, resilience, hope, and self-efficacy.

Joint FASF-Navy research is underway to expand the measurement spectrum of the current personality inventory used by these armed forces. Additionally, during the aforementioned CERP'Air 2017 study, subject-matter experts also distinguished between qualities required immediately of a candidate, and those that can be honed later on, such as organisational skills, leadership, or autonomy. These last two, for instance, while unnecessary during training, should nonetheless be developed after the new graduate joins a squadron. Such criteria are therefore not prioritised in candidate selections, where the average age is currently 22 – an age where most have never had the opportunity to develop these skills previously.

The EOPN candidate's personality is explored during two individual interviews in Stage 3 of their selection process. Each candidate is interviewed successively by firstly, a jury composed of two pilots, and then by a CERP'Air psychologist in the second jury. Moreover, these interviews also simultaneously assess the candidate's professional objectives and motivations. Indeed, considering the events of this past decade (e.g., the interventions in Afghanistan, Mali, and Iraq/Syria, as well as the Russian-Ukrainian conflict), subject-matter experts have been forced to forgo the distinction between being passionate about aeronautics and being motivated to enlist in the military. In front of the panel of qualified pilots, candidates need to demonstrate that they have wholly digested the military pilot's singularity as one being both the instigator and victim of death.

As for social skills, these are commonly divided into two components. The cognitive component refers to the analysis and understanding of social situations and interpersonal relationships. The behavioural component, on the other hand, refers to the behavioural patterns that allow for the appropriate management of social situations and effective influence of others' responses onto oneself. Needless to say, pilots not only need strong communication and cooperation skills, but also leadership. Post-incident or -accident analyses and air safety investigations have often revealed that air missions may have been compromised by crew members who either lacked assertiveness or had communicated poorly. At other times, however, neither the initial training nor flight experience accumulation can be enough to develop strong social skills. While the introduction of cockpit resource management (CRM)<sup>9</sup> in the 1990s did partly make up for this shortcoming, it is still necessary to ensure that candidates possess satisfactory levels of these qualities from the first point of selection or, at *a minima*, have no underlying prohibitive traits.

9. Cockpit Resource Management (CRM) is a set of procedures for aircrew training in order to prepare them to operate in environments where human error can induce devastating effects.

Within the EOPN selection process, such qualities are also assessed in its third stage (see Figure 1). This is carried out through a group test where different observers analyse the behaviour of 4 to 8 candidates involved in solving a complex problem (e.g. one with a lot of data and several possible solutions). Indeed, how the group functions directly results from the interaction of all its members in a given environment. Further, an individual may behave differently depending on the composition of the group (e.g. a “toxic” member) or the subject type (e.g. poor data assimilation). This group test is therefore not so much selective as it is in providing insight for the psychologist. These observations can then be later addressed during the individual interviews.

To conclude on the qualities expected of a military pilot, it may indeed be relevant to identify future fighter or future transport pilots, starting from the selection process. For instance, the 2017 CERP’Air analysis revealed that there was a strong consensus between the pilots of both aircraft types in regard to the ten top-most qualities required of a pilot. Thus, there would be no real gain in efficiency by being too restrictive at the recruitment stage. Furthermore, integration into the FASF, initial training, and participation in motivation courses can develop certain qualities in students, such as commitment for a particular specialisation, teamwork competencies, or the ability to manage stress.

As for the EAE students’ soft skills and motivation levels, they are to be evaluated during the EAE competitive examinations (comprising a jury chaired by a general officer who is assisted by a senior officer, as well as a CERP’Air psychologist). Throughout the rest of their school years at EAE, the students’ behaviours would continue to be assessed. The sum of the data is then finally compared during the pre-orientation commission.

### **The Focus of Psychotechnical Tests**

The EOPN selection process consists of numerous cognitive and psychomotor tests intended to assess the skills required of candidates. Should a specific aptitude be measured, this reflected the necessity of said aptitude for professional success. This then translated, for example, to the unanimous agreement of a panel of experienced pilots on the subject or to the full support from the evidence-based scientific literature. The next step would be to find a mean to accurately measure this aptitude, either by using an existing “off-the-shelf” test and procuring it, or by developing it in-house. CERP’Air, for one, creates its own tests. This provides the advantage of being able to adapt assessments to a target population. In addition, the costs (often 10 to 30 euros per test) can be greatly reduced.

In detail, different rules govern the development of a test, which is divided into several stages, spread over 2 to 3 years<sup>10</sup>. Specifically, only the questions

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10. Please refer to the infographic in Figure 1 at the end of this article.

that are neither too difficult (less than 20% success rate) nor too easy (less than 20% failure rate) are retained for the test's final version in order to maximise its efficacy in screening suitable candidates. Indeed, it would be much too difficult to decide which candidates would move on to the next stage if all were to have the same scores on a given test. In addition, the tests are standardised, making it possible to situate an individual's results in relation to a reference population. For example, it allows for the quick observation that the performance of Candidate so-and-so is ranked in the top 40% percentile on a given test. The standards therefore establish reliable and fair thresholds in the selection process.

To end, the last step in validating a test is verifying its ability to predict professional success measured by the relevant criteria (e.g. flight scores). The stronger the correlation between the test score and the performance criterion, the better the predictive validity. As the EOPN selection procedure involves several tests of high predictive validity, the scores of these different tests were further analysed to combine the scores with data derived from statistical calculations. The predictive potential of the selection process can then be maximised. For instance, the EOPN selection's psychotechnical tests account for 26% of the success of the pilot trainee's core curriculum – with the remainder being a reflection of the individual's non-technical qualities (e.g., soft skills, motivation levels, social integration, etc.) or of external organisational factors (e.g., quality of instruction). It is also of interest to note that the RAF and USAF selection assessments have similar predictive validity to the FASF.

### **The Selection Process**

To recount, the preceding sections have introduced the various necessary aptitudes for candidate assessment, as well as the selection process itself. The latter is organised into three stages of which the first two serve the purpose of eliminating and narrowing down the candidate list (see Figure 1). The demand to administer a large number of tests to a substantial influx of candidates eventually led to the establishment of the Assessment Centre. For EOPN selections, all human and technical resources necessary for candidate assessment take place at Air Base 705 in Tours in two units. CERP'Air develops procedures and tests, then prepares recruitment commissions to guarantee assessment reliability and fairness. The CSSA, in parallel, manages assessment schedules, welcomes and directs candidates, as well as ensures the smooth running of the process (e.g. taking computerised tests, managing candidates on site, providing information to candidates, etc.).

The candidate lists of those who have completed both the third and final selection stages are subsequently reviewed by the recruitment office board, which convenes for 4 to 5 sessions a year. The commission may authorise, according to specific criteria, candidates to retake certain tests (e.g. exams on aeronautic knowledge), or even to undergo all of Stage 3 again (e.g. in the case of a candi-

date scoring high on psychotechnical tests, but demonstrating a lack of social aptitude during the interview; or in another case where there is a drastic difference between the results from the psychological assessments and the ones before the jury of professionals). Psychometric tests (i.e. cognitive and psychomotor skills), on the other hand, cannot be retaken, since a second round would defeat the purpose of spontaneity and surprise (e.g. candidates may have memorised some of the questions during the first round and/or adopted of a better strategy to take the test the second time).

As such, the purpose of any selection system is to identify and retain the best candidates. Nevertheless, this objective should not be referred to in absolute adherence, but rather, relativised to changing factors that emerge in practice. In fact, a selection system that is overly preferential to high scorers may yield a shortage of successful candidates in relation to the target set by human resources, resulting, in the long run, to a shortage of pilots in squadrons. This would ultimately prevent the FASF from fulfilling its operational contract. Conversely, too much leniency in the selection process with low elimination thresholds would generate more shortcomings in training or practice. This would be cause to implement additional flying hours, mobilising more instructors, and undermining the training system overall. It is therefore necessary to strategically identify the threshold between elimination and selection to not only cultivate forces in quantity (i.e., targets) but also quality (i.e., success). Moreover, this fine balance may be upset at any time by external circumstances (e.g., high HR requirements in squadrons, raising the difficulty in training, etc.). A flexible and responsive selection system is therefore needed to rapidly adapt to any emerging element so that recruitment remains not only strategic, but also resilient.

In this respect, regulations for the selection process have evolved in a restrictive manner. As of today, there are two main frameworks that govern recruitment practices, namely the General Data Protection Regulation (GDPR) and the Labour Code. The GDPR applies first and foremost to any entity processing personal data, i.e. information relating to a natural person who can be identified, either directly (e.g. by name) or indirectly (e.g. via their *Numéro d'Identification Défense* – in other words, their military service number). Essentially, the GDPR aims to enforce several key protective principles aimed at the non-consensual use of personal data (e.g., being exploited for discriminatory practices or non-professional uses). The GDPR hence requires the recruiter to comply with a number of administrative formalities and to put in place documented and regularly updated procedures (e.g. keeping a register of processing activities, data protection impact assessments, etc.).

The Labour Code sets the legal framework within which all recruitments must operate. In particular, it imposes three main principles: 1) the relevance of the information gathered (e.g. a necessary and direct relation to the occupational skills assessed); 2) transparency (e.g. informing the candidate about the methods used during recruitment); and 3) relevance of the methods with regard to the

purpose pursued. The first two principles demand for a scientific approach or methodology to the selection process, such as the one presented earlier in this article. In addition, the recruiter must also be able to prove that they have the right to carry out an assessment procedure on candidates for a specific position. Finally, candidates must now be informed when they take experimental tests. This consequently results in lower engagement as there would be less at stake for the candidate than if the tests were to involve eliminations. Needless to say, this inevitably affects the quality of the data collected. Likewise, more time would need to be invested in developing more effective tests under these conditions.

## Prospects for Further Development

Aviation has undergone a meteoric technological boom, despite the marginal evolution of a pilot's basic skills. In parallel, recruitment methods are currently undergoing significant innovations with the advent of big data and digitalisation. However, consideration for human factors and compliance with regulations must be well balanced against disruptive tendencies that may oftentimes be detrimental and without return. The objective of military pilot selection must be first and foremost to remain efficient and resilient while capitalising on all existing and future tools and methods.

### *Contributions and Limits of Artificial Intelligence*

Artificial Intelligence (AI) provides the promised dual benefit of screening candidate applications more efficiently via the use of programs and apps. In turn, this allows recruiters to focus on more value-added tasks. In the context of psychological assessments, AI enables predictive assessments with the possibility of anticipating and identifying a potential candidate's behaviour in relation to a specific position (such as an automatic filtering of resumes). In technical terms, algorithms would process the information available online – either from social networks or a submitted resume – before organising the information gathered into an synthesised report. In addition, start-ups are already developing tools for analysing video recruitment interviews based on keywords and body language. The objective is to efficiently provide a list of relevant candidates to recruiters.

Yet, despite such appealing and potentially useful contributions to the recruiter within a framework of reasonable use, the risk of dehumanisation and discrimination remains prevalent. For the armed forces especially, it is vital that future soldiers are recruited in the most morally humane way possible, especially as cohesion, mutual aid, and a sense of humanity are amongst the cardinal values of military institutions. Robert Walters' 2018 white book entitled, *Recrutement et intégration des talents : Quelle place pour l'innovation ?* ("Talent Recruitment and Integration: Where Does Innovation Fit In?"), estimated that 62% of candidates felt that the use of AI in recruitment presented a risk of dehumanisation and exclusion of "outside-the-box" individuality. The main concern for candidates

were that decisions would be made by technology without human supervision, or that candidates could be eliminated due a poor score following a video interview, which lacks human interaction.

Furthermore, AI also runs the risk of recruiting candidates of similar, “cookie-cutter” profiles. Indeed, algorithms can sometimes discriminate applicants – a case in point being Amazon’s recruitment software that excluded women. For an algorithm to be reliable, it must be developed from a gross amount of not only candidate data but also employee data (or pilots in this context). However, the annual training influx of FASF pilots is too low to satisfy such statistical criteria to develop reliable AI. Such relies on processing a bulk collection of data from years of training. Yet, contrarily, this holds the risk of generating a heterogeneous pool due to outliers (e.g. changes in training programs, reductions in flying hours) and therefore, again, produces biased conclusions. Finally, the GDPR requires that a fully automated decision using algorithmic processing be subjected to an impact analysis due to risks identified by the legal authority, such as depriving one’s rights or discriminating against certain groups. AI should therefore only be considered as a complementary tool to existing selection methods, which have already been proven to be reliable.

#### *Towards an Improved and Adaptive Pilot Selection Process*

The SECPIL’s developmental growth also raises questions. Playing a central role in EOPN selection, it enables the assessment of attention capacities, psychomotor finesse, as well as learning capabilities. Nearing forty years since its establishment, its means of aptitude measurement remains pertinent with strong statistical linkage to training results. Nevertheless, this system still has its weaknesses, and thus requires to be replaced in the near future. The technology is undoubtedly outdated and sometimes requires reverse engineering for replacement parts. The only ones possessing the specific skills required for maintenance are the technicians who are close to retirement. Moreover, with only two cabins, the SECPIL cannot take in and assess all the candidates on the first day, invalidating its suitability to host even the first stage of the selection process. More critically, in the event of a major geopolitical upheaval demanding the FASF to drastically increase its fleets and pilot numbers, the minimal number of cabins would not be able to take in a sudden large influx of candidates. The current war between Russia and Ukraine demonstrates that such a high-intensity situation is indeed a plausible scenario.

Beyond the replacement of the SECPIL as a selection tool, the CERP’Air is part of a more global project aimed at increasing the recruitment capacity of FASF pilots in both quality and quantity. In parallel to the research endeavours to replace the SECPIL (e.g. eye-tracking experiments<sup>11</sup>, comparisons between the use of mobile and static cabins, etc.), the CERP’Air envisions to modify its

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11. Eye-tracking is a set of techniques to record eye movements.

building infrastructure in order to double the capacity of its computerised tests (i.e., from 24 to 50 stations), increase the number of SECPIL NG cabins from 2 to 12, and build two additional interview rooms. These upgrades allow for the assessment of more candidates per session, while reducing their assessment period by one day (a quantitative gain), thereby overall improving the candidate experience. All candidates would then henceforth take the “SECPIL NG” test, as opposed to the current situation, where only 40% of the yet-to-be-eliminated candidates would take said test.

Lastly, should SECPIL be dissolved without an alternative replacement, flight crew training institutions would be forced to reintroduce in-flight selection, which requires acquiring designated aircrafts (for potentially up to 700 flight hours a year), as well as instructors, who, today, are both scarce and high in demand. In the case where there is neither the SECPIL nor in-flight selections implemented, the FASF’s operational capacity will take a detrimental hit due to training difficulties and graduation delays.

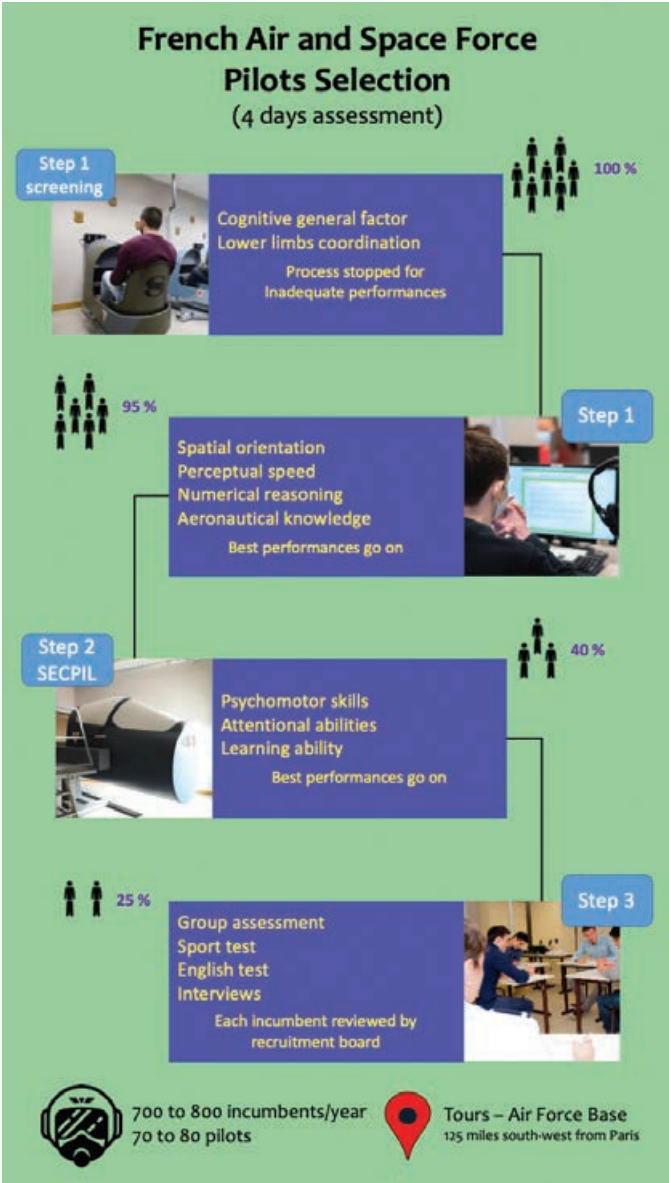
## **Conclusion**

The history of France’s military pilot selection can be traced back to the First World War with the birth of military aviation. The challenges encountered then persists to this day: recruiting candidates with the qualities to succeed in the long term in this profession, as well as absorbing the high costs required to finance pilot training. As illustrated in this article, the selection process is based on scientific methodology drawing its data from the field (via e.g. subject-matter experts), research literature, as well as from data gathered over the years by CERP’Air (e.g., test results, scores at different stages of training, etc.). A foundation built upon evidence-based science is required to secure efficacy. Beyond this aspect, the FASF has an inherent duty to carry out fair and efficient candidate assessments adapted to the profession’s needs. At the same time, institutions also, in turn, are increasingly being assessed on the “candidate experience” they provide. Finally, the discussions regarding further enhancing the selection process highlighted not only the need for continuous improvement but also for heightened resilience by moving towards an increased evaluation capacity in quantity and quality.

It is of interest to lastly note that to date, very few institutions have experience in psychologically assessing candidates in a manner that covers a wide range of aptitudes, including but not limited to cognitive skills, personality traits, psychological health, teamwork skills, or even decision-making. Thus, a complex selection procedure is still a necessity that cannot be avoided for the FASF. The objective is not only to have the forces occupied with reliable and competent personnel, but also to avoid the dreadful personal disappointments due to a lack of flight progress. This is often a traumatic experience for the apprentice pilot, who assumes that perhaps, their wings have been forever broken.

For more information on the FASF’s pilot selection events, please register and login to [devenir-aviateur.fr](https://devenir-aviateur.fr) and refer to the various presentation videos featured<sup>12</sup>.

Figure 1: French Air and Space Force Pilots Selection Stages



12. Ministère des Armées, “Tests d’évaluation pour les pilotes et les navigateurs officiers systèmes d’armes,” *Devenir-Aviateur*, Accessed on 4 October 2022, [https://devenir-aviateur.fr/les-tests-devaluation-pour-les-pilotes-et-les-navigateurs-officiers-systemes-darmes?gclid=CjwK-CAjwvsqZBhAIEiwAqAHEleqyoolpffYwMvSHw5VoK3UVQ05i\\_EDPefCMtajPI1feqQS5Kot-mdhoCYJoQAvD\\_BwE&gclid=aw.ds](https://devenir-aviateur.fr/les-tests-devaluation-pour-les-pilotes-et-les-navigateurs-officiers-systemes-darmes?gclid=CjwK-CAjwvsqZBhAIEiwAqAHEleqyoolpffYwMvSHw5VoK3UVQ05i_EDPefCMtajPI1feqQS5Kot-mdhoCYJoQAvD_BwE&gclid=aw.ds).

Figure 2: Test Design

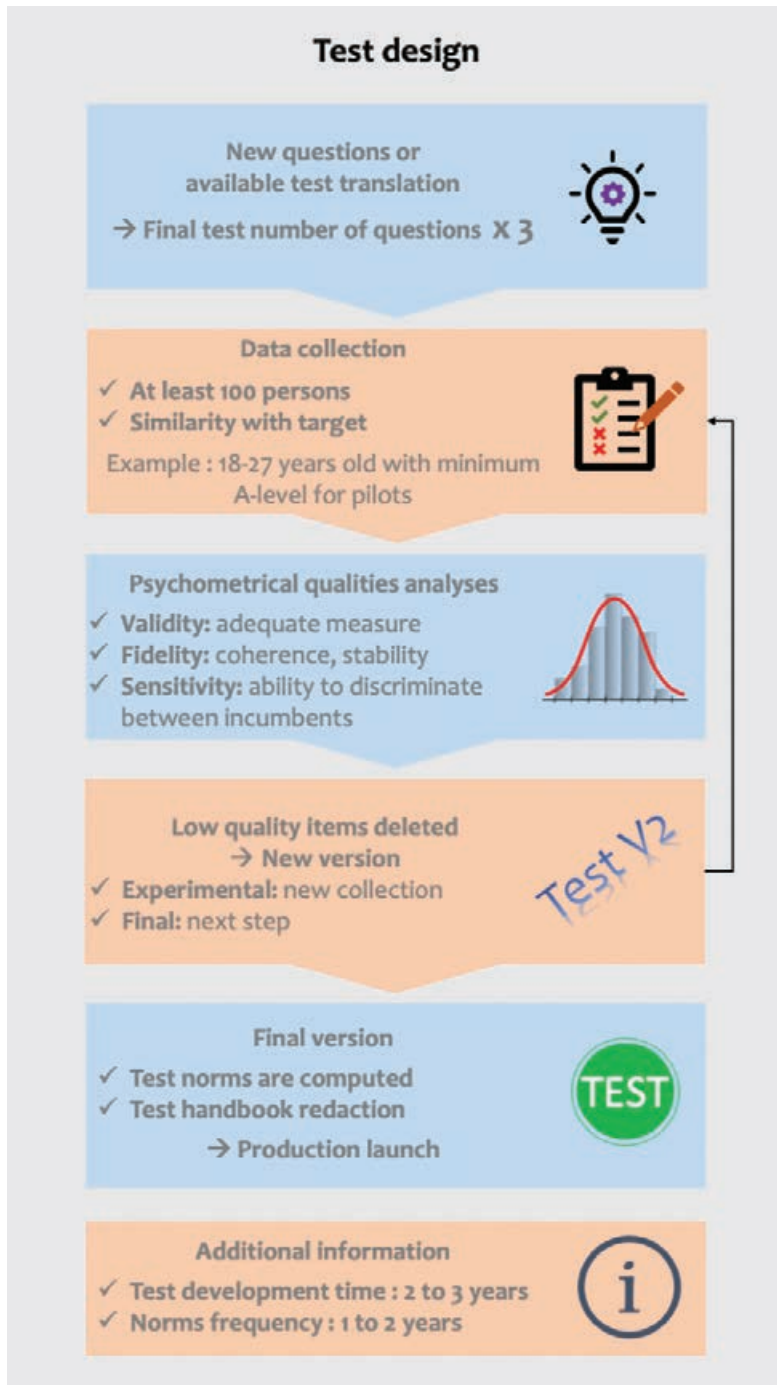


Table 1: Glossary of Pilot Abilities

Abilities	Definitions
<b>Spatial orientation</b>	Ability to tell where you are in relation to the location of some object or to tell where the object is in relation to you.
<b>Perceptual speed</b>	Ability to compare letters, numbers, objects, pictures or patterns, quickly and accurately. The things to be compared may be presented at the same time or one after the other. This ability also includes comparing a presented object with a remembered object.
<b>Numerical reasoning</b>	Ability to understand and organize a problem and then to select a mathematical method or formula to solve the problem. It encompasses reasoning through mathematical problems to determine appropriate operations that can be performed to solve problems. It also includes the understanding or structuring of mathematical problems.
<b>Time sharing</b>	Ability to shift back and forth between two or more sources of information.
<b>Selective attention</b>	Ability to concentrate on a task one is doing. This ability involves concentrating while performing a boring task and not being distracted.
<b>Manual dexterity</b>	Ability to make skillful coordinated movements of one hand, a hand together with its arm, or two hands to grasp, place, move or assemble objects, such as hand tools or blocks. This ability involves the degree to which these arm-hand movements can be carried out quickly. It does not involve moving machine or equipment controls, such as levers.
<b>Motor Coordination</b>	Ability to coordinate movements of two or more limbs (for example, two arms, two legs or one leg and one arm), such as in moving equipment controls. Two or more limbs are in motion while the individual is sitting, standing or lying down.

# Space: The Continuation of an Economic, Technological, and Financial War

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Space assets, from the time of their development in the early 1960s, have been profiled for their stabilising function in preventing conflicts. The Cold War is a classic paradigm where the risk of nuclear conflict between the two great powers was tightly contained thanks to its exploitation. Indeed, one of the first functions of satellites was to monitor and measure the adversary's arsenal in order to assess their degree of readiness. The Gulf War, subsequently, shed light on the broad spectrum of missions that space systems could perform during a conflict or crisis.

Among these systems, those that can observe, listen, communicate, navigate, and alert are considered the most critical to the defence and security of national interests. As illustrated by the *Centre d'études de recherche internationale de Paris* ("Centre for International Research Studies in Paris"), such complex and technical programmes have been primarily developed under the auspices of public funds – either via military or a related contracting authority – and advanced most markedly by the United States and the Soviet Union<sup>1</sup>.

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1. B. de Montluc. "Les enjeux de l'espace après la guerre froide." *Les Études du CERI*, no. 44 (September 1998): 9. <https://www.sciencespo.fr/ceri/sites/sciencespo.fr/ceri/files/etude44.pdf>.

In 2021, as made evident by the European Commission<sup>2</sup>, space activities today have become one of the main topics of concern amidst the competition between the world's superpowers and the European Union. From near and far, states are painstakingly scrambling, one after the other, to acquire sovereign capabilities, strengthen their strategic autonomy, and maintain a competitive edge in their national space industry. In this race to outrun the emerging challenges in both digital and other new technologies, the face of the space industry has been irrevocably changed with the mass influx of commercial players, giving birth to what is commonly referred to as "New Space"<sup>3</sup>.

Yet, commercial activities had existed long before the concept of New Space even entered the lexicon. The difference today lies in the meteoric amount of commercial contracts awarded by governments to the private sector that are swallowing the space field. To fulfil these mounting needs, numerous alliances are often created on an international scale that increasingly involve partnerships with private companies.

This article hence outlines a conceptual model by studying the evolution of "strategic technological alliances" formed between private and public institutions within the space sector. It presents the main issues and limitations of public-private partnerships in France. Further, it examines several public-private partnership governance models of the space sector that exist outside the European Union, from which France could draw inspiration and replicate. This perspective will allow, in particular, to situate the technological cooperation issues between the French Air and Space Forces and private companies – both domestic and international. This will then be followed by a corresponding provisional assessment. The conclusions of this article closes by alluding to a linkage between the performance of the French space ecosystem and the definition of a new collective strategy of technological alliances made between scrupulously identified partners.

## **New Space and Its Challenges:**

### *New Space: Defining a Constantly Evolving Ecosystem*

Satellite communication systems and GPS-type navigation systems, amongst a multitude of space sector technologies, contribute to the functioning of elements that make up today's daily life. Fueling this momentous progress are the remarkable expertise of private companies, start-ups, and public bodies, such as space agencies and research and development organisations

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2. European Commission. "Europe's space industry – competing globally in a complex sector." *European Commission*. 28 February 2013. [https://ec.europa.eu/commission/presscorner/detail/fr/MEMO\\_13\\_146](https://ec.europa.eu/commission/presscorner/detail/fr/MEMO_13_146).

3. New Space consists of private companies that act independently of public policy and space funding for the development of new space applications. See publications by Walter Peeters from the International Space University.

linked to the defence sector (e.g. DARPA, the Defense Advanced Research Projects Agency<sup>4</sup>). Mirroring rising societal needs, the space ecosystem has moulded itself accordingly by transforming its governance model. Notably, it has evolved away from its traditional model – where space innovations were born from the marriage of state and large private companies – to an integrative, multi-level governance model, characterised by the emergence of what has been coined, “New Space”.

Although there is no general consensus on the definition of New Space, the term is nevertheless widely used by the space sector’s various value supply chains. As such, there is a markedly distinct dichotomy between “old and “new” space. However, for the sake of coherence, this article will adopt Laurence Nardon’s definition<sup>5</sup>, which describes New Space as what has manifested from a meticulous mutation of the methods of strategic technological alliances formed between private entities and public organisations.

### *The Challenges of New Space*

With the coming of New Space came a transition in the traditional role of the field’s state actors. Historically, space innovation projects were financed with the funds that states had granted to supporting companies. Contrarily, in the contemporary New Space setting, funding pools in from multiple sources. A case in point is the European Commission, who works in close collaboration with the European Central Bank. The two provide financial support to start-ups, regardless of their status. Organisations, such as the European Defence Fund, are also projected to support more than 340 start-ups in the coming years<sup>6</sup>.

Alas, due to global competition, these initiatives – bred from more or less a palliative approach – do not guarantee success nor do they provide, as of yet, a new state governance model acclimated to New Space. Furthermore, New Space actors have quite the impregnating sphere of influence on both national space strategies, as well as those of the European Union. Consequently, alliances between different actors now raise new challenges for corporate decision-making.

This notion is prominently elaborated by writings published by David Teece<sup>7</sup> on innovation and alliances. Namely, he cautions that technological alliances are additionally made vulnerable to risks of intellectual property rights, technological inventions, and/or the hidden ulterior motives of other alliance partners.

4. DARPA is an agency of the United States Department of Defense.

5. Editor’s translation of L. Nardon. “New space : L’impact de la révolution numérique sur les acteurs et les politiques spatiales en Europe.” *Notes de l’Ifri*, (January 2017). [https://www.ifri.org/sites/default/files/atoms/files/nardon\\_new\\_space\\_2017\\_p.pdf](https://www.ifri.org/sites/default/files/atoms/files/nardon_new_space_2017_p.pdf).

6. This is according to the Multiannual Financial Framework 2021-2027 issued by the European Parliament and the in-depth analysis carried out by the European Parliament’s research department.

7. Researcher in the fields of corporate strategy and innovation, who, in 2002, was listed in the “Top 50 Business Intellectuals” by Accenture.

However, other writers construe the concept of strategic alliances differently, resulting in varying definitions<sup>8</sup>.

This article, specifically, will follow Teece’s definition, which establishes “strategic technology alliances” as “a constellation of agreements characterized by the commitment of two or more partner firms to reach a common goal, entailing the pooling of their resources and activities”<sup>9</sup>. He further explains that these long-term arrangements may take place between companies in either the same or different countries, and that may or may not be embodied into formal agreements. With his explanation, a matrix of numerous but non-exhaustive criteria has been developed to study and analyse the characteristics and players’ positioning within the New Space ecosystem (see Figure 1).

Partnership - Characteristics	Nature of the relationship				Share			Identity		Financial participation		Collaboration purpose		
	Formel	Not Formel	Long Terme	National / International	Risk / benefits	Project Management effectiveness	Resources	Existing Player	New Player	With	Without	Commercial	Technological	Research and development
Partner 1														
Partner 2														
Partner 3														
Partner 4														

Figure 1: Characteristics for defining strategic alliances<sup>10</sup>.

Vis-à-vis the technological effervescence of New Space actors, uncertainty and risks remain increasingly high. The industrial race to acquire the highest knowledge capital produced by private space companies and startups, represents an arduous challenge for France – and no less for European Union Member States. According to Teece, this has consequently increased the number of com-

8. F. Chesnais. *Les accords de coopération technologique et les choix des entreprises européennes: le cas des industries de haute technologie dans un contexte mondial de turbulence économique* (Paris: OCDE, 1987); H. Fusfeld and C. Haklisch. “Coopérative R et D for Competitors.” *Harvard Business Review*, (November and December 1985): 60-86; P. Mariti and R. Smiley. “Cooperative Agreements and the Organisation of Industry.” *The Journal of Industrial Economies*, vol. xxxi (June 1983): 437-451; L. Mytelka. *L’économie politique du regroupement stratégique d’entreprises* (Ottawa: Investissement Canada, 1987).

9. D. Teece. “Competition, cooperation, and innovation: Organizational arrangements for regimes of rapid technological progress.” *Journal of Economic Behavior & Organization* 18, issue 1 (1992): 19-20. [https://doi.org/10.1016/0167-2681\(92\)90050-L](https://doi.org/10.1016/0167-2681(92)90050-L).

10. Based on K. Jones. *Public-private Partnerships: Stimulating Innovation in the Space Sector* (El Segundo, CA: The Aerospace Corporation, April 2018). [https://aerospace.org/sites/default/files/2018-06/Partnerships\\_Rev\\_5-4-18.pdf](https://aerospace.org/sites/default/files/2018-06/Partnerships_Rev_5-4-18.pdf).

petitors at the international scale, who all strive to outrun the other. He also highlights that no matter how innovative a company is, it can be easily driven out of the market by new, emerging competitors or further technological breakthroughs. This is what he coins as the “overcoming knowledge gap”.

This article therefore addresses the question of how New Space’s sustainability and success depend on the public-private partnership governance strategy formed between space sector’s various actors. This is examined in two stages. Firstly, France’s space ecosystem and its governance is introduced. Subsequently, public-private partnership practices outside of the European Union are explored to highlight the priority of space for France. The article aims, in its closing words, to highlight the importance of technological alliance types adopted between public and private partners, as is the particular case for the French Air and Space Forces.

## **France: A Spatial Ecosystem of Governance under Public Domination?**

### *Strategic Alignment of Space Governance – A Priority for France*

As mentioned earlier in the introduction, technological progress and the digitisation of the last two decade’s economies have enriched the development of space policies. With the influx of new space sector actors, nearly every country currently has at least one satellite serving either a military, governmental, or civil purpose (or a combination of all three). According to Statista<sup>11</sup>, in July 2022, there were about 4,852 active satellites orbiting the Earth. Some of these assets consisted of enablers that multiplied military effects. This chapter briefly recapitulates – without venturing into too much detail – the existing civilian and military needs and means by field of use. It then explores the main factors that govern the notions of civilian and military duality, which place space on France’s primary axis of priority.

Evidently, the military domain is not the sole entity to which space is crucial. Rather, it is a field that heavily affects the economy, as well as current day-to-day life itself in broader terms. To grasp this significance, the daily lives of the French population is affixed to the influence of ten to forty satellites<sup>12</sup>. Thus, if the French space sector were to be threatened, a substantial portion of the French economy, and even Europe’s, could be in danger. Considering such a security issue, the French Ministry of the Armed Forces has devoted efforts alongside the *Centre national d’études spatiales* (“National Centre for Space Studies” or CNES) to jointly publish their 2019 Space Defence Strategy. Its objective serves to protect the interests of France and its citizens, while guaranteeing a free and autonomous access to space.

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11. German portal specialising in statistics and market intelligence.

12. According to a programme proposed by CNES with the French Ministry of Armed Forces, hosted by Stefan Barensky.

In terms of the military's interest in space systems, France is focusing on three main areas: (1) observation satellites (Optical Space Component or "OSC"); (2) listening satellites for electromagnetic intelligence gathering (CERES Space system : Space-based Signal Intelligence Capability); and (3), secure satellite telecommunications systems (SYRACUSE 4). Notably, at the International Astronautical Congress (held in Paris from 18 to 22 September 2022), French Prime Minister Elisabeth Borne announced a space sector investment of 9 billion euros over the course of the next three years. In addition, the country's *Loi de programmation militaire* ("Military Programming Law") is modernising all existing state satellite assets to secure strategic and technological advantages in the above three areas, while continuing its advancement in disruptive technologies<sup>13</sup>. Such decisions then directly or indirectly improve France's space industry. Namely, they provide the impetus to produce new, pioneering, and innovative systems. Space is therefore a clear priority for the French Armed Forces.

Of further interest, elaborating the strategy of managing space partners has become a considerable feat for the sector's industrialists, who compete to best position themselves within the national defence market. To summarise in broad terms, there are three types of strategies that characterise the approach followed by the different space sector actors (both historical and new entrants). Specifically, these strategies are the ones that have an impact on the proper conduct of the French Space Defence Strategy and its future roadmap. They are presented in the following table:

Strategic position	What ?	How ?
Specialization	Satisfy the demands of a former customer with newly launched products in the market - more or less similar to those that the company can already provide, or have in their shelves	The industrial uses its existing synergies of skills, know-how and organizational processes that have been already mastered. The industrial draws their new strategy on their existing knowledge and skills
Diversification	Satisfy new customer requests with goods or with services that the company can already provide	The industrial seeks to deploy methods, skills and technical know – how that they are specialized in – nevertheless they must acquire constantly new knowledge
Dual Strategy	The industrialists satisfy new demands with new technology, new civil and military know-how - Innovation is at the heart of their strategy	The industrial is seeking to satisfy the market new demands by acquiring a variety of new knowledge, know-how (technological, commercial, legal) – and implement new organizational

Figure 2: Comparison of development and/or diversification strategies of industrialists<sup>14</sup>.

13. In a speech on 16 February 2022, the President of the French Republic, Emmanuel Macron, reviewed the challenges of European and French space sovereignty. He identified the four pillars of action to take vis-à-vis space.

14. Figure 1: Characteristics for defining strategic alliances, inspired by the review: K. L. Jones, *Public-private partnerships stimulating innovation in the space sector*, 2018.

Indeed, the conduct by which commercial actors strategically position themselves – dual-use or otherwise – directly impacts France’s national industrial policy. As the state strives to preserve technologies critical to its interests (e.g. controlling the export of sensitive or war equipment), as well as to promote a constant engine that churns in favour of innovation. Moreover, in order to increase the instantaneous performance of the French space sector, it is essential to thoroughly understand how to position industrial actors. To efficiently develop technological alliance strategies that fit the country needs, positioning must be done according to the actors’ strategic ambitions, as well as the partnership type sought after.

### **Public-Private Partnership: A Tangible Solution for the French Armed Forces?**

The private sector has gained recognition from both government and public agencies for their important role in providing capabilities at reduced costs and risks via public-private partnership contractual models. This section of the article provides a definition of public-private partnerships, before exploring the different types of governance that exist. Finally, propositions are made regarding how to improve the French market’s level of adaptability in the face of space’s rapid evolution.

#### *Prerequisites for an Efficient Public-Private Partnership*

According to the World Bank’s definition<sup>15</sup>, a public-private partnership is a long-term contract between a public party and a private party for the development, upgrading, or significant renovation of the management of public goods or services. Throughout the duration of the contract, the private party normally assumes the main risk and management responsibilities. In particular, the private sector provides a substantial portion of the financing required. Moreover, its remuneration is significantly linked to the performance, the demand’s growth, or the use of the asset or service in such a way so that the interests of both parties converge. As Karen L. Jones details<sup>16</sup>, public-private partnerships are pursued by governments for reasons of cost reduction and sharing in their search for the most cost-effective solutions and risk transfers.

Jones goes further to specify that, in addition to these three objectives, private companies must also respect certain prerequisites (as readapted to the French case):

- Regarding the use of innovation and new technologies: The public-private partnership model must be structured in a way that encourages innovation from both traditional actors and new entrants in the space sector.

<sup>15</sup>. See World Bank. “About Public-Private Partnerships.” *World Bank Public-Private Partnerships Legal Resource Center*. Updated 15 December 2022. <https://ppp.worldbank.org/public-private-partnership/about-public-private-partnerships>.

<sup>16</sup>. K. L. Jones. *op. cit.*

- Regarding objective alignments: The 2019 French space policy encourages the use of the public-private partnership model as a means to inject more agility and vigour into the space industry<sup>17</sup>.
- Regarding the return on investment: In return for the risk transfer assumed by the private actor on behalf of the public sector, the private actor expects a return on investment, particularly in terms of exports. The higher the risk, the higher the expectation becomes in this area.
- Regarding competitors: Securing a competitive edge is a key priority for any organisation, whether public or private<sup>18</sup>.
- Regarding public market share: The public-private partnership model can be a useful technological and commercial lever to gain public market shares, for example, across Europe.
- Regarding additional revenues: Depending on the case, there may be a fortuitous convergence between the desire to leverage products or services available in the private sector and the needs that may exist in public sector programmes.

Another hurdle lies in the fact that public-private partnership terminology is often misused or misunderstood<sup>19</sup>. The key elements for a successful application of the public-private partnership model primarily include: developing an appropriate financing model; determining the duration and conditions for future operations and maintenance contracts; and finally, applying said conditions and performance requirements onto the final product or service. These will then be incorporated into the drafting of a proposed solution.

The subsequent table below illustrates the space sector's public-private partnership delivery model. Assuming that the private sector obtains funding in the form of a cooperative agreement from the state for research and development, the state may then claim the intellectual service associated with said research and development. Consequently, the state, in turn, assumes all project risks but generally retains the rights to patents and inventions. The exploration of a public-private partnership contract then becomes relevant.

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17. *Ibid.*

18. M. Porter. *Competitive Advantage: Creating and Sustaining Superior Performance* (New York City, NY: The Free Press, 1985).

19. G. Denisa et al. "From new space to big space: How commercial space dream is becoming a reality." *Acta Astronautica* 166 (2020): 431-443. <https://doi.org/10.1016/j.actaastro.2019.08.031>.

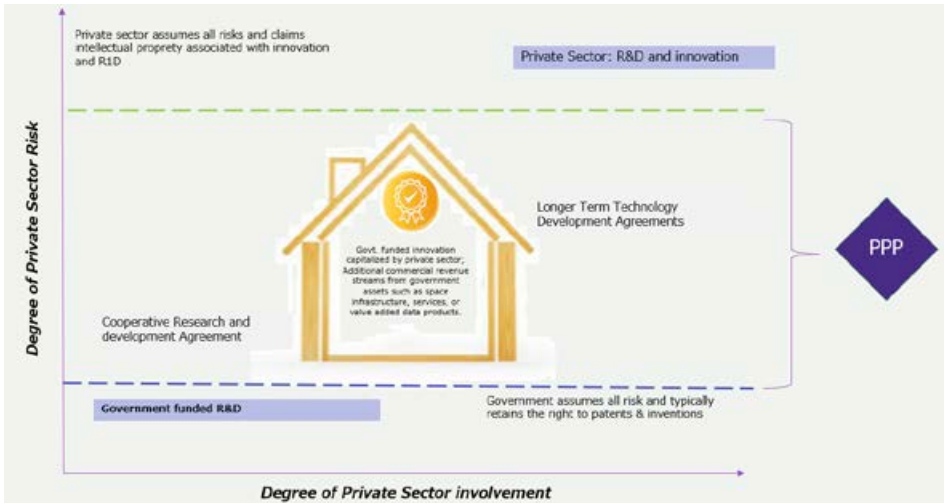


Figure 3: The space sector's public-private partnership delivery model<sup>20</sup>.

Jones again explains that the rights to industrial property and the results of research conducted under a public-private partnership model depend on the nature of the programmes and operations. For instance, the success of the Commercial Orbital Transportation Service (COTS) programme developed by NASA is due to the use of the Space Act Agreement (SAA), and the ability of private companies in finding a return on investment through this framework. In France, the Very High Throughput Satellite-Ground Optical Link (VERTIGO) is a 2020 collaborative project spanning the course of three years. Launched on 1 June 2019, it endeavours to develop concepts that increase the capacity of connection links via advanced optical technology. The project mobilises the key technology (high optical power generation, high efficiency waveforms, weathering alleviations) needed for the implementation of high speed optical links.

VERTIGO's tests are carried out in indoor and outdoor ground demonstrations by a consortium composed of CREONIC GmbH, ETH Zürich, Fraunhofer HHI, G&H, LEO Space Photonics R&D, ONERA, Thales Alenia Space in France and Switzerland and Thales Research & Technology. This project was funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 822030, which is not considered a public-private partnership but rather a research programme. It would therefore be worthwhile for French organisations to reconsider the framing of public-private partnership models. Specifically, they should be located on the graph in a placement that would allow for a degree of involvement by private partners – specifically one that can result in a higher performance, as NASA has done.

<sup>20</sup>. Space sector public-private partnership delivery models: The space sector is focused on sharing innovation and risks with the private sector.

The public-private partnership model may also be of particular interest to policy-makers as it offers a medium-term solution to avoid or limit the risks associated with closing the gap on industry standards. As noted in the previous section, industrial competition only perpetuates a growth in the number of competitors at the international scale. To establish a coherent and effective strategy, Jones suggests that the public-private partnership model should be implemented in eight stages<sup>21</sup>.

### *Eight Public-Private Partnership Steps to Effective Governance*

#### *1. Market Assessment and Forecasting*

According to case studies conducted by Jones, governments, prior to committing to a long-term project, should conduct a full review of its economic model, including forecasts of market changes, associated risks, and possible additional costs. In parallel to this first phase are private companies, which also have an important role to play. Namely, they must calibrate their expectations according to the budgets given by the State, i.e. in France being its Military Programming Law. In order to not compromise on readiness, the French Air and Space Forces should create an upstream project team whose main role would be to study in advance each commitment linked to one or several long-term projects with the private sector.

#### *2. Establishing Contingencies*

To illustrate this second step, it suffices to simply look at the case of Galileo, a constellation of navigation satellites. Its public-private partnership contract was signed in 2007, after certain scheduling setbacks and disruptions due to project delays. Changing certain contractual clauses (such as the delay period) thus proves that manufacturers must make realistic and attainable commitments to avoid conflicts over accomplishing set objectives<sup>22</sup>. In other words, this is a list of risk factors that the aforementioned project team should take into account. Beyond risk identification, the French Air and Space Forces should also study the legal liability clauses related to delivery delays of one or more long-term projects with commercial actors.

#### *3. Launching Investment Plans and Resources*

This step puts into perspective the fact that the state is not the sole investor but rather more or so a secure source of funding and a trusted partner for private companies. In the example of the public-private partnership contract model that NASA applies to its orbital transport services project, a tripartite contract was signed with SpaceX, Orbital ATK, and the Sierra Nevada Corporation. This

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21. K. L. Jones. *op. cit.*

22. *Ibid.*

partnership is built on a cost and risk sharing basis. Its model is seen as a suitable medium to generate and raise investment funds by stakeholders, as needed for the project's various stages. NASA's interest in increasing competition between existing commercial partners thus lies in the tangible benefits that it brings, namely a more competitive pricing, a broader innovation basis, and a reduced market risk.

#### *4. Encouraging Businesses to Respond to Government Needs*

In certain cases, the public-private partnership is designed so that the industry is obligated to meet the most stringent requirements set by government partners. It also forces the industry to reduce its dependence on foreign countries for strategic capabilities intended to be sovereign and autonomous. For example, the United States Air Force chose to adopt a procurement policy based on the Other Transaction Authority (OTA) system. The OTA is a legal instrument instituted by the federal government that authorises the establishment of a cooperation agreement or a grant in return for the requested objective without the use of a contract. The OTA was used in particular by the United States for the case study on strategic capability building with the Rocket Propulsion System (RPS). This choice of public-private partnership model with manufacturers has thus proved to be successful as a key element of the acquisition strategy to ensure access to space, while addressing the urgent need to wean off of foreign dependence<sup>23</sup>.

#### *5. Scope of Contracts*

The public-private partnership model requires contracts to be tailored to the assignment duration, while providing sufficient incentives to the commercial sector to ensure its full support throughout the project management period. As Jones states, overly long commitments that do not allow for cycles of technological revival should be avoided. Determining the contractual scope is therefore a significant step in defining partner responsibilities and their boundaries to accurately assign the roles that players must assume.

#### *6. Using Success to Fuel Growth*

The International Space Station is a prime example that strategic technological collaborations between industrial and governmental powers are evolving. This space research and innovation laboratory, developed with Nano Racks, is characteristic of the success brought forth by the public-private partnership model. Nano Racks currently provides equipment and services for the International Space Station, such as Earth and deep-sky observations, sensor development, electronic testing, and advanced materials capabilities. The company offers a clear cost breakdown model for the services it provides, starting at \$100 and rising to \$1,000,000 or more depending on user needs. Successful projects based

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23. United States Space Force, Space and Missile System Center, Public Affairs Office, 2016.

on the public-private partnership model allows a nation to showcase and promote the know-how of its manufacturers.

#### *7. Adjusting Expenses According to Financial Projection*

This stage sets the project's technical and financial deadlines and develops its performance success criteria. For example, NASA updates this stage regularly to meet the delivery dates expected by government partners as required through the National Defense Authorization Act (NDAA). However, not every delay can be avoided, as is the case of the ARTEMIS programme. ARTEMIS is a series of ongoing space missions led by NASA. Three missions are currently scheduled: *Artemis 1*, an unmanned test flight to orbit and fly over the Moon (the launch was successfully performed on 16 November 2022); *Artemis 2*, a manned flight beyond the Moon; *Artemis 3*, a week of scientific studies to be carried out on the lunar surface. The latter will also be the first time in history that a female astronaut and an astronaut of colour set foot on the Moon. These different phases will evidently involve monitoring project milestones through the NDAA, which is a performance evaluation tool. In short, projects of this scale involve adjusting the expenditure according to the achievement of each deliverable.

#### *8. Optimising the Value Chain through Data Exchange:*

Depending on its application, data ownership and its commercialisation can be shared amongst both public and private sectors. However, all parties must agree on their standards, means of dissemination, and use of data in such a way that each party can benefit from the competitive advantage it may provide – but without encroaching on their respective productivity.

Assessing the market according to these principles allows space ecosystem actors to renew investment plans and means, while ensuring that companies fulfil government needs. The chosen contractual scope thus offers a leeway to adjust spending according to the government's financial projection. In specific cases, success is a tool for growth based on well-established contingencies. While such steps should optimise the value chain of France's space sector, they remain insufficient in guaranteeing the implementation of an optimised public-private partnership model.

The public-private partnership model thus naturally establishes itself as the pathway to conceiving the most appropriate development strategy. This is because it offers the possibility of obtaining higher performance and efficiency, while using a transparent and accountable legal framework.

#### *The “Public-Private Partnership” Model: A Global-Tiered Consortium?*

The public-private partnership model is a concept that is constantly evolving within the armed forces. As France has a visible strategic position in the space ecosystem, it can become an example of a partnership and collaborative ma-

nagement of external stakeholders. Other nations prominent in the sector have already successfully adopted said model.

To begin, the United Kingdom<sup>24</sup> and Australia<sup>25</sup>, for example, have come to the same conclusion that led them to both rely on a similar framework. This started with the establishment of a national policy that set out broad objectives based on the defence of national interests. It positioned the national private space sector in the forefront by advancing through partnerships, excelling in key capabilities, and finally, promoting space as a beneficial model for other sectors and the country itself.

Canada, for its part, has chosen to complement advanced manufacturing activities with its science, technology, and innovation priorities. Moreover, the country has integrated automation with robotics, aerospace, and nanotechnology – three of Canada’s seven flagship and strategic sectors for advanced manufacturing<sup>26</sup>. In particular, the Canadian start-up, North Star Earth and Space, is indicative of a collective, technological, and dual performance. The start-up is projected to launch up to 30 satellites dedicated to space surveillance. It has also invested interests in the United States and other military clients. Although it remains unlikely that all its data will be opened up to public access, North Star Earth and Space aspires to make available as much as possible the data collected by satellites to commercial users in both the United States and Europe<sup>27</sup>. Additionally, the start-up’s CEO Stewart Bain has also expressed the company’s ambitions to venture beyond current borders, and maximise even further their technology collaboration with different key space players, such as France and India<sup>28</sup>.

The above cases only demonstrate the interest of private companies to cultivate two-pronged collaborations with the needs of the French Air and Space Forces. According to Anna Wetter<sup>29</sup>, duality can be defined as the goods or services that can be used for both non-military and military applications. Dual-use technology is subsequently considered to be the specific information

24. Government of the United Kingdom et al. *National Space Strategy* (London: Crown, September 2021). [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1034313/national-space-strategy.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1034313/national-space-strategy.pdf).

25. Government of Australia and Australian Space Agency. *Advancing Space: Australian Civil Space Strategy 2019 – 2028* (Canberra: Australian Space Agency, April 2019). <https://csps.aerospace.org/sites/default/files/2021-08/Australian%20Civil%20Space%20Strategy%202019-28%20Apr19.pdf>.

26. Euroconsult for the Canadian Space Agency. *Comprehensive Socio-Economic Impact Assessment of the Canadian Space Sector* (Montréal, QC: Euroconsult, 2015). <https://www.asc-csa.gc.ca/pdf/eng/publications/2015-assessment-canadian-space-sector-v2.pdf>.

27. T. Hitchens. “North Star plans blanket coverage of near Earth orbits with up to 30 satellites.” *Breaking Defense*. 15 August 2022. <https://breakingdefense.com/2022/08/north-star-plans-blanket-coverage-of-near-earth-orbits-with-up-to-30-satellites/>.

28. Thesis interview on the governance of the North Star’s public-private partnership, given in Montreal in August 2022.

29. Glossary XV of A. Wetter. *Enforcing European Union Law on Exports of Dual-Use Goods* (Solna: SIPRI, 2009). See also J. Heinz, *U.S. Strategic Trade: An Export Control System for the 1990s* (Oxford: Westview Press, 1991).

and associated knowledge required for the development, production, or use of a good or service.

The article, as a result, undertakes to highlight that the performance of the French space ecosystem can be tied to the definition of a collective strategy of technological alliance formed between exclusively identified and appointed partners. It especially takes into account the differing potential risks encountered in the construction of such strategic technological alliances. Indeed, alliances designed for technological purposes do not systematically offer advantages in terms of cost reduction, risks, and uncertainties on development outcomes, nor on the exploitation of technological complementarities.

This is not to mention that strategic technological alliances also entail certain risks that armed forces must bear in mind when embarking on such an endeavour. Firstly, there is an increased possibility of collusion between cooperating companies that have learned, through alliances, to exchange technological information that apply to their own research and development projects. Thus, they may be quick to sell their expertise and market products across borders. Hence, this factor must be addressed meticulously with national export control mechanisms. However, this does not necessarily translate to going as far as adopting the United States' International Traffic Arms Regulation (ITAR) model. Such is considered, on the contrary, to be too restrictive and, at times, counterproductive to the country's industry. A second jeopardy at stake is in regard to larger firms, who may partake in technological plundering of small and medium-sized companies. Finally, the last possible risk is the increase in certain costs related to the transactions born of cooperation, specifically, the concentration management, intellectual property, risks, and information<sup>30</sup>. This list is, of course, not at all exhaustive.

### *Types of Consortia Proposed*

Considering the awareness needed to be adopted regarding the risks and benefits existing within public-private partnerships, it is now appropriate to identify possibilities that can promote the model's success for the French Armed Forces.

As companies conduct their industrial activities, their attention is often turned towards reducing costs and uncertainties in manufacturing, as well as improving technological processes. Strategic alliances, however, may be focused on performing very specific research or development on a particular topic that falls, perhaps, outside this spectrum. It is, as a result, more forward-looking due to its anticipatory nature. Referencing again to Teece, there are three forms of strategic alliances. These especially deserve careful consideration by the French Armed Forces:

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30. D. Teece. *The Multinational Corporation and the Resource Cost of International Technology Transfer* (Cambridge, MA: Ballinger, 1976).

- The pre-competitive research and development consortium: This alliance focuses mainly on elementary research and tends to produce long-term results. In most cases, this type of alliance involves the participation of universities, considering that these institutions are essential hubs for the accumulation of scientific knowledge. Moreover, the risks of intellectual property leakage are lower, as the products or services developed are not marketable. In this alliance type, it is necessary to anticipate the possibility of working with future competitors, partners, clients, suppliers, as well as users.
- The “horizontal” consortium of applied research and development between competitors: Members of this league are solely companies who seek to resolve a specific issue in a practical manner. Most of the French Armed Forces’ medium-term objectives are situated under this category. For instance, this is the type of consortium carried out for the *AsterX* exercise<sup>31</sup>. The overall project is also likely to be divided into sub-projects in order to either disassemble the question at hand or explore the various possible solutions separately. Inevitably, this involves a greater risk of intellectual property leakage, including issues in measuring the costs and technological inputs required.
- The “vertical” consortium of research and development between suppliers and users: This model is found in well-established industries. It is, in other words, the traditional model, where each cooperant is protected by important barriers to entry (as in the case of France, where the public procurement code regulates the different entries of small, medium-sized, and large companies). The participation of public entities is more often present in this alliance type. This occurrence is also often found in the military.

Within the French Space Command, various research conducted and field observations made demonstrate that the application of the aforementioned horizontal consortium can be employed more so by the internal actors within the French defence sector. This approach should thus include the mapping of project segments planned within the Space Command in collaboration with other organisations attached to the Ministry of the Armed Forces. It must also be directly linked to strategic decision-making, such as with the *Direction générale de l’armement* (“General Directorate of Armaments”), *Direction générale des relations internationales et de la stratégie* (“General Directorate of International Relations and Strategy”), *Direction générale de la Sécurité extérieure* (“General Directorate for External Security”), and so forth.

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31. The objective of the *AsterX* exercise, whose first edition took place in March 2021 at CNES, is to define and test certain operational processes in the field of Space Situational Awareness and to test reaction capabilities in high-alert situations. This is an exclusive operation in Europe.

## **Conclusion: Prospects and Next Steps**

As space powers seek to position their most ideal technological orientation and strengthen their space defence innovation capabilities, national players should also review their approach in this area. Performing a global analysis on both national and international markets to better understand the current environment, as well as existing good practices is a fitting starting point. Revising the French space market's position to better adhere to today's global players and New Space is a critical step that should be undertaken on an annual basis within the French Armed Forces. Importantly, this endeavour would enable the implementation of a detailed mapping of existing, traditional, and new strategic technological alliances.

Indeed, New Space is changing the face of the traditional space ecosystem with the arrival *en masse* of start-ups to the market. As dual demands rise, emerging French private companies are presented with an exceptional opportunity to position themselves on par with the traditional actors already in possession of defence contracts. In this perspective, identifying the appropriate organisational devices and means to increase civilian and military synergies remains a significant challenge. This further plays a major factor in a company's competitiveness and their ability to make the appropriate choices towards strategic technological alliances.

This article hence seeks to define the characteristics of French space governance, which is currently dominated by the country's public sector. In order to keep up with the ceaseless technological developments, public authorities must revise their decision-making bodies to align in accordance with France's space strategy. They must also be adapted to the three aforementioned consortia (pre-competitive, horizontal, and vertical) that encapsulate the public-private partnership governance model.

In today's case, the public-private partnership model is a strategic tool to be applied in the event of market saturation. The governance method of public-private partnerships is not only the representation of a management tool for sharing costs and risks, but it is also seen as a strategic process, allowing public authorities to bring coherence to the creation or renewal of a contract with their specifically identified and confirmed partners. This naturally implies addressing the issue of setting the criteria for choosing such partners and the recognition of their status through a system of labelling trusted actors as a military grade or combat-proven type. This article hence emphasises the importance of such an analysis. For one, this must be carried out to open the way forwards for pertinent structural and organisational decisions to be made. Specifically, they must allow state actors of France's military space domain to avoid finding themselves in a situation, where they are trailing behind their adversaries in the industrial competition.

As presented by prominent writers who have been deciphering the transition from “New Space” to “Next Space”, and even “Big Space”<sup>32</sup>, it appears that yet another space race has begun. This tension is, indeed, palpable between the two domineering nations of China and the United States. Prestige and supremacy, along with economic and financial competitiveness are all at stake. As a consequence, the time is now ripe for studying the impact of a new collective strategy on technological alliances. Specifically, this pertains to their influence on the elaboration and execution of France’s – including Europe’s – space vision for the years to come.

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32. G. Denisa et al. *art. cit.*



# The Future of Air Missions in a Carbon Neutral World

Nicolas Leprince, Thibault Ricci, Xavier Rival

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*Colonel Nicolas Leprince’s career saw him commanding the Ecole de pilotage de l’armée de l’Air (Air Force Pilot School). During his studies at the École de Guerre (War School), he produced his thesis on the security impact of climate change, specifically on the paradoxical relationship between finite energy sources and economic growth. As of present day, he has taken on the role of drafting officer in the Planning, Programming, and Evaluation Office of the Joint Staff (EMA).*

*Lieutenant-Colonel Thibault Ricci authored in 2022 a critical analysis of the “Royal Air Force Net Zero 2040” strategic plan during his Command and Staff Course studies in the United Kingdom. He now commands the Fighter Aviation School, which is implementing the PC-21 aircraft as a replacement for the Alpha Jet.*

Air power provides political and military leaders with the responsiveness and scope required to gather intelligence, assist populations in distress and, if necessary, use force in a combination of both firepower and precision. Winning the war can never be taken for granted. Yet, as Field Marshal Bernard Montgomery remarks, “If we lose the war in the air, we lose the war and we lose it quickly”<sup>3</sup>.

Air missions, in general, are carried out *via* aircraft that use, in quasi-exclusivity, thermal engines and fossil fuels, which have unparalleled energy density.

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1. Advanced Command and Staff Course, equivalent to France’s *École de Guerre* (EMS2)

2. Royal College of Defence Studies, equivalent to the Centre for Advanced Military Studies (EMS3)

3. Quoted in P. Meilinger, “Dix propositions sur l’arme aérienne”, *Stratégique*, no. 64 (April 1996): 19-52.

However, the use of electric or steam engines is an exception to this norm<sup>4</sup>. A case in point is Clément Ader's *Eole*, which lifted off the ground in 1890, powered by a 20 hp steam engine<sup>5</sup>. Fast forward to present day, France, through the European Union (EU), has set ambitious objectives to limit its greenhouse gas (GHG) emissions – particularly that of carbon dioxide – over the next thirty years. In June 2021, the European Parliament and the Council of the EU approved Regulation 2021/1119, thereby “establishing the framework for achieving climate neutrality”. This European climate law sets a binding target to make the EU the first climate-neutral, regional integration structure. Member States will be required to reduce their GHG emissions as much as possible and offset any remaining emissions through carbon capture and means of sequestration.

Interestingly, the armed forces of EU countries do not appear to be implicated by this regulation. Rather, the carbon cost of air missions is thus far “tolerated” by policy-makers. Indeed, as Europe endures Russia's partial invasion into Ukraine, it must also keep a watchful eye on the rising tensions brewing in Asia between the United States and China. Moreover, this is not to overlook the continuing threat of terrorism. France must therefore maintain its capacity to protect itself and defend its interests by employing force from the air when necessary. Nevertheless, it is still genuinely legitimate to question whether governments will continue to accept this carbon cost as the pressure rises to achieve carbon neutrality by 2050. Since energy transition is largely driven by technological innovation, new opportunities may come forth to propel such a shift. The linkage between technological progress and air power – which has constituted the core identity of aviators for over a century – represents a strategic matter for the French Air and Space Forces (FASF) and for armed forces as a whole.

Air power is not only founded upon the implementation of aircrafts. Energy, to be largely decarbonised in the future, is necessary in ensuring the functioning of both air bases and land vehicles. This, for instance, is the case in powering command and control information systems that process the intelligence gathered from the air. Notwithstanding the dependence of these generic issues on the energy and environmental approach of the armed forces as a whole, such analyses would fall outside the scope of this article, which focuses on the specificities of air power itself. They will, therefore, not be addressed herein.

Instead, the article will dive into the heart of aircraft. The authors will illustrate how managing such an energy and operational transition is becoming an imperative for armed forces (I). Yet, to do so would require regular readjustments to ensure that the FASF remains operationally up to par (II). Hence, such

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4. In 1883, brothers Gaston and Albert Tissandier built and flew “the first truly dirigible balloon, driven by a propeller powered by an electric motor,” R. Chambe, *Histoire de l'aviation* (Paris: Flammarion, 1958): 50.

5. Two-cylinder engine weighing 90 kg, including 30 kg of water and 10kg of alcohol to provide the steam, see: *Ibid.*, p. 41. In 1933, the Besler brothers installed a 150 hp steam engine on a bi-plane and flew for 5 minutes without incident.

challenges call for the need to adopt a principle of energy sobriety, along with further research investments on alternative fuels. All these issues require strengthening inter-allied cooperation on the question of operational energy.

### Armed Forces and Energy Transition: Towards the End of Relative Exemption

Relativisation has long been the argument to downplay the carbon cost of aviation. Indeed, in its totality, aviation accounts for “only” 3% of annual GHG emissions worldwide, of which the relative share of military aviation is even smaller. However, considering the negative outward impact of aviation, it will be harder to turn a blind eye to such emissions as the political pressure to reduce them rises. The summer of 2022 is testament to such shifts in attitudes. Notably, private jets came under heavy fire as the country suffered through enduring heatwaves. It can be said that today, the ecological movement is no longer the prerogative of a few “perennialists”. In the days of Arne Næss’s cabin<sup>6</sup> and John Muir’s wilderness essays<sup>7</sup>, while they indeed fomented public opinion, their resulting introspective questioning of modernity failed to induce much of a shift in paradigm.

It was not until the *Meadows Report*<sup>8</sup> that a breakthrough in ecological thinking penetrated into the political sphere. Fifty years ago, at the height of France’s “Glorious Thirties”, five scientists from the Massachusetts Institute of Technology challenged the sustainability of a modern society’s system, affirming that such model was only possible upon a radical and rapid change in policy. Unfortunately, the report was met with severe criticisms from economists who considered the report’s hypotheses insufficient. In particular, they argued that the report failed to take account of technological progress. However, in 2021, Graham Turner<sup>9</sup> reversely proved that the planet was indeed scrupulously following the “business as usual” trajectory predicted in the *Meadows Report*<sup>10</sup>. In short, it is Kenneth Boulding’s words<sup>11</sup> that accurately encapsulate this now outdated debate: “Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist”.

Today, environmentalism has significantly risen in rank amongst the list of public concerns, particularly in France and Europe. In France, 47% of its population consider climate change to be a priority concern<sup>12</sup>. The media is brimming with whistleblowers, whilst sociologists, philosophers, anthropologists, and climatologists are daily mobilised to question the future. A generation gap seems

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6. Norwegian philosopher (1912-2009), founder of the deep ecological movement.

7. U.S. writer (1838-1914), author of numerous essays and books about his adventures in nature and wildlife.

8. Co-edited by Dennis Meadows in 1972 under the title, “*The Limits to Growth*”.

9. With a PhD in applied physics, Boulding’s work focuses on the physical sustainability of the environment and the economy.

10. T. Graham. “On the cusp of global collapse? Updated Comparison of the Limits to Growth with Historical Data,” *GAIA Ecological Perspectives for Sciences and Society* 21, no. 2 (2012): 116-124.

11. U.S. economist and philosopher (1910-1993), systems theorist.

12. IPSOS poll of 5 February 2022.

to be widening and decision-makers are torn in two. On the one hand, they are forced to contend with the compelling short-term constraints. On the other hand, they are faced with young graduates joining the labour market, whose concerns are growing in regard to the prospects presented in the reports by the Intergovernmental Panel on Climate Change. A groundswell is also building up throughout France's top higher education institutions (known as "*grandes écoles*"). Graduates of *AgroParisTech* (the Paris Institute of Technology for Life, Food and Environmental Sciences) are galvanising fellow students to become "deserters". The student body at *Écoles normales supérieures* (highly competitive public institutions, where only four exist in France) are mobilising to ensure that science is at the standard of addressing environmental challenges. Over at the renowned *École polytechnique* (a *grande école* university overseen by the French military that specialises in science and engineering), students are calling for the end of "climate immobilism". Finally, students from *Sciences Po* (the Paris Institute of Political Studies) are urging society to "snap out of denial".

All in all, energy transition is also an urgent matter for armed forces, who can no longer remain immune to the "carbon neutral by 2050" commitments and objectives born of the Paris Agreement. Political pressure in favour of raising GHG reduction targets is mounting. The 2022 annual report of France's High Council on Climate notes that the country's GHG emissions are showing signs of the beginnings of a slow decline in all major sectors (construction, industrial, and energy). However, for both transport and agriculture sectors, the decline is yet to be confirmed. In terms of the EU, the GHG reduction targets set out in its *Fit for 55* roadmap<sup>13</sup> have been raised from the current -40% to -55% by 2030, which lies in stark contrast to the gross volume of emissions in 1990.

In this context, sectors that emit the highest GHG will evidently be subjected to higher scrutiny. Concurrently, the use of fossil fuels will grow to be further injurious. The relative weight of GHG emissions by the military will increase conspicuously as total emissions decrease across the board. As its exemption from environmentalism nears the expiration date, the military aviation sector's consideration of emissions has already begun to evolve. On 7 June 2022, the European Parliament adopted *The EU's Climate Change and Defence Roadmap*, which recounts how the rate of the EU's energy dependency rose from 56% to 61% between 2000 and 2019. Specifically, it states that "the 2019 carbon footprint of the military sector in Member States, including both national armed forces and military technology industries based in the EU, was estimated at approximately 24.8 millions tonnes of CO<sub>2</sub> equivalent".

As military aviation is one of the main emitters within the French Ministry of Armed Forces, the FASF must now seek to reduce its emissions without compromising its operational capabilities. Certain key figures are already making great

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**13.** *Fit for 55* is a package of 12 legislative proposals published by the European Commission in July 2021. This package has not yet been approved by the European Parliament and Council.

strides in this direction. The network of experts from the International Military Council on Climate and Security (IMCCS) – led by former Chief of Staff of the Dutch Armed Forces, Tom Middendorp – has worked in collaboration with the French Institute for International and Strategic Affairs (IRIS) to publish a new study, entitled *Decarbonized Defense: The Need for Clean Military Power in the Age of Climate Change*<sup>14</sup>. The paper argues that the military must accelerate its energy transition policy in order to meet three challenges: reducing operational vulnerabilities related to fossil fuels without creating new ones (e.g. rare metals); reducing dependence on petro-dictatorships such as Russia; and finally, combating climate change.

### **The Ability to Adapt: A Key Asset for Aviators vis-à-vis Energy Transition Uncertainties**

From the point of view of the armed forces, achieving carbon neutrality by 2050 constitutes a fundamentally uncertain gamble. Managing this energy transition will be a delicate process which requires regular readjustments, particularly according to future technological progress.

To begin, this transition is most likely to be conducted under severe operational and budgetary constraints. This will occur within the context of global rearmament and against a backdrop of rising international tensions, growing resource scarcity, and the increasing frequency of extreme weather conditions. The multiplication of such crises will likely witness a more extensive use of air power. Indeed, the ability to act quickly and remotely, from both the homeland and support bases abroad, will remain invaluable in preventing crises from escalating into armed conflict – where the latter would demand for even higher commitments. More interventions undoubtedly lead to higher competition for access to the primary resources needed to conduct such operations (i.e. fossil fuels). This, in turn, will only generate new tensions. In its 2018 annual report, the International Energy Agency observes that the production peak for conventional oil has already been exceeded<sup>15</sup>. The report also highlights the risk of a structural failure in oil supply chains due to the inability of unconventional oil producers to offset this constraint<sup>16</sup>. More recently and in line with these projections, France's Directorate General for International Relations and Strategy (DGRIS) commissioned a study from The Shift Project think tank, which warns that the 2020's may witness a tightening of the EU's oil supply<sup>17</sup>.

In order to cope with these tensions, the FASF will certainly require more

14. International Military Council on Climate and Security, <https://imccs.org/>.

15. This means that at that time the extraction level passed through a maximum value and has only decreased since then.

16. International Energy Agency, *World Energy Outlook 2018* (OECD/IEA, 2018), <https://iea.blob.core.windows.net/>

17. The Shift Project, *Future Oil Supply to the European Union: Status of Reserves and Production Prospects of Major Supplier Countries* (The Shift Project: May 2021), <https://theshiftproject.org/>

aircrafts and aircrews despite increasing budget constraints. Amongst other challenges, the training of these crews will have to be optimized. The role of air simulation apparatus is of particular interest in this context and the FASF's expertise displays constant growth through multiple innovative projects (massive networked simulation, low cost simulation, etc.). Nevertheless, the right balance between the advantages and limitations of virtual training must be struck. Simulation provides a tangible mechanized setting essential for training responses to particularly stressful situations (i.e. failure of a critical system), as well as for rehearsing tactics used without regulatory constraints (i.e. preparing for supersonic flight). Simulation also contributes to the protection of sensitive information. Specifically, the observational means of competitor armed forces render it difficult during flight trainings to utilize the full capabilities offered by the latest generation systems.

On the other hand, real-life flight experiences remain nonetheless irreplaceable, as crews must constantly train to adapt to unforeseen circumstances. A multitude of factors – from weather conditions to the various actors involved in the success of a mission (mechanics, air traffic controllers, air-to-air refuelling crews, etc.) – all contribute to create “resistance” from which generates the necessary experience to qualify combat crews. The essence of tactical expertise lies in the ability to find *a* solution, if not *the* best solution, in an environment of temporal and physiological constraints that simulations could only imperfectly reproduce. Finding the equilibrium in the simulated and real-life training ratio is therefore of the utmost importance. Needless to say, the objective is to maintain tactical expertise and flight safety at the highest possible level. Yet, in this field, growth can only occur gradually. As such, this demands for a pragmatic risk management policy that takes into account the experience of crews, the volume of hours allocated to individual pilots, as well as the quality of the air activity.

Furthermore, it is likely that the FASF will adopt a proactive monitoring posture (the “fast follower” concept) rather than being a driving force in the face of technological innovations related to energy transition. The emergence of these innovations, particularly in the aviation sector, is marked by uncertainty. In terms of aircraft propulsion notably, it seems unlikely that a single solution will prevail. The development of aircrafts equipped with either electric engines, hydrogen engines, or jet engines running on non-fossil fuels, all have their own pros and cons. Any of these options may be the specific solution that satisfies particular mission's requirements (i.e. drones, transport aircraft, helicopters, combat aircraft). However, given the investments needed to do so, these innovations will mainly be led by the civil aeronautics sector. The FASF will then have to ensure that the technological solutions developed by civilian companies are also compatible or adaptable for future operational use.

The necessity to remain “interoperable” – in other words, the capability to fight in collaboration with other partners – appears equally crucial as any solution adopted is set to be diversified. Aviators must remain up to date with various new

developments. Such could be ever-changing, especially so if aviators are reliant on “disruptive” technologies. They will have to exchange very regularly with their counterparts from other air forces, alliances, and cooperation structures involved in the issue of energy transition (the United States, the United Kingdom, Canada, Netherlands, Sweden, the EU, and NATO). For instance, within inter-allied coordination, air-to-air refuelling is emblematic of this critical need. Nevertheless, this is based on the use of fuels with standardised chemical compositions (NATO’s Single Fuel Policy). While energy transition will demand for the development of new alternative fuels, cooperation between Allied Staffs will be essential in ensuring their compatibility for all aircraft types.

Again, this transition is likely to be gradual and only achieved over a long time. Technological solutions specific to each aircraft will not always be simultaneously presented, and could take time before being effectively transposable in demanding operational environments. The end of the oil age will reflect not only greater energy diversity but also more complex logistical challenges for those “heavier than air”. The transition will first concern UAVs (within 20-30 years), then transport aviation (within 30-50 years), and finally, fighter aircrafts, which will take place even further into the future (perhaps before the end of this century). The implementation of various technological innovations (electric, hydrogen, non-fossil fuels) will perhaps engender operational breakthroughs, such as exploits in autonomy. The impact will be significant for equipment either already in service, modernised, or withdrawn from active service early on, as well as for programmes in progress – all of which could upset any well-established plans. In the face of such uncertainty, “operational redundancies” must be accounted for in order to avoid unpleasant surprises. Indeed, from design to retirement, only a reduced and agile equipment programme cycle can be a foolproof mean of managing this critical transition phase. The effects will also be immediately felt by personnel training. Aviators will have to quickly master new energy’s fields.

Regardless, certain major weapons systems currently being developed by Western powers for the horizon of 2050 will continue to use fossil fuels – or at least in part. Examples of such are Europe’s Future Air Combat System (FACS) and *Tempest* programmes, as well as the U.S.’s Next Generation Air Dominance (NGAD) project. In each of these, supersonic aircrafts (weighing around 20 tonnes and capable of cruising in the stratosphere) play a central role. The nature of tomorrow’s fighter aircraft is a highly debated subject, whose forefront tends to be occupied by the question of “to be manned or to be unmanned”. However, it is these simple orders of the physical magnitude that must be first and foremost addressed from the energy point of view. Hence, it would therefore be reasonable to speculate that, by 2050, the implementation of such aircraft fleets will require significant levels of energy consumption, not too different from the current orders of magnitude.

While the FCAS is unlikely to be electric, neither it nor any other in the future (drones, transport planes, helicopters) will be able to steer clear of the

technological innovations that are sure to emerge and on which the civilian sector and other air forces (USAF, RAF) are already working. These major trends also necessitate a redoubling of efforts and attention to recruit, train, and retain young generations of aviators that are capable of embracing the transformational context set to come into force in the coming decades.

### **Embarking on Energy Transitions to Last on the Operations Front**

Another essential element to take into account in the course of energy transition is the strategic context. Western powers must now be able to discourage, and if necessary, counter adversaries who resort to force, all without imposing any environmental constraints on the use of their military capabilities. The challenge for armed forces is therefore not only moral, ethical or social but also operational. Firstly, Western forces must be able to militarily dominate an adversary over the long term, even amidst environmental crises (i.e. competition for access to resources, frequency of extreme weather conditions, deterioration of intervention circumstances, etc.)<sup>18</sup>.

The French Defense Energy Strategy published in 2020 defines three axes to consider vis-à-vis such binding constraints: consume less, consume better, consume safely<sup>19</sup>. The first axis consists of exploring all avenues to reduce energy consumption in an immediate and sustainable manner. This proactive approach is known as “energy sobriety”<sup>20</sup>. Three options of effort can thus be envisaged: technological progress, operational optimisation, and promotion of a culture of energy sobriety within the armed forces.

However, the prospects offered in this area are as necessary as they are insufficient, in the sense that these alone will not be enough to overcome the challenges faced by the armed forces. The technological prospects for improving the efficiency of aero-engines by 2040/2050 are limited to an increase of a few percent, or 10% in the most optimistic scenarios<sup>21</sup>. Similarly, any necessary and marginal improvements can be made possible through optimising the planning and execution of flight operations. The USAF has been able to make up around 10% in fuel efficiency by reorganising the use of its tanker fleets<sup>22</sup>. In terms of cultivating a certain culture, an ethos of energy sobriety must be imposed at all levels of responsibility in the armed forces or, as stated by Air Chief Marshal Sir Mik Wigston, Chief of Staff of the RAF,

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18. V. Breton, “Dérèglements climatiques : Quelles conséquences sur les engagements opérationnels ?” in N. Regaud et al. (eds) *La guerre chaude* (Paris: Les Presses Science Po, 2022): 35.

19. Ministry of the Armed Forces, *Defense Energy Strategy* (2020), <https://www.defense.gouv.fr/>

20. J.-M. Jancovici, “Éléments de base sur l’énergie au XXI<sup>e</sup> siècle : Partie 5 – Les économies d’énergie,” Cours magistraux, MINES ParisTech, Année scolaire 2018 – 2019, <https://jancovici.com/>

21. Dixon, who is in charge of the ASTRA Sustainability Program at the British Royal Air Force, was interviewed for this article on 22 March 2022.

22. United States Air Force Operational Energy, *Annual Report 2020*, <https://www.safie.hq.af.mil/Portals/>

“from the moment we put on our uniforms”<sup>23</sup>. This is also the case when designing the military equipment of the future<sup>24</sup>. Such an imperative would go against the grain of a culture based on fuel abundance, which remains prevalent to this day. Breaking away from the past is therefore a challenge that requires a redoubling of educational efforts, while also pushing for the additional advantages of such a posture.

Beyond this obligatory but currently inherently limited, endeavours undertaken in the non-fossil fuel sector of aeronautics are the only means to achieve carbon neutrality without compromising the use of state-of-the-art aircraft. As a result, various solutions in the field of synthetic fuels are thus being explored in what is known as Sustainable Aviation Fuels. It should be emphasised that these non-fossil fuels emit as much CO<sub>2</sub> as kerosene. As such, the entire chain, from production lines to their expulsion through the nozzle, must be considered in order to obtain a CO<sub>2</sub>-neutral cycle. Hence, steps must also be taken upstream, and not solely during fuel combustion.

Moreover, while the production of most biofuels faces either high competition for the use of arable land or limits of biomass stocks, synthetic fuels, on the contrary, offer the possibility to overcome such constraints. From an environmental point of view, the production chain born from the Fischer Tropsch-Power to Liquid (FT-PTL) process – essentially modern alchemy that synthesises fuel from the hydrogen in water and the carbon in CO<sub>2</sub> – appears to be the most promising as of yet<sup>25</sup>. The RAF recently achieved spectacular results through its partnership with Zero Petroleum, by successfully completing the first ever flight recorded in history using FT-PTL synthetic fuel.

The decisive advantage of this process developed by the British company is that it relies neither on biomass nor fossil fuel, but rather on resources that are readily available everywhere and in virtually unlimited quantities<sup>26</sup>. This subsequently rips apart the cycle of dependence on imported fuels. However, the energy efficiency of this process is around 20%. In order to have a certain amount of energy available at the reactor’s outlet, it is therefore necessary to inject five times the equivalent amount into the production chain to synthesise this fuel<sup>27</sup> in the form of electricity. The environmental and economic costs of

23. M. Wigston, “The Chief of the Air Staff’s speech at the Global Air Chiefs’ Conference 2021,” transcript of speech delivered at London, 14 July 2021, <https://www.gov.uk/government/speeches/the-chief-of-the-air-staffs-speech-at-the-global-air-chiefs-conference-2021>.

24. C. Maisonneuve, “Opérations d’armement : De l’éco-conception à l’adaptation au changement climatique,” in N. Regaud et al. (eds) *La guerre chaude* (Paris: Les Presses Science Po, 2022): 207.

25. R. Thomson, “Sustainable Aviation Fuels: The Best Solution to Large Sustainable Aircraft?” (London: Roland Berger, 2020), [https://www.rolandberger.com/publications/publication\\_pdf/roland-berger\\_sustainable\\_aviation](https://www.rolandberger.com/publications/publication_pdf/roland-berger_sustainable_aviation).

26. P. Lowe, *White Paper: Petrosynthesis – The Competition of the Industrial Revolution* (Patrick Lowe, 2021), <https://zeropetroleum.com/wp-content/uploads/2021/11/White-Paper-Petrosynthesis-15-11-21.pdf>.

27. J.-M. Jancovici, *art. cit.*

a FT-PTL synthetic fuel chain of production are therefore undoubtedly high. In environmental terms specifically, the “low carbon” electricity production capacity offered by the French nuclear fleet gives the country a clear edge. From the economic point of view, the additional costs inherent in the production of alternative fuels prevent them from being completely adopted in the aviation industry for the time being. Nevertheless, the idea of a state or even European synthetic fuel production chain, freed from market profitability issues, is a sliver of hope that may guarantee both the sustainability of critical air missions and compliance with reducing CO<sub>2</sub> emissions in the long term.

Finally, experiments are currently being conducted to identify the technical difficulties associated with the widespread use of synthetic fuels on aircrafts currently in service (UK A330 MRTT Voyager, Swedish Gripen). These technical examples illustrate the need to develop partnerships with Allied nations on the subject of operational energy. An example would be strengthening the FASF’s participation in the working group on environmental issues, the Global Air Chiefs Climate Change Collaboration, which is chaired by the British Chief of Air Staff.

For financial, political, ecological, and operational reasons, dependence on fossil fuels has become one that is scorned upon. In broader terms, no matter the type of energy envisaged, the pitiless appetite of armed forces locks their consumption into a vicious cycle. This dependence, which armed forces are called upon to douse, limits prospects of reducing their energy footprint. Needless to say, armed forces cannot be wholly held responsible for such a situation. Indeed, at the national level, they are but a small part of the whole. Yet, this contribution will grow inexorably as the rest of society makes its descent towards carbon neutrality. The finite abundance of oil resources strikes a clear parallel with the way in which armed forces, and air power in particular, will find themselves increasingly trapped in a ouroboros linking together energy consumption, security crises, and military intervention ultimately with higher energy dependence.

Far from being a dead end for the FASF, developments towards energy transition would very well open new horizons. The FASF’s short history is but a testament to this as it continuously reinvents itself by optimising scarce resources (human resources, equipment, fuel). A case in point is the Fighter Aviation School, which is no longer equipped with the Alpha Jet for training purposes. Instead, it has been replaced by the PC-21, which is equipped with a turboprop engine. This new equipment not only consumes less fuel than its predecessor, but it is also more suitable for training young pilots with its modernised system. To compare the two simply, training on the PC-21 consumes 70% less fuel than on the Alpha Jet. Indeed, the history of aviation directly overlaps with the course of technological innovations in both aerodynamics and propulsion. The energy enabling this propulsion and the corollary issue of access to the resources needed to generate this energy will become an increasingly vital point of interest. It will therefore be necessary to deploy a strategic vision, such as the ability to envision

the future in the face of environmental uncertainty. Imperatives are emerging in this respect, from the cultivation of energy sobriety in the armed forces, to partnership developments with the civilian aeronautics industry and international partners, and finally *via* the conception of synthetic fuels or humouring the idea of a dedicated state or even European sector.



# The Eagles Are Coming!

## Tolkien, an Air Warfare theorist?

Adrien Gorremans

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*“But an equally basic passion of mine ab initio was for myth (not allegory !) and for fairy-story, and above all for heroic legend on the brink of Fairy tale and history.”<sup>1</sup>*

John Ronald Ruel Tolkien felt that England did not possess enough Myths. The Arthurian medieval literary tradition was not English enough for him, and most of all too permeated by Christianity to be a myth worthy of the Edda, the Icelandic cosmogonic saga from the early Middle-ages, or of the Finnish, Germanic and Celt legends. As a passionate linguist since childhood, gifted with a rare and early erudition, he created several imaginary languages (the “Elvish” languages, which he named Quenya and Sindarin) according to his philological and aesthetic tastes, and he dreamed of giving them an alternate historicity. For his own personal satisfaction then, he started to write intertwined legends and tales that he dared not dream would ever be published.

On a particularly mundane day in the year 1937, Tolkien, then a professor of Middle English at the prestigious Pembroke College in Oxford, was overcome by boredom as he was correcting student papers. He took a blank sheet and wrote: “*In a hole in the ground there lived a Hobbit*”. Fifteen years later, the author of *The Hobbit*<sup>2</sup> and of *The Lord of the Rings*<sup>3</sup> had given the literary genre of *Fantasy* global and timeless fame.

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1. J. R. R. Tolkien. “Letter no.131, dated late 1951 to Milton Waldman,” in *The Letters of J.R.R. Tolkien* (London: HarperCollinsPublishers, 1995): 502.

2. J. R. R. Tolkien. *The Hobbit* (London: HarperCollinsPublishers, 1997): 291.

3. J. R. R. Tolkien. *The Lord of the Rings* (London: HarperCollinsPublishers, 2004): 1157.

Beyond these two major works of fiction, published before his death, Tolkien left us a reference commentary<sup>4</sup> and a prose translation into modern English<sup>5</sup> of the Anglo-Saxon medieval literature classic *Beowulf*. He also, and more importantly, wrote tens of thousands of pages of heroic and legendary fiction. The first of these tales were drafted on the Great War hospital beds, and they shape altogether a coherent, poetic and brilliant, alternative and mythologic History, and on which he worked until his death in 1973. His third child Christopher spend his entire life editing and publishing them in the name of his father : *The Silmarillion*<sup>6</sup> (1977), *Unfinished Tales*<sup>7</sup> (1980), *The Children of Húrin*<sup>8</sup> (2007), *Beren and Lúthien*<sup>9</sup> (2017), *The Fall of Gondolin*<sup>10</sup> (2018), and *The History of Middle Earth*, an immense collection of twelve volumes, published between 1983 and 1996.

Actions from the air appear along these heroic tales, among infinite warlike narratives in which Elves, Humans, Dwarves (note the deliberately obsolete plural, which Tolkien loved and which made it into modern English to this day) savagely battle various Orcs, Gobelins, Wargs, and other fiery demons. Eagles save desperate heroes from certain death, winged dragons burn everything on their way, wraiths mounted on hideous flying creatures inspire fear in the hearts of the defenders of a besieged city... The *Lord of the Rings* was partly written during the Second World War, which also saw air warfare grow to industrial scale, and during which most of the templates for modern air operation doctrines were experimented. The question arises from this concurrency, and from the small amount of often decisive narrative developments happening in the air: what did military aviation mean for J.R.R Tolkien? Is it possible to find elements of air strategy or tactics his works?

Faced with these questions, the author, whose teenage years were inhabited by the tales from Middle Earth, has to make admission of his own humility, a very rare feeling among fighter pilots, that we hope the reader will enjoy at the measure of its scarcity. As work on this article began, indeed, it became rapidly clear that Tolkien, whose war experience was particularly traumatising, had never shown any specific enthusiasm for general aviation, and was vehemently hostile towards its military offsprings. Answering the question through the modern paradigm of air operations would be all but impossible.

Dr Kenneth Payne has already correlated the modern typology of air operations to those narratives in the *Lord of the Rings* that include airborne characters,

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4. J. R. R. Tolkien. *Beowulf, The Monsters and Critics and other Essays* (London: HarperCollins-Publishers, 2007): 256.

5. J. R. R. Tolkien. *Beowulf, A Translation and Commentary, together with Sellic Spell* (London: HarperCollinsPublishers, 2016): 448.

6. J. R. R. Tolkien. *The Silmarillion* (London: HarperCollinsPublishers, 1999): 370.

7. J. R. R. Tolkien. *Unfinished Tales* (London: HarperCollinsPublishers, 2006): 452.

8. J. R. R. Tolkien. *The Children of Húrin* (London: HarperCollinsPublishers, 2007): 315.

9. J. R. R. Tolkien. *Beren and Lúthien* (London: HarperCollinsPublishers, 2017): 288.

10. J. R. R. Tolkien. *The Fall of Gondolin* (London: HarperCollinsPublishers, 2018): 304.

in a brilliant and impertinent article full of erudition<sup>11</sup>. It is however difficult to imagine Tolkien thinking about air strategy while he was building his storytelling. Air warfare was so opposed to his intellectual values that we shall avoid this approach, in so much as it is possible. We will instead develop the deep moral convictions which structured his works, then analyse the narrative contexts in which air power appear on Middle Earth. Finally, we will cautiously attempt to determine whether an intuitive understanding of the fundamentals of air warfare can be found inside the tales, despite the best intents of their author.

### Fundamental themes and values of Tolkien's works

*"It is, I suppose, fundamentally concerned with the problem of the relation of Art (and Sub-creation) and Primary Reality."<sup>12</sup>*

The experience of the First World War shapes the fundamental themes of Tolkien's works; he served as a signals officer in the absurd British offensives on the Somme in 1916, during which his unit (11<sup>th</sup> -service- Battalion, Lancashire Fusiliers) was almost entirely annihilated. Of his three close friends from the *Tea Club Barrovian Society*, an informal and merry student club from the idle afternoons in Oxford, Rob Gilson and Geoffrey Smith died on that same fateful year (Christopher Wiseman, who served in the *Royal Navy*, survived the war). Evacuated from the horrors of trench warfare, sick with trench fever, Tolkien spent the rest of the war as a patient in military hospitals, and started writing myths for an imaginary world, which would later form a background of legends for his novels. The themes of death, and of the inescapable trauma of those who sacrificed themselves for the common Good, began to inhabit his writing as an obsession with loss, with the impossibility of any return to normal life, and with the artificiality of the glory in war. The following lines illustrate the individual soldier's perspective, located in Middle Earth but no doubt influenced by memories from the trenches as lived by the author himself: *"It was Sam's first view of a battle of Men against Men and he did not like it much. He was glad he could not see the dead face. He wondered what the man's name was and where he came from; and if he was really evil of heart, or what lies and threats had led him on the long march from his home; and if he would not rather have stayed there in peace."<sup>13</sup>*

In Tolkien's vast imaginary world, the mortality of Humans, as opposed to the Elves whose life is as long as that of the world itself, is one of the central questions, left unanswered, of large parts of the *Silmarillion*.

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11. K. Payne. "[Eagles and Air Power: The Lord of the Ring as Doctrine.](#)" in *Air Power Review*, volume 17 no.1. 2014.

12. J. R. R. Tolkien. Letter no. 131, not dated but from the end of 1951, to Milton Waldman. in *The Letters of J.R.R Tolkien. op. cit.*

13. J. R. R. Tolkien. Book IV, Chapter 4: Of Herbs and Stewed Rabbit. in *The Lord of the Rings. op. cit.*

The *Akallabêth*, which follows immediately in the chronology of the tales, and which relates the Fall of Númenor in reference to the myth of Atlantis, mainly deals with Men refusing to die and their hopeless and blasphemous fight for immortality. Frodo's character, once the quest to destroy the Ring is over, can no longer live in the world he has saved and leaves Middle Earth of his own will alleviate his own suffering. "*Anyway all this stuff is mainly concerned with Fall, Mortality, and the Machine.*"<sup>14</sup>

Tolkien was a man from the English countryside, towards which he had a very fond affection, full of humour and finesse, and that he described as the Shire where the Hobbits live; he clearly loathed technology and the machines. All his works are built around an obvious, Manichean opposition between Art and mechanisation. An ideal, natural world order, symbiotic, almost ecologic in the modern (and totally anachronic) meaning of the word, resists the onslaught of an evil, tyrannic and industrial power, obsessed with world domination. In this fantasy world, Elvish powers, akin to extremely skilled and subtle workmanship, and with no other aim but pure aesthetics, are opposed to a brand of witchcraft which resembles a caricature of immoral science and nightmarish mechanisation: "... *the desire for power, for making the will more quickly effective, - and so to the Machine (or Magic). By the last I intend all use of external plans or devices (apparatus) instead of development of the inherent inner powers or talents - or even the use of these talents with the corrupted motive of dominating: bulldozing the real world, or coercing other wills.*"<sup>15</sup>

More fundamentally, this contrast is that of artistic creation against the will for power: "*Their 'Magic' is Art (...) its object is Art not Power; sub-creation not domination and tyrannous re-forming of Creation.*"<sup>16</sup> Evil uses its power for purely practical goals, in order to gain direct advantages or mastery on other forms of life: "*The Enemy in successive forms is always 'naturally' concerned with sheer domination, and, so the Lord of magic and machines...*"<sup>17</sup>

In as much as air warfare is concerned, Tolkien's comments that made it to us are unambiguous and straightforward. They almost all date back to the Second World War, during which he served as a volunteer in the *Royal Observer Corps*. He sent letters throughout the war to his son Christopher, then a student fighter pilot with the *Royal Air Force* in South Africa, containing chapters of the *Lord of the Ring* for comment as they were being written. These letters bear testimony to the inner conflict of a father that was both admiring and anxious for the military career of his son, and, also,

14. Letter no.131, not dated but from the end of 1951, to Milton Waldman. *The Letters of J. R. R. Tolkien. op. cit.*

15. *Ibid.*

16. *Ibid.*

17. *Ibid.*

and mostly, despair at knowing him to serve in a service he so clearly abhors: “*But I fear an Air Force is a fundamentally irrational thing per se. I could wish dearly that you had nothing to do with anything so monstrous. It is in fact a sore trial to me that any son of mine should serve this modern Moloch.*”<sup>18</sup> This genuine fatherly love, together with the intense intellectual complicity between Tolkien and Christopher, who was later responsible for the literary posterity of most of his father’s works, stand in stark contrast with a heated detestation for combat aviation: “*It would not be easy for me to express to you the measure of my loathing for the Third Service [the Royal Air Force] – which can be nonetheless, and is for me, combined with admiration, gratitude, and above all pity, for the young men caught in it. (...) And nothing can really amend my grief that you, my best beloved, have had any connexion with it...*”<sup>19</sup>

Tolkien’s fascination for Germanic culture, whose myths and philology fed his fantasy world, added greatly to his hate for military aviation : the massive night bombing raids by the RAF Bomber Command on the German Cities between 1943 and 1945 triggered particularly acerbic remarks: “*The destruction of Germany, be it 100 times merited, is one of the most appalling world-catastrophes.*”<sup>20</sup> The Allied victory of 1945, which Tolkien saw as soiled by the unlimited violence unleashed by the winners, and most of all by the destructions caused by air warfare, inspires one of the most potent moral themes of the *Lord of the Rings*: the near-impossibility to defeat Evil without giving in to the temptation to use Evil’s own weapons to win, and therefore to be corrupted beyond salvation. “*An ultimately evil job. For we are attempting to conquer Sauron with the Ring.*”<sup>21</sup> This theme was impressed upon Tolkien, among others, well before 1914, by Wagner’s *Ring der Nibelungen* saga, whose narrative obviously inspired the main story of the *Lord of the Rings*. The Second World War clearly added to this chain of thought: “*Well the first War of the Machines seems to be drawing to its final inconclusive chapter – leaving, alas, everyone the poorer, many bereaved or maimed and millions dead, and only one thing triumphant : the Machines.*”<sup>22</sup>

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18. Letter no. 92, dated December 18th, 1944, to Christopher Tolkien. *The Letters of J. R. R. Tolkien. op. cit.*

19. Letter no. 100, dated May 29th, 1945, to Christopher Tolkien. *The Letters of J. R. R. Tolkien. op. cit.*

20. Letter no. 96, dated January 30th, 1945, to Christopher Tolkien. *The Letters of J. R. R. Tolkien. op. cit.*

21. Letter no. 66, dated May 6th, 1944, to Christopher Tolkien. *The Letters of J. R. R. Tolkien. op. cit.*

22. Letter no. 96, dated January 30th, 1945, to Christopher Tolkien. *The Letters of J. R. R. Tolkien. op. cit.*



A Nazgûl flies towards Barad-Dûr (*The Lord of the Rings*). ©John Howe (www.john-howe.com)

These feelings are even stronger when they are expressed towards air warfare, as allusions to the writing of the *Lord of the Rings*: “My sentiments are more or less those that Frodo would have had if he discovered some Hobbits learning to ride Nazgûl-birds, ‘for the liberation of the Shire’.”<sup>23</sup> And sometimes much more explicitly: “As long as war is fought with such weapons, and one accepts any profits that may accrue (...) it is merely shrinking the issue to hold war-aircraft in special horror. I do so all the same...”<sup>24</sup> Finally, the expression of sheer horror that follows the atomic bombing of Hiroshima does not call for further comment: “The news today about ‘Atomic bombs’ is so horrifying one is stunned. The utter folly of these lunatic physicists to consent to do such works of war-purposes: calmly plotting the destruction of the world!”<sup>25</sup>

23. Letter no.100, dated May 29th, 1945, to Christopher Tolkien. *The Letters of J. R. R. Tolkien. op. cit.*

24. Letter no.92, dated December 18th, 1944, to Christopher Tolkien. *The Letters of J. R. R. Tolkien. op. cit.*

25. Letter no.102, dated August 9th, 1945, to Christopher Tolkien. *The Letters of J. R. R. Tolkien. op. cit.*

In one of these long letters, written in July 1944, Tolkien sums up the preceding developments with intense clarity: “*There is the tragedy and despair of all machinery laid bare. Unlike art which is content to create a new secondary world in the mind, it attempts to actualize desire, and so to create power in this World; that cannot be done with any real satisfaction. (...) our devices not only fail in their desires but turn to new and horrible evil. So we come inevitably from Daedalus and Icarus to the Giant Bomber. It is not an advance in wisdom!*”<sup>26</sup>



Eowyn challenges the Witch-King of Angmar (*The Lord of the Rings*).  
©John Howe (www.john-howe.com)

### Air power in Tolkien's works, really?

Tolkien insisted that his legends were not allegories (a literary genre which he despised almost as much as the works of Shakespeare). In the preface to the Second Edition of the *Lord of the Rings*, and in his innumerable letters to his friends and admirers, he persistently and vehemently denies having written an imitation of the Second World War. It would then seem pointless to attempt to correlate to the air events of the history of Middle Earth (actually quite rare in the infinite mass of narrative developments written by Tolkien) with influences or metaphors of real events. If however, such an attempt is to be made, a clear distinction appears in the typology of the different stories, depending on whether the action is conducted by aerial characters from the sides of Good or of Evil.

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26. Letter no. 75, dated July 7th, 1944, to Christopher Tolkien. *The Letters of J. R. R. Tolkien. op. cit.*

The forces of Evil who use the air battlespace (dragons and winged Nazgûl, mostly) do so in the pursuit of a pragmatic and direct tactical or strategic advantage. We find here the modern paradigm of air power, that of the air forces of the 20th Century. When the first Lord of Darkness, Morgoth, is about to lose the War of Wrath (waged by the divinities of Good to save Middle Earth at the end of the *Silmarillion*), he unleashes by surprise his winged dragons<sup>27</sup>, similar in essence to a *Wunderwaffe*. The argument of Bilbo's adventure is the attack and destruction from the air of the dwarven underground fortress under the mountain Erebor and the human city of Dale by the dragon Smaug, brought there by the famous wealth of the Dwarf king<sup>28</sup>. The Fellowship of the Ring's movements are spied by the Crebain, an evil species of Raven<sup>29</sup>. The Nazgûl, wraiths and slaves to the Ring, use their monstrous winged mounts to change the course of battles (so of the air attack that wounds Faramir as he retreats from Osgiliath<sup>30</sup>, or of the onslaught that stops the cavalry charge of Théoden and the Rohirrim during the Battle of the Pelennor Fields<sup>31</sup>), and to break the will of the defenders of Minas Tirith when it is besieged<sup>32</sup>. These evil air actions are varied and can easily be allocated in the modern catalogue of airpower mission types: strategic and/or terror bombing, close air support on the battlefield, aerial reconnaissance... The actors are creatures that are indeed fantastic but are part of the "ordinary" bestiary of Tolkien's imagination. They sometimes wield or come from Magic but are always, flesh and bones, part of the fantasy world, and they always are an offspring of the will for power that is a characteristic of Evil (dragons are created by Morgoth, the winged creatures used by the Nazgûl by Sauron). Mechanisation and air warfare are presented as inherently evil, which is perfectly consistent with Tolkien's sentiments on the matter.

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27. "Chapter 24: Of the Voyage of Eärendil and the War of Wrath." in *The Silmarillion*. *op. cit.*

28. *The Hobbit*. *op. cit.*

29. "Book 2, Chapter 3: The Ring goes South," in *The Lord of the Rings*. *op. cit.*

30. "Book 5, Chapter 4: The Siege of Gondor," in *The Lord of the Rings*. *op. cit.*

31. "Book 5, Chapter 6: The Battle of the Pelennor Fields," in *The Lord of the Rings*. *op. cit.*

32. "Book 2, Chapter 3: The Ring goes South," in *The Lord of the Rings*. *op. cit.*



Smaug burns the city of Escargoth (*The Hobbit*). ©John Howe (www.john-howe.com)

When the forces of the side of light intervene from the air, however, they do so on a very different tone. They appear through only one type of creature (the giant eagles and their two successive leaders, Thorondor and Gwaihir), whose action is almost exclusively a miraculous narrative development. Thorondor claws at Morgoth's face and brings back *in extremis* the body of Fingolfin, High King of the Noldor Elves, after his desperate duel against the Lord of Evil<sup>33</sup>. He saves Húrin and Huor, surrounded by orcs during the defeat of Dagor Bragollach, while Morgoth destroys by surprise the allied kingdoms of Elves and Men who resisted him<sup>34</sup>, and he brings them to the hidden city of Gondolin, the last safe refuge on Middle Earth. He then saves Beren and Lúthien, a Human and an Elf destined through their marriage to bring forth Morgoth's fall, when they flee the infernal fortress of Angband after having stolen a Silmaril from Morgoth's crown<sup>35</sup>. He finally saves Glorfindel, Tuor and Idriel (another Men-Elf mixed couple from which salvation is doomed to come) during the fall of Gondolin, as the last elven realm is finally destroyed<sup>36</sup>. Thousands of years and two ages of the world later, Gwaihir and his brothers help the dwarves, Bilbo and Gandalf to evade orcs and

33. "Chapter 18: Of the Ruin of Beleriand and the Fall of Fingolfin." in *The Silmarillion*. *op. cit.*

34. *Ibid.*

35. "Chapter 19: Of Beren and Lúthien." *op. cit.*

36. "Chapter 23: Of Tuor and the Fall of Gondolin." *op. cit.*

wargs and the burning trees and set them on their way through Beorn's lands<sup>37</sup>. They then turn the tide of the desperate Battle of the Five Armies<sup>38</sup>, save Gandalf from the rooftop of the tower of Orthanc where Saruman holds him prisoner<sup>39</sup>, save him again from the Mountains of Mist after his duel with the Balrog<sup>40</sup>, attack the Nazgûl by surprise in the hopeless Battle of the Black Gate<sup>41</sup>, and finally save Frodo and Sam from the fiery chaos of Mount Doom<sup>42</sup>.



Gwaihir saves Gandalf from Isengard (*The Lord of the Rings*). ©John Howe  
([www.john-howe.com](http://www.john-howe.com))

This repetitive list aggregates miraculous interventions that save the desperate narrative situations in which Tolkien liked to put his unfortunate heroes. It seems to be more than an allegory (foul world for any Tolkienist) of the Royal Air Force *Lysander* aircraft infiltrating or exfiltrating special forces operatives in the heart of German-occupied Europe. Furthermore, on a purely historical perspective, most of these stories were written long before the start of the Second World War: the many texts, stories, tales and lays that would become the *Silmarillion* in 1977 were first imagined, written, redacted and re-written between 1917 and 1937.

37. "Chapter 6: Out of the Frying-Pan into the Fire." in *The Hobbit*. *op. cit.*

38. "Chapter 17: The Cloud Burst." in *The Hobbit*. *op. cit.*

39. "Book II, Chapter 2: The Council of Elrond." in *The Lord of the Rings*. *op. cit.*

40. "Book III, Chapter 5: The White Rider." in *Ibid.*

41. "Book VI, Chapter 4: The Field of Cormallen." in *Ibid.*

42. "Book VI, Chapter 3: Mount Doom." in *Ibid.*

Indeed, it seems more relevant to interpret these developments as a cover for divine intervention, the divine element being curiously very passive, directly, rather than a use of air power in the service of Good. Despite an extensive and very detailed cosmogony, particularly in the *Silmarillion*, with a One God (Eru-Ilúvatar), major angelic powers (the Valar) comparable to the Greek or Roman pantheon, and their servants (the Maiar), Tolkien's works only rarely forces these divinities to intervene directly in the elven or human affairs, still critical. And when that happens, it is when Evil has triumphed and victory becomes out of reach of the main characters. In all the rest of the narrative, as long as stories stay within an elf's grasp, the gods influence the actions only indirectly, through intermediaries whose links to the divine is never more than alluded to.

The race of eagles, which appears, as seen above, quite often in desperate situations, is associated to the Vala Manwë, earthly God of air and of the winds, the most powerful Vala and the closest in counsel to the will of Eru. In *The Lord of the Rings*, there is a manifest complicity between Gandalf, whom the last annex describes cautiously as a Maia named Olorin, affiliated to Manwë, and Gwaihir, the Lord of Eagles of Middle Earth, scion of Thorondor. It is to be noted that in the longest lay written by Tolkien, *The Children of Húrin*, the sky is quite empty of any benevolent actor above the hero Túrin, cursed by the Dark Lord and abandoned to his fate by the divinities of Good, who do not possess the power to revoke the curse...

It is very clear indeed that for Tolkien, the airborne interventions on the side of Good are indirect manifestations of divine aid given to heroes, not air power incarnate. An anecdote illustrates perfectly how the eagles were not instrumental in Tolkien's narrative developments: to an admirer who candidly asked him in a letter why in heaven the Hobbits didn't travel to Mount Doom on eagle back with the Ring, saving themselves thousands of leagues on foot and countless dangers, the teacher of ancient literature answered in front of a journalist with a smile and a distinguished "Shut up"...<sup>43</sup>

### **Tolkien, air warfare thinker ?**

Tolkien, as we have seen, categorically refused that the *Hobbit* or *The Lord of the Rings* be read as allegories of the two World Wars. However, it is obvious, with the insight of several decades, that he had understood, with much depth and deep disgust, the military revolution that was the formidable development of combat aviation between 1914 and 1945. It cannot be denied that Tolkien demonstrated, in the very few narratives in his works that are akin to air power employment, often happening on the Evil side, a strategical and tactical depth of perception far richer than his description of ground battles, which are almost exclusively driven by aesthetical and philosophical considerations, and are perfectly absurd when viewed through modern operative paradigms.

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43. The conversation, short, subtle, and deliciously full of British humour, is available on [YouTube](#).

Even though it is absolutely certain that Tolkien had not read the air warfare theorists of the 1920s and 1930s, the influence of their ideas in the collective subconscious probably led to the development of specific themes in Tolkien's works, particularly the psychological impact of strategic bombings as advocated by Giulio Douhet<sup>44</sup>. It is hard, when reading the description of the siege of Minas Tirith and the fear instilled into the hearts of the defenders by the Nazgûl, simply by loitering above the walls, not to make the link with the latent anguish and the terror lived by the victims of the *Luftwaffe* bombings on British cities during the *Blitz*: “Ever they circled above the City, like vultures that expect their fill of doomed men's flesh. Out of sight and shot they flew, and yet were ever present, and their deadly voices rent the air. More unbearable they became, not less, at each new cry. At length even the stout-hearted would fling themselves to the ground as the hidden menace passed over them, or they would stand, letting their weapons fall from nerveless hands while into their minds a blackness came, and they thought no more of war; but only of hiding and of crawling, and of death.”<sup>45</sup>



The Siege of Gondor (*The Lord of the Rings*). ©John Howe (www.john-howe.com)

More generally, and with the reserves and caution discussed above, several key characteristics of air warfare are tenuously visible in Tolkien's works. We have identified three of them for further commentary, as they are also some of the most fundamental aspects of modern air power:

- The ability to decisively invert the balance of strength on a battlefield in a very short timeframe, through a sudden and violent tactical intervention. Morgoth, cornered by the Valar, temporarily reverts the course of the War of Wrath by releasing the Uruloki, his winged dragons. The eagles turn the

44. G. Douet. *La maitrise de l'air* (Paris: Economica, 2007): 438.

45. “Book V, Chapter 4: The Siege of Gondor.” in *The Lord of the Rings. op. cit.*

tides of two desperate battles by their sudden (and miraculous, need it be said again) onslaught: at the Battle of the Five Armies in *The Hobbit*, and during the Battle of the Black Gate in the *Lord of the Rings*;

- The compression of distances and time, particularly through what we would call today air mobility, and both its tactical and strategic variants. Tolkien had an obsession for making the multiple branches of the Lord of the Rings' narrative structure temporally consistent, to the point of using a real-life calendar, that of 1942, as a reference for event dates in the tale – only the months' names were changed according to his philological tastes. Sorting out the Lord of the Ring's timetable took him several years after he finished writing the book (around 1948), and postponed the publication to 1952. Characters had to be moved very quickly between distant places, which could only be done on Eagles' backs, notably Gandalf from Orthanc to Rivendell and from the summit of Zirak-Zigil to Lothlorien, and Frodo and Sam from Mount Doom to the field of Cormallen. These narrative tricks created philosophical opportunities to insert, at key moments of the intrigues, divine interventions. They also show how even the most ferocious adversary of the very idea of an air force had to submit to air transport being the only way to mitigate the tyranny of distances, which was made even worse by the slow pace of available ground transport (walking or, at best, horse riding) in the pseudo-medieval setting of Tolkien's imagination;
- The intuitive, almost systematic correlation between air dominance and military victory, that is obvious on the battlefields of Middle Earth. The Valar only achieve victory in the War of Wrath (the first war of Tolkien's alternative history that include air power) when Eärendil descends from the skies with a Silmaril, defeats the winged dragons with the help of all the birds, and throws down Ancalagon the Black, the mightiest of the Uruloki, on the accursed mountain that stands over Morgoth's fortress. The Battle of the Five Armies and the Battle of the Black Gate are indecisive if not outright disasters until the eagles enter the fray. The victory on the Pelennor Fields, that ends the siege of Minas Tirith, becomes possible when the Nazgûls are neutralized, in a surprisingly early feminist heroic scene. This correlation, which cannot have been obvious for the First World War infantry officer, becomes an indisputable fact during the Second, even for the most ardent critic of the *Royal Air Force*. Air superiority becomes a very visible condition to the success of any ground or naval offensive action, particularly on these theatres for which news were abundantly available to the British audience.

It is anyway obvious that Tolkien did not reflect in depth on these matters. If it is possible to extract air strategy concepts from the narrative patterns of his works, it is against his deepest moral convictions, and the intuitions explained above are more testimonies of the rapid penetration of the air factor in western culture between the two World Wars.

Tolkien, air power specialist? The question itself makes no sense, Tolkien saw in warplanes the ultimate outcome of the mechanization of the world, a tool evil in nature, both in its intents and in its designs: “*But it is the aeroplane of war that is the real villain.*”<sup>46</sup> His flesh marked by the brutality of industrial warfare, deprived of his friends by the terrible year of 1916, Tolkien hated war and never really reflected on questions of military doctrine, even less so on the employment of air power. He categorically refused any interpretation of his works as an allegory of the real world, and just wished to create a heroic and fantastic legendarium, certainly inspired by the Greek, Scandinavian and Germanic myths and values, but totally disjointed from the real history of mankind. The aerial characters in Tolkien’s works are among the least developed of all, with almost no personality, no voice, and no inner conflicts. As silent, gigantic animals, they appear either as stoic divinities, or as paragons of brutal and evil bestiality.

Tolkien did not read the air warfare theorists of his time: he probably did not even know the names of Douhet or Mitchell. The triumphant military relevance of air warfare was obvious to any European citizen, all the more so to the British subjects. It is therefore quite understandable that the writing of a monument of literature, in which war is present in almost every chapter, should have been influenced by the deadliest conflict in human history, and that the martyrdom of London, Dresden or Tokyo should find a faint echo in the despair of the Gondorian soldiers defending Minas Tirith.

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46. “*But it is the aeroplane of war that is the real villain,*” Letter no.100, dated May 29, 1945, to Christopher Tolkien, in *The Letters of J. R. R. Tolkien. op. cit.*

## ***HISTORY***



# WWI and the Birth of Strategic Aerial Intelligence

Baptiste Colom-y-Canals

The Battle of Fleurus in 1794 brought forth the advent of the balloon for enemy observations, and with it, the third dimension proved its centrality in informing command. Throughout the 19th century, the eyes of various military powers drew towards this new method of data collection, and further refined it for battle. By the end of the 1800s, the use of observation balloons successfully proliferated in all conflicts, including colonial conquest campaigns<sup>1</sup>. Notably, it was used for battlefield surveillance, observation of enemy lines, topographical reconnaissance, and artillery adjustment. Nonetheless, balloons remained bound within the boundaries of the tactical domain, as their mobility difficulties restricted both their assemblage and use.

By the turn of the 20th century, the world saw its first aircrafts. This enthralled military personnel worldwide, who quickly moved to secure the new equipment and capitalise on their capabilities. As military aeronautics began to take form in France, a debate emerged, pitting artillery against engineering<sup>2</sup>. Specifically, the former argued that the ideal use of aircrafts lay in conducting observation missions to detect enemy artillery and inform firing. Alternatively, the latter viewed the aircraft as the perfect instrument to expose any advancing enemy troops *via* their long-range reconnaissance missions. In this wrestling match to assert control on the fledgling military aeronautic, this dispute essentially came down to those who favoured the aircraft for tactical use and those who preferred the strategic exploitation of aerial reconnaissance. Such a discord is but only a reflection of the high stakes that intelligence-gathering missions hold for each service branch. In short, even back then, the perceived advantages of aerial reconnaissance had already begun to shape the framework of use for this novel instrument in intelligence-gathering.

The constitution of *Aéronautique Militaire* in 1912 – followed by major changes during the following years – highlighted the importance the general staff, particularly General Joseph Joffre, gave to aerial observation during ope-

1. L. Kennett, *La première guerre aérienne 1914-1918* (Paris: Economica, 2005): 3.

2. P. Vennesson, *Les chevaliers de l'air: aviation et conflits au XX<sup>e</sup> siècle* (Paris: Presses de Science-Po and Fondation pour les études de défense, 1997): 53.

rations, despite the first aircrafts' poor qualities<sup>3</sup>. Indeed, the military recognised the value of aerial observation well before the World War I. Its roles in ensuring the scouting of troops and adjusting artillery fire were widely acknowledged. However, its widespread use remained contested. Lee Kenneth aptly explains how this medium of intelligence-gathering, which was highly dependent on the pilot's own naked eye and immediate interpretation, was not always considered reliable by the command, who only accepted such observations with a grain of salt<sup>4</sup>. In this respect, WWII appears to have been a large-scale laboratory test for aerial intelligence. Patrick Facon appropriately describes this period as a "decisive experiment"<sup>5</sup>, since the war not only put to test the hypotheses developed prior to 1914, but also served as an incubator to revisit previous manners of use and the emergence of newer ones.

For both the French Air Force and aerial intelligence, it was above all an inaugurating undertaking that would have a lasting impact on the perception of how aerial intelligence was to be used. Moreover, it was through this dispute that strategic aerial intelligence eventually took on the definition it is today. Hence, it is imperative to identify the pivotal factors that marked the development of the concepts of use. Namely, the ones that eventually endowed aerial intelligence with the strategic nature it needed to be reborn as a decision-making tool. In short, this article seeks to unravel how aerial intelligence rose to sit at the strategic level.

### **Indispensable Fundamentals: The Development of Tactical Aerial Intelligence**

During their very first operations in August 1914, aeroplanes were integrated into the French armed forces to conduct reconnaissance, locate enemy positions, and identify their axes of advance<sup>6</sup>. This use of aerial reconnaissance is very similar to that of cavalry reconnaissance: the aim is to uncover the adversary and successfully anticipate enemy movements during battle preparation. "In the event that there is insufficient information on where the bulk of opposing forces are situated, four cavalry divisions remain available at any given time to provide all necessary information"<sup>7</sup>. Aerial reconnaissance is hence only but one of the means available to the command to ensure manoeuvre safety. They were put into use in a similar way to the cavalry, which the command saw as having the additional advantage of an offensive potential<sup>8</sup>.

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3. P. Facon, *Histoire de l'armée de l'Air* (Paris: La Documentation Française, 2009), 25; and M.C. Villatoux, "Joffre: père méconnu de l'aviation militaire?" *Revue Historique des Armées*, no. 206 (March 1997): 3-16.

4. L. Kennett, *op. cit.*: 33.

5. P. Facon, *op. cit.*: 39.

6. J.-C. Delhez, *La bataille des frontières : Joffre attaque au centre 22-26 août 1914* (Paris: Economica, 2013), 46; and "Notes sur les opérations d'août 1914," *Cahiers du colonel Bellenger*, n.d., SHD, DEX, AI Z 35 435, Service historique de la Défense, Paris.

7. Editor's translation from F. Foch, *De la conduite de la guerre* (Paris: Economica, 2000): 61.

8. *Ibid*: 63.

The First Battle of the Marne in September 1914 marked the coming-of-age milestone for aerial reconnaissance at the strategic level. By notifying General Joseph Gallieni that General Alexander von Kluck's troops had turned around, aeronautics provided a clear account of Germany's manoeuvrings to French commanders, which provided the means for Joffre to seize his victory<sup>9</sup>. Yet, on the other hand, the shortcomings of Germany's aviation forces were precisely the reason *why* the movements of Commander Michel-Joseph Maunoury's Sixth Army failed to be located<sup>10</sup>. Aerial intelligence thus demonstrated its ability to provide strategic information.

This battle also offered insight into another avenue of potential: observation planes had the capacity to provide directions for artillery adjustment. Namely, this capacity created the opportunity for France to annihilate half of Germany's XVI Army Corps's artillery. It categorically showcased the potential and efficiency of observation missions for artillery adjustment<sup>11</sup>. Such success raised the credibility of aerial intelligence for Joffre. This, in turn, allowed the requests, made by Commander Joseph-Édouard Barès, chief of military aeronautics service, to increase the number of fielded squadrons to be accepted.

The stabilisation of the front in the fall of 1914 transformed how aerial observation was put into use. With the war of position entrenched, artillery took on a central role, and along with it, both planes and balloons became essential in ensuring the effectiveness of firing adjustments. Demands for both became so high that the French military had to relaunch an observation balloon programme, despite having abandoned this intelligence-gathering vector back in 1911. Additionally, the balloon also served as observation posts that watched over the front lines, all while adjusting artillery batteries over extended periods<sup>12</sup>. However, such novel ways of utilisation created communication issues between artillery batteries and both observation balloons and aircrafts. Initially, aviators depended on flares or weighted message streamers, but both regrettably generated misunderstandings and communication delays with artillerists.<sup>13</sup> By early 1915, the first radio sets were introduced in aircrafts, which notably improved communications with artillery batteries<sup>14</sup>. This landmark innovation led to the creation of a, more or less, intelligence-gathering system that integrated aircrafts and sensors with means of transmission. As transmitters and receivers then evolved to become lighter, the use of radios became widespread from 1916 and onwards. This constituted the first functional link, which reinforced the effectiveness of artillery adjustment missions.

9. "Comment fut découverte l'inflexion de la 1<sup>re</sup> armée allemande," *Cahiers du colonel Bellenger*, n.d., SHD, DEX, AI Z 35 435, Service historique de la Défense, Paris.

10. L. Kennett, *op. cit.*: 35.

11. T. Finnegan, *Shooting the Front: Allied Aerial Reconnaissance in the First World War* (Gloucestershire: Spellmount, 2011): 43.

12. J. de Cagny, "Aérostiers de 1914-1918," *Revue Historique des armées* 2, no. 123 (1976): 69-90.

13. *Cahiers du colonel Bellenger*, n.d., SHD, DEX, AI Z 35 435, Service historique de la Défense, Paris.

14. T. Finnegan, *op. cit.*: 50.

Indeed, trench warfare, with the establishment of an elongated front, the excessive dependence on artillery and the resulting destructive terrain upheaval obliged the general staff to launch a vast cartographic program. This was necessary not only in updating the topographic base, but most importantly, in re-drawing maps at more precise scales that would be better adapted to the needs of positional warfare<sup>15</sup>. Producing these revised maps to fuel artillery master plans became the topmost priority. Needless to say, after the autumn of 1914, aerial photography proved to be essential in the collection of adequately precise technical data, which was the prerequisite for the creation of such invaluable maps. Despite this, it took the perseverance and tenacity of three officers for the general staff to wholly recognise the value of aerial photography.

The first of the three, Captain Georges Bellenger, conceived the idea of experimenting with cameras to capture the exact layout of enemy defence systems<sup>16</sup>. Aerial photography not only took in substantially more details than the naked eye, it also allowed for a detailed post-analysis of its images. However, Bellenger, was confronted with the problem of calculating the necessary scale transpositions required to faithfully recreate the reality of the terrain on a topographic map with precision.

It was only through the work of artillery officer, Lieutenant Grout, that a reliable photogrammetry process was developed to produce topographical maps with the accuracy level needed for artillery adjustment. At the end of 1914, Grout also formed the first photography section attached to a reconnaissance squadron. This became the first step towards the organisation of a photographic interpretation structure. The analytical work this was to produce would not only translate aerial photographs into topographical data, but also contribute to the overall collection of enemy information<sup>17</sup>.

Finally, Second Lieutenant Paul-Louis Weiller built on these photogrammetric processes. The army's cartographic databases subsequently underwent an overhaul with improved methodology. As a result, detailed maps for the general staff, replicating the reality of the terrain to the highest possible accuracy, were drawn up<sup>18</sup>.

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15. *Ibid*, p. 131.

16. *Cahiers du colonel Bellenger, op. cit.*

17. T. Finnegan, *op. cit.*: 49.

18. J. Mousseau, *Le siècle de Paul-Louis Weiller 1893-1993* (Paris: Stock, 1998): 133.



Photo of Paul-Louis Weiller.

Source: Gallica Digital Library, *Bibliothèque nationale de France*.

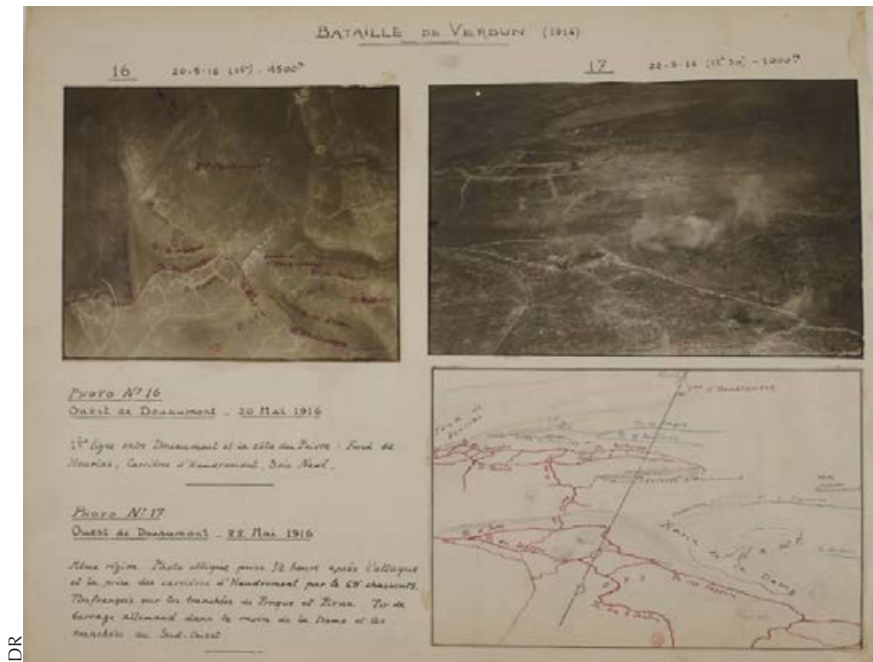
Needless to say, these three officers significantly contributed to standardising the use of aerial photography in cartographic production, which, in turn, granted recognition to the medium as a reliable and valued source of intelligence. The master plan that was specifically developed for operational purposes, became henceforth dependent on the exploits of aerial intelligence. This blueprint was a highly accurate map detailing the front at a grand scale, which eventually merged with other sources of intelligence. Unsurprisingly, from 1915 onwards, this working document was no longer solely used by the artillery, but also by the general staff<sup>19</sup>.

The centrality of artillery preparations in the planning and conduct of operations further underscored the need for tactical aerial intelligence. The essential role that intelligence-gathering vectors played – along with the maintenance of their capacities – was a principal concern for the *Grand Quartier Général* (general headquarters of the French Army, hereafter “GQG”) throughout the Battle of Verdun. Indeed, each side endeavoured to neutralise the enemy’s observation aircrafts in order to adjust its artillery fires and stay the initiative.

The Battle of Verdun in 1916 thus demonstrates the completion of the first structuring stage of aviation as an intelligence system. This systematisation of tactical data collection by the army corps’s observation aircrafts made it possible to further develop: firstly, the master plan on a tactical scale; then an intelligence system that structured data collection; followed by imagery interpretation conducted by the photography section; and finally, a working document with the above information synthesized for the artillery to use. Nevertheless, this tactical aerial intelligence gathering, which only operated in the immediate vicinity of the front line, could do nothing to disclose the activity within the enemy’s rear<sup>20</sup>. As a result, the general staff began to show an interest from a strategic standpoint towards acquiring capacities that could gather intelligence from further distances, particularly on the preparation of enemy attacks.

19. P.-L., Weiller, “L’aviation française de reconnaissance”, in *L’aéronautique pendant la guerre* (Paris: Maurice de Brunoff Editions, 1919): 63-94.

20. *Ibid.*



Sketches and photographs from the album by Georges Sirot (1898-1977).

Source: G. Sirot, "Vues aériennes du front, de l'Artois à la Lorraine," in *Campagne 1914-1918: Photos d'avions* (Gallica Digital Library, Bibliothèque nationale de France, 1915-1918).

## The Emergence of New Strategic Needs

Beyond the above, the Battle of Verdun also highlighted the preeminence of aerial photography in assessing the destruction caused by heavy long-range artillery. This, in turn, underlined the importance of obtaining up-to-date information to accordingly adapt, especially at the last moment, any necessary changes to planning<sup>21</sup>. Even though such use concerned the tactical domain, it denotes an evolution in the treatment of aerial intelligence. General Philippe Pétain, who was very much interested in such prospects, encouraged the creation of a unit dedicated to photographic interpretation within his staff of the Army Group Centre<sup>22</sup>. The preparation of offensives in this context of positional warfare – involving firstly the planning of artillery preparation at the operational level, then the increasingly important use of long-range heavy artillery, and finally, the precisely planned progress of the infantry advances – all contributed to elevating aerial intelligence into a planning tool. This was all the more valuable in that the information it acquired could, owing in part to reconnaissance missions, be updated within a fairly short period of time. This use quickly led to the systematic

21. *Ibid.*

22. T. Finnegan, *op. cit.*: 71.

study of aerial photographs at the army group level to finetune the effectiveness of artillery preparation *vis-à-vis* the enemy's positions.

The Battle of the Somme in the summer of 1916 thus confirms the enthusiasm at the time towards such an application. Fittingly, a reconnaissance pilot's testimony illustrates this awareness: "General Ferdinand Foch, then commander of the Army Group North after the bloody failure of the Second Colonial Corps – I believe – on Bouchavesnes, had in an order, which has remained infamous, said verbatim: 'From now on, no infantry attack should be launched without having confirmed with certainty, via a thorough study of aerial photographs, that the position to be taken is ripe for assault'"<sup>23</sup>. In short, the failure of that offensive led towards a transition of operations at a larger scale, which addressed the entire scope of Germany's defences, including its rear lines.

To meet this demand, the GQG subsequently decided to create army reconnaissance squadrons to obtain a panoramic view of enemy defences. These squadrons were responsible for collecting aerial intelligence up to 25 km beyond the front line<sup>24</sup>. This more or less operational mission also involved a strategic scheme. Essentially, this was a matter of ensuring the army's safety by preventing enemy preparations. It was done by organising – through the grace of aerial intelligence and the meticulous, routine collection of aerial photographs – a surveillance that formed the premises of a strategic watch. The success of this mission was possible owing to the analytical work of the photography sections, which exploited the intelligence collected and interpreted, before compiling it into regularly updated data files of targets<sup>25</sup>. This organisational procedure in its entirety directly supplied the army and army group staff with both an abundant quality and quantity of intelligence to incorporate into their respective levels.

Yet, this was a procedure that depended on the collection capacity of reconnaissance squadrons. When the French Air Force lost control of the air, as it did in the spring of 1917, its data collection capabilities dropped, and with it, the effectiveness of aerial intelligence itself. Despite this, the need for aerial intelligence became even more pressing as preparations for the planned offensive in the Chemin des Dames sector went underway. Indeed, artillery preparation was the key to success in the operational planning devised by General Robert Nivelle<sup>26</sup>.

To encapsulate, the entirety of data collection had been oriented towards fulfilling tactical and operational objectives, whose synthesis was necessary in providing the most truthful representations of terrain preparations for high command. However, the superiority of Germany's fighter fleets unfortunately hindered the

23. Editor's translation of *Lettre anonyme d'un officier observateur*, 2 May 1917, AN 313, AP 122, Archives privées, Archives nationales de France, Paris.

24. T. Finnegan, *op. cit.*: 66.

25. P.-L., Weiller, *op. cit.*

26. *Note pour les armées au sujet de la préparation d'artillerie*, 7 March 1917, document no. 796, t.V. annexe vol. 2, Groupe d'armées de réserve, Armées françaises dans la Grande Guerre, Archives nationales de France, Paris.

success of such information-collecting missions<sup>27</sup>. Even more detrimental was that April of 1917 was marked by recurrent bad weather conditions, amongst them violent winds, persistent cloud cover, and even snowfalls<sup>28</sup>. This all only further complicated aerial intelligence gathering. Yet, while both the army and army group level generals were aware of the shortcomings of such missions<sup>29</sup>, Nivelle – keen on completing his operational planning – did little to take these issues into consideration. Two days before the launch of the offensive, the scarce aerial photographs captured only exposed the inefficiency of artillery preparations<sup>30</sup>.

In short, the failure of the Chemin des Dames offensive in the spring of 1917 only corroborated the lessons accumulated from previous operations. Acquiring aerial intelligence deep into enemy lines was not only essential for operational planning, but also for their successful execution. The GQG's initial scepticism, along with the absence of strategic intelligence gathering from its direct destination prevented the development of a total, realistic view of a situation. Having understood the value of strategic aerial intelligence, Nivelle proposed, upon said offensive's termination, to establish a system to equip him with such a genre of intelligence for him to exploit as needed. Aerial photographs would "provide high command with scrupulous data on the strength of defensive organisations and the state of the artillery's destruction [...] These reports were all the more prized as they were delivered with rapidity"<sup>31</sup>. In essence, Nivelle detailed an aerial intelligence system based on the interpretation of aerial photographs, which became the eyes of high command and guided their strategic decisions.

## **1918: The Birth of Strategic Aerial Intelligence**

Convinced of aerial intelligence's importance for high command in its strategic potential, observation pilot and hero of reconnaissance aviation, Weiller and then commander of the Br 224 reconnaissance squadron, proposed to form a squadron dedicated solely to long-range reconnaissance. This squadron would gather intelligence up to 40 km beyond the front lines. His intention was to use the collected data to provide high command with a comprehensive view of both the front and the enemy's rear<sup>32</sup>.

A year later, in the spring of 1918, when the German offensive thwarted Allied reconnaissance surveillance, this further proved the need to expand the range of intelligence gathering, both in terms of scope and objectives. It also altered

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27. *Lettre du commandant la VI<sup>e</sup> armée au commandant le GAR*, 6 April 1917, SHD, GR 18 N 406, Service historique de la Défense, Paris.

28. *Bulletins quotidiens de l'activité aérienne*, April 1917, SHD, GR 16 N 1093, Service historique de la Défense, Paris.

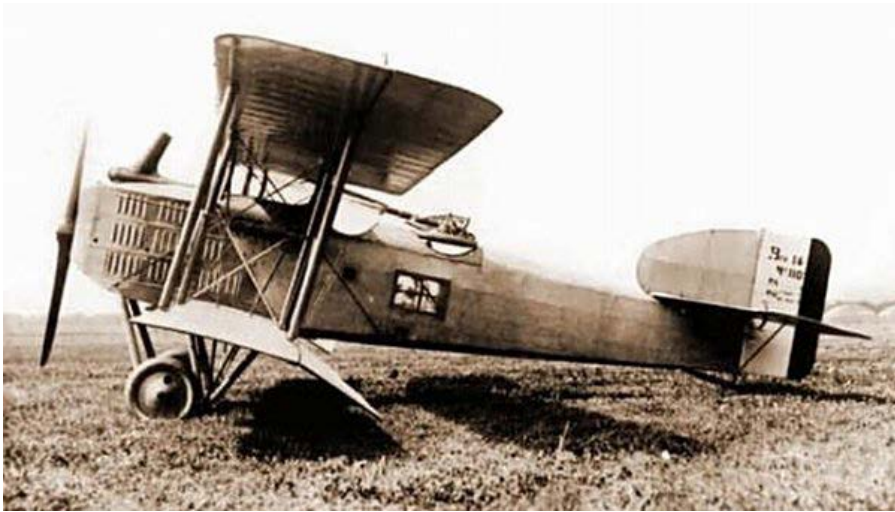
29. *Lettre du commandant la VI<sup>e</sup> armée au commandant le GAR*, *op. cit.*

30. *Bulletins de renseignements de la I<sup>re</sup> armée*, 14 April 1917, SHD, GR 18 N 398, Service historique de la défense, Paris.

31. *Editor's translation of Note du général Nivelle pour les groupes d'armées et les armées*, 24 April 1917, SHD, GR 16 N 1762, Service historique de la défense, Paris.

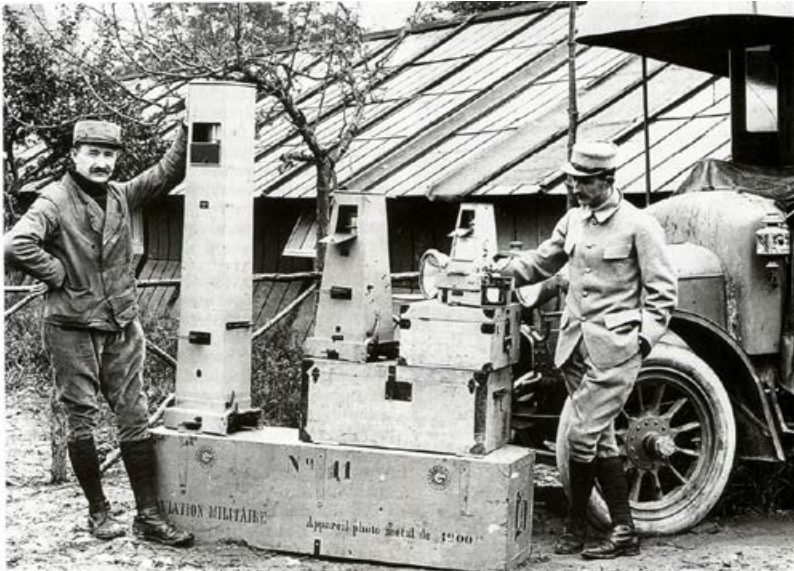
32. J. Mousseau, *op. cit.*, 153.

the nature of operations, marking a return to the war of manoeuvre that called for different aerial intelligence needs. In short, it became necessary to obtain and transmit information on enemy intentions to the GQG without delay. In line with the high quality intelligence gathered by army reconnaissance aviation, along with the stellar results achieved of Weiller's squadron, the GQG subsequently moved forward to create army group reconnaissance squadrons.



© SHD

*Bréguet 14 ready to take off.*



DR

Aerial cameras with 120 mm, 50 mm, and 26 mm focal lengths.

Source: Photographic archives, Service historique de la défense de l'armée de l'Air.

This seamlessly led to the new *Breguet XIVs*' entry into service, which equipped reconnaissance aviation with aircrafts that had a greater range of action and a more substantial payload for conducting in-depth intelligence-gathering missions. The modernisation of both the collection platform and its cameras increased the collection capacity, contributing to a more rapid coverage of larger areas. Similarly, the arrival of the first flexible photographic films and the first automatic cameras that were adapted for aeronautic use, enhanced the automation of photographic processes<sup>33</sup>. The combination of these technological innovations henceforth revolutionised intelligence-gathering missions, increasing both their coverage capabilities and the potential of aerial intelligence as a whole.

In July 1918, Foch sought to acquire a strategic aerial intelligence capability to not only secure preparations for his next offensives, but most importantly, to foil any potential German counter-offensive. He therefore asked Weiller to form a group of squadrons dedicated solely to such vital reconnaissance missions and gather strategic aerial intelligence for army groups and the GQG. Directly placed under the orders of Foch, Weiller was granted complete freedom to not only carry out these collection missions, but also to take charge of their photographic interpretations.

He first set out by bringing into fruition a novel manner of conducting missions: equipping modified single-seater fighters with cameras to fly at high altitudes<sup>34</sup>. This innovative tactic produced spectacular results and laid the foundations for modern strategic reconnaissance missions. His group was able to provide photographic coverage of 1,500 km<sup>2</sup> per day. Their subsequent interpretations reached an industrial rhythm capable of analysing all the captured images. In order to anticipate the adversary's next manoeuvres, analysis was carried out everyday on the construction progress in Germany's rear lines, as well as surveillance on infrastructure and railway traffic<sup>35</sup>. Setting up data files for targets became a widespread and standardised task. An official organisation was established to produce summary documents based on aerial photographs that could be used at the strategic level. Strategic reconnaissance further monitored the enemy's depots and logistical nodes in order to anticipate their next actions. Foch's staff was thus able to predict the axes of future enemy offensives with a precise, realistic vision of how the situation was evolving.

To recapitulate, aerial intelligence in 1918 constituted an efficient system capable of satisfying the GQG's urgency for strategic intelligence in both quality and quantity. Weiller, in particular, greatly contributed to its development, which, in turn, became the founding pillars upon which modern-day strategic aerial intelligence and their systems are built. This in-depth reconnaissance of

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33. P. Ehrhardt, *Les chevaliers de l'ombre : la 33e escadre de reconnaissance* (Paris: Edipol, 1996), 1723.

34. J. Mousseau, *op. cit.*: 161.

35. M.-C. Villatoux, "Le renseignement photographique dans la manœuvre : l'exemple de la Grande Guerre," *Revue Historique des armées* 4, no. 261 (2010): 13; and T. Finnegan, *op. cit.*: 200.

the enemy's rear became known as "deep" or "long-range" reconnaissance. Indeed, WWI can be characterised by the importance of front lines at the ground level. This consequently heavily impacted the nature of strategic reconnaissance, which was then defined in terms of its ability to explore the enemy's rear areas in depth. The strategic intelligence collection missions were henceforth distinguished separately from those carried out at the tactical level, due to the notion of distances from the front line.

Strategic reconnaissance soon after focused on Germany's industrial regions that were directly involved in the war effort. Allied air forces launched a coordinated intelligence collecting campaign to photograph the industrial complexes of Lorraine and the Ruhr. Data files for targets would then be compiled in preparation for a strategic bombing campaign<sup>36</sup>. When the war came to an end, so did this project, giving way, instead, to the birth of strategic bombing, which fueled air power debates throughout the post-war period<sup>37</sup>. This collection campaign marked an increase in the power of information gathering. It proved how vital strategic aerial intelligence was for the planning of strategic bombing operations.

Moreover, this Allied intelligence-gathering campaign also raised the question of the definition of strategic aerial intelligence in relation to its perceived use. During the final months of the conflict, strategic aerial intelligence covered a very broad field, incorporating both intelligence on the enemy's rear with its industrial capabilities for the purpose of cutting off the enemy's economic potential and supplies to its troops. The field of aerial intelligence had then ventured beyond the operational sphere to occupy that of grand strategy. As a result, the field of strategic aerial intelligence was, on the contrary, not precisely defined post-1918. It depended essentially on the strategic objectives and needs of high command. The question of determining its field of action remained open, leaving the issue of its strategic perception and collection methods unresolved.

Although the high command had already perceived, from the very onset of aviation, the potential of strategic reconnaissance for securing the movement of armies, its definition did not reflect that of today's until WWI. This emergence gradually came to be during the War's four years. The artillery's growing needs in the war of position was highly influential in the eventual employment of aerial intelligence at the tactical level for the objective of optimising artillery adjustments. This exploitation standardised and diffused the use of aerial photography as a main source of intelligence gathering. Dedicated primarily to topographic surveying at first, the technology evolved rapidly to provide information on enemy positions as well. A master plan was thus conceived, born of different data merged together onto a cartographic medium.

The operational context specific to trench warfare led to the development of long-range artillery, whose effects had to be controlled via observation and

36. T. Finnegan, *op. cit.*: 208.

37. P. Facon, *Le bombardement stratégique* (Monaco: Editions du Rocher, 1996): 48.

aerial photography. Specifically, the use of aerial intelligence in the preparation and planning of offensives by the high command became essential. The strategic dimension of aerial intelligence was thus cultivated from the high command's ambitions to precisely and rapidly grasp the situation, first in the immediate vicinity of the front line, and then in the enemy's rear. Aerial intelligence, with its methodical and scientific use of aerial photographs, proved to be the only means to fulfil these requirements.

The operations from the years of 1916 to 1918 clearly highlighted the inter-playing dynamics between the constantly improving techniques for intelligence gathering and the expectations from the top. Nevertheless, this dynamic did not develop naturally. In 1915, the technical limitations of aerial reconnaissance to provide usable intelligence at the strategic level caused high command to lose interest. Hence, despite embarking in 1916, the integration of aerial intelligence into strategic operational planning did not become efficient and systematic until 1918. From the summer of that year onwards, Weiller aptly exploited technical innovations and know-how to establish a functional and operational service that would be capable of producing quality intelligence at high quantities.

Born from the needs of positional warfare to offer an insider's view of enemy intentions by studying their defensive and logistical arrangements, strategic aerial intelligence was at last accredited legitimacy with the resumption of manoeuvre warfare in 1918. It alone made it possible to scrutinise enemy movements and compile data files of targets for use by the artillery and the nascent bombing force. Indeed, strategic aerial intelligence made a name for itself in both effective decision-making and the planning of ground and air operations.

As in the words of Terrence Finnegan, France achieved the most dynamic track record in the field of strategic reconnaissance during WWI. In addition, the country trained the fledgling U.S. Air Force in aerial intelligence<sup>38</sup>. However, after the War, this inertia seemed to have died out. Although French generals were unanimously convinced of the value of using aerial intelligence in operations, they limited themselves to using it mostly for the benefit of ground battles, opting instead for aerial reconnaissance's tactical and operational uses. As a result, the perception of employing the air force remained contingent on the orientation and implementation of aerial intelligence collection, and more particularly, on its strategic dimension.

It hence continues to be an enigma that post-war debates on air weapon deployment went so far as to restrict the use of aerial intelligence, even after France developed the modern-day version of strategic reconnaissance. Nevertheless, the air forces of other countries continued their experimentations. At the beginning of WWII, the British Royal Air Force's Bomber Command's demand for strategic intelligence led to the creation of a full-fledged aerial photography service, operating purposely within the strategic sphere. This service became one of the predominant sources of strategic intelligence for the Allied High Command throughout WWII.

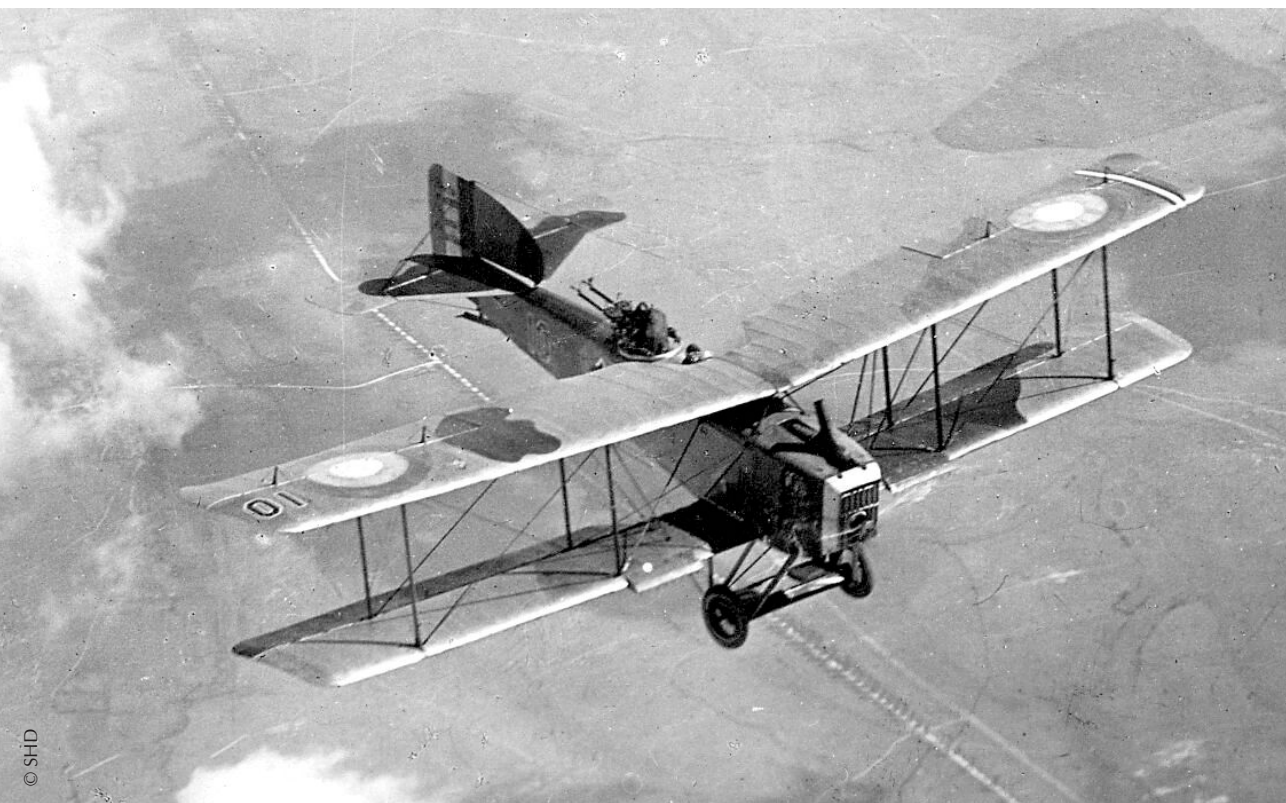
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38. T. Finnegan, *op. cit.*: 50, 80, and 148.



*Letord 12 with a vertical wide-angle camera.*

Source: Service historique de la défense de l'armée de l'Air.



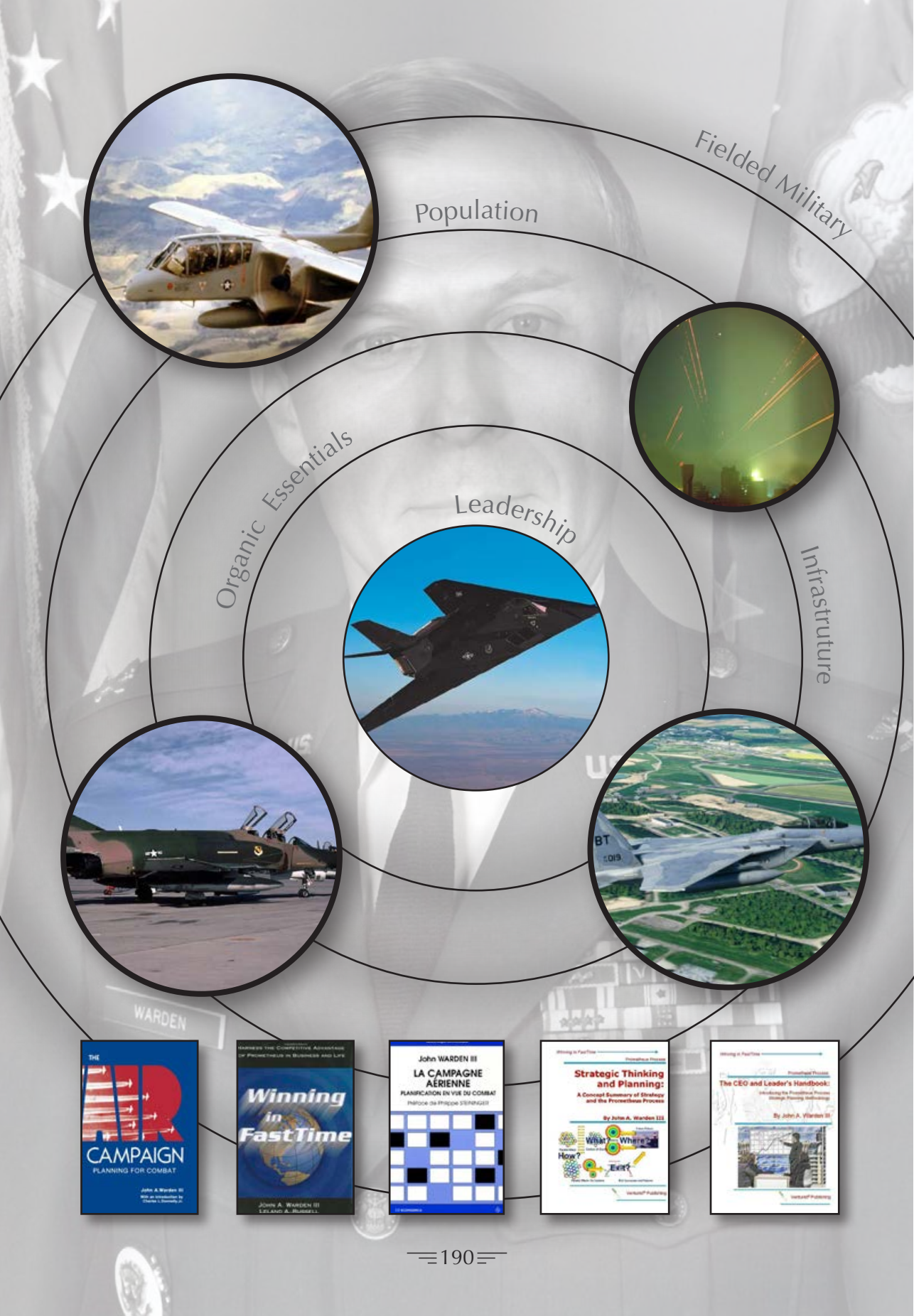
*Bréguet 14*



© SHD

*Salmson 2A2.*

# INTERVIEW



Fielded Military

Population

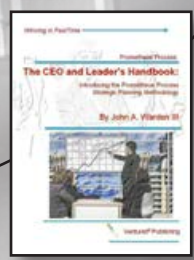
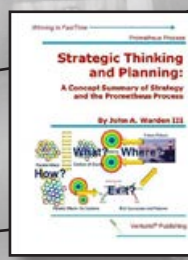
Infrastructure

Leadership

Organic Essentials



WARDEN



# Interview with colonel John A. Warden III

Jean-Christophe Noël



DR

## **1) Could you briefly describe your family background? Where in the US did you grow up and were any of your family members in the military?**

My father worked for a big corporation so we moved frequently. I grew up in Texas, Pennsylvania, and Maryland. My father was an officer in the Army Corps of Engineers and served in the Pacific, first year of the occupation of Japan included. My grandfather was a brigadier who commanded a significant logistics operation in India during the war. My uncle was a fighter and bomber pilot who was one of the last to leave the Philippines before its surrender and later played a major role in the B-52's development.

## **2) Why did you choose military aeronautics as a profession?**

Battles and wars interested me from an early age. My uncle, Henry Edward (Pete) Warden, had a very distinguished record in the Air Force, pointed out how the Air Force contributes so much to victory, and recommended aviation to me over the Army or Navy.

**3) It seems that you were initially disappointed by the Air Force Academy and you were hesitant to join West Point at the beginning of your second year. Is that right?**

I don't recall that there was any serious opportunity to transfer to West Point. My concern during and shortly after my first year was that airpower seemed less relevant to the US wars at the time than the Army did. Strangely enough, instructors at the Air Force Academy rarely were real airpower enthusiasts but rather big proponents of guerilla warfare and saw it as the solution to Vietnam. However, over the next three years as a cadet, I saw what was happening in Vietnam and had read enough history to change my mind.

**4) You graduated from the Academy in June 1965 and then were assigned to the F-4 Phantom at the 334<sup>th</sup> Tactical Fighter Squadron (TFS) at Seymour-Johnson AFB in North Carolina after your initial pilot training. Did you enjoy the F-4? Did you feel that the tactics you adopted then were appropriate for the Vietnam War that was about to start?**

I reported to the 334 tactical fighter squadron in the spring of 1967, at which point the war in Vietnam had been raging since the Gulf of Tonkin incident. The F-4 was a very good airplane for its time and seemed to be as appropriate for the war as any of the other aircraft in use then. The general concern about the F-4 in the squadron centered around the fact that it did not have an internal gun nor was it equipped with any kind of jamming pods. The lack of jamming meant that we practiced flying in a formation with a 4 ship spread over perhaps 1500 feet with the aircraft at varying altitudes designed to interfere with the SAM tracking resolution. It worked to some degree but was risky and difficult to fly precisely.

**5) You wanted to serve in Vietnam but finally did it on the OV-10 Bronco, which is a low-speed twin-engine with highly appreciated reconnaissance and fire support qualities for ground combat. Why did you make this choice?**

The 4<sup>th</sup> Tactical Fighter Wing deployed from Seymour Johnson to Korea in late January 1968 in response to the North Korean seizure of the USS Pueblo. During the time I was there, I became concerned that the war in Vietnam would end before I could get there in the F-4 so I told the Air Force personnel Center that I was amenable to another kind of airplane if I could get to Vietnam quickly. They offered me the OV-10 with duty as a forward air controller and a training class date late in the summer of 1968.

**6) How was the atmosphere in the Bronco units compared to the F-4 ones?**

When I arrived in Vietnam in early January 1969, I was assigned to a small forward air control team at Tay Ninh. There were about a half-dozen officers and several enlisted in the group. Most of our flying was solo which was completely different from the flying that took place in a fighter unit. The morale in the group was great as was that of the first Air Cavalry brigade which was the primary unit we supported. After several months at Tay Ninh in South Vietnam, however, the opportunity arose to transfer to Nakhon Phanom in Thailand where I would be

flying over Laos and the Ho Chi Minh Trail. Thus, I had an opportunity to see two major parts of the war: the ground operations in Vietnam and the interdiction operations over Laos. Morale and spirit were equally good at NKP.

**7) You took part in 266 combat missions in Vietnam. Has one of them left its mark on you more than the others?**

There were several missions that were quite exciting from a personal standpoint. We dropped a lot of bombs which were of obvious benefit to our troops in contact and we destroyed a lot of NVA equipment on the Ho Chi Minh trail, but we saw little in the way of strategic progress. Much of the problem was that we were bombing fifth ring fielded force personnel and equipment that were being replaced faster than we could strike them. It was clear that the problem was not going to be solved by attacking North Vietnamese troops in South Vietnam or North Vietnamese trucks as they dispersed themselves through Laos and Cambodia. The strategic solution was clearly in the north.

**8) One might argue that your experience with the Bronco would have stimulated your belief in Air Support. But that is rather the opposite, isn't it?**

I have never had any doubt about the tactical efficacy of close air support. An untold number of American soldiers in close contact with an enemy have been saved by air power. My problem with close air support is that, comparatively, it is not the best place to use a limited and expensive resource. The fact that it is available, however, leads commanders to put themselves and their troops in positions where it is needed and thus not available for what could have been targets with far higher strategic and operational impact.

**9) Your last tour in a wing was on the F-15 in Bitburg. You were preparing to face the Warsaw Pact. You believed that the best way to deal with them was to adopt the Big Wing formation, that is to say to put as many interceptors as possible in the air at the same time to oppose enemy raids, rather than taking off in formations of 2 or 4 aircraft to intercept them. What are the reasons that made you choose this tactic, which had been rejected for example by General Park during the Battle of Britain?**

We believed at the time, and apparently correctly, that the Soviets would attack in large numbers. Large numbers opposed by one or two interceptors seemed to be a very inefficient and dangerous way to solve the problem. If we were going to be successful, it was necessary to destroy large numbers of attacking Soviet aircraft which required concentrating enough firepower to destroy, disrupt, and discourage Soviet air attacks. My reading of military history suggests that losses of a number of combatants spread over a wide area are relatively easy to manage whereas large losses to an operational unit in a compressed period of time create far more problems and if the loss rates exceed something in the vicinity of 25%, units become operationally ineffective. At Bitburg in December 1987, we deployed an augmented squadron to Incirlik, Turkey to practice large formations and found them to be exceedingly effective and invaluable training.



last flight at Bitburg

**10) Regarding your intellectual works, it seems that you were especially marked by 2 British authors. On the one hand, Fuller, the author of *The Generalship of Alexander the Great*, who put forward the advantage of attacking directly the enemy leaders, namely Darius III, at the battles of Issus and Arbela. And on the other hand, Liddell Hart, who favored the indirect approach to frontal clashes. This is a far cry from the American culture of leaders such as Grant and Patton, right?**

In my mind, Alexander is the foremost commander/ruler of all time. He was superb in developing strategy to defeat and take over the Persian empire even though hugely outnumbered. As a strategist, he knew when to attack directly and when to conduct indirect attacks such as his seizure of Mediterranean ports to win sea control of the Mediterranean as a prelude to his march into Persia. On the other hand, once in Persia, it was his goal to defeat Darius directly as he understood that as being necessary to win over the many Persian satraps. I don't see much contradiction between Liddell Hart and Alexander and have great respect for both and for JFC Fuller. In so far as Grant and Patton, the former had significant strategic responsibilities whereas the latter had operational/tactical authority and responsibility. Grant certainly used direct attack at a tactical level for battles, but also employed indirect attacks at strategic levels as witnessed by his southern March to the Sea operation as well as his Mississippi campaigns to cut off the western side of the Confederacy. Patton on the

other hand was assigned the task of moving as rapidly as possible to the east which he did with great success.

**11. You have written a thesis entitled *The Grand Alliance: Strategy and Decision*, which analyzed and criticized the Anglo-Saxon grand strategy during World War II. What teachings have you learned from this work and did they guide you in your career?**

Writing that thesis gave me significant insight into planning and conducting major wars, specifically: the importance of understanding the peace that is to follow a war before undertaking military operations; the importance of careful staff work ; the difficulties of coalition warfare; the advantage from a planning standpoint when one participant is in charge; the inclination of the most senior commanders to want to re-fight their last war; and the carelessness of senior leaders in ignoring political objectives.

**12) At the end of the seventies, you were posted to the Planning Directorate's Middle East and African Division, where you designed a lot of plans. One of which was to repel the Soviets in the case of an invasion of Iran thanks to air power. As early as this period, did you already think air power was able to beat a great power alone?**

During this time period (1975-1980), almost everyone expected that if war with the Soviets took place, it would be one in which the Soviets would make a frontal attack across the Fulda Gap where we and the rest of NATO would take our stand. It struck me that the Soviets might decide that a better approach would be an attack down through Iran with the objective of seizing control of Persian Gulf oil. I knew that it would be extraordinarily difficult to deploy sufficient land forces to stop such an attack but I was convinced that we could deploy sufficient airpower to do it with a high probability of success. At the time, I was trying to solve an operational problem as opposed to devising a plan for the strategic defeat of the Soviet Union. However, the ideas that flowed from this excursion stood me in good stead for both the strategic campaign against Iraq and for the accompanying operational campaign against the Iraqi army in Kuwait.

**13) The publication of *The Air Campaign : Planning for Combat* announced a new era in the reflection on the use of air power at the operative level. It contrasted with *Airland Battle's* orientations. If we had to keep only one principle of this book, would it be that the operational commander's duty is to ensure that he masses superior forces at a particular time and place? And what does it mean for the aviator? Isn't it counter-intuitive with respect to *Parallel Warfare* that you advocate for?**

When I wrote *The Air Campaign*, the best way to produce the right power at the right time and place was by assembling enough numbers to get the job done. The operative thought is enough to get the job done—that is to produce

a desired effect on the enemy. By the time of the first Gulf War, however, two technologies had advanced enough to enable getting the right amount of power to the right place at the right time: low observability and precision delivery of weapons. These two meant that a single vehicle could bring the requisite power to bear that even a few years earlier would have required hundreds of aircraft. This technological leap also made the concept of parallel attack feasible which is simply understanding that there are multiple targets (centers of gravity) that need to be attacked and that if many can be attacked simultaneously because stealth and precision are concentrations of effect (vice numbers), doing so is far superior to attacking them serially as earlier technology dictated. Serial attack allows and invites enemy response whereas good parallel attack makes enemy response difficult to impossible.

**14) At the time, you seemed to think that the surface-to-air threat could not significantly stop air raids. However, nowadays, experts insist on the difficulty of bursting A2/AD bubbles, in particular those defended by surface-to-air batteries. Would you temper these comments today?**

My impression is that we have seen a significant increase in the capability of Surface to Air threats while we have made mostly marginal changes in our attack vehicles and methods. As just one example, had we successfully pursued development of hypersonic penetrators, we would have significantly outpaced defensive systems. Despite the challenge, I believe that the air offense is still substantially stronger than the defense.

**15) Nowadays, the importance of “air operational reserve” and “composite wings” you stressed in *The Air Campaign* isn’t much discussed. Could you elaborate on this?**

A very smart and very senior USAF general told me a few years ago that he likened airpower to a firehose that was pointed where needed. At that time and still today, I believe that is an erroneous and dangerous idea; among other things, it assumes that war is a continuing steady state situation but in fact it has huge ebbs and flows (although they may have a time period of hours). Anything that is not steady state cannot be predicted with any degree of certainty and reserves are the best possible hedge that provide the opportunity to stave off disaster or exploit an opportunity. I am sorry I was not successful in advancing the concept of air reserves. We originally called “composite wings” Air Legions with the idea that properly formed, equipped, and commanded that they could play a key role at an operational level. Unfortunately, the doctrine and command for their employment lagged the initial formation of two such wings. In addition, the next Air Force Chief of Staff did not provide them much support.

**16) One of the reproaches addressed to your strategic theory concerns your definition of the center of gravity, which is “ a point against which a given level of effort would accomplish more than it would accomplish if applied elsewhere ”. You also identified many centers of gravity, the command and**

**control being identified as the most critical one. Yet, in the minds of many experts, the center of gravity must be unique. What do you think about this? Is it merely a naming problem?**

I believe that the idea in which there can only be one center of gravity is sheer nonsense and defies even casual thought. Complex systems (like countries, markets, companies, and armies) clearly have multiple centers of gravity--some combinations of which must be addressed to force requisite change. Trying to name one center of gravity for a complex organization means aggregating up to an impossibly abstract level.

**17) The goal of your theory is to create chaos, confusion and paralysis among the enemy. How would you explain the shift from the paralysis of some of his abilities to a moral and psychological collapse decisively weakening his will to fight?**

Moral and psychological collapse may lead to a combatant surrendering or otherwise quitting, but in the overwhelming number of cases (all ?) moral and psychological collapses are the result of physical events—such as the destruction of key capabilities or the death of enemy participants. I can make reasonable estimates of what it takes to create strategic paralysis regardless of the enemy's morale or will but our record for predicting how much will an opponent has is very poor at best. Even at an individual level, some men will die with their will and morale intact whereas others will quit at the first whiff of danger. Will and morale are chimerical and should not be the basis on which to plan or conduct a war.

**18) You are sometimes depicted as a “Jominian” because you propose a path to victory, as a “Clausewitzian” because you refer to centers of gravity, and also as a “Douhetian” because of the importance you give to strategic attacks. Do you feel close to a particular strategic school?**

I used the same term, center of gravity, as Clausewitz and regret not coming up with a better word. I believe Jomini was on the right track as he approached war on a rational basis and we owe much to Douhet because he correctly foresaw the power of air attack well before the technology was there to do it effectively. In addition, Douhet placed far too much emphasis on breaking the will of an opponent. I found many good ideas in Jomini and Douhet on which new concepts could be built and many not so good ideas in Clausewitz that needed to be avoided.

**19) You are famous for the *Instant Thunder* plan that you inspired and which set the fate of the Gulf War. Yet, *Instant Thunder* faced serious opposition from the air force tactical community. How do you explain that? Do you attribute this to human issues, to hostility towards a stranger suddenly stepping on one's toes, to a lack of open-mindedness or to a true theoretical opposition?**

I suspect it was a combination of all these factors reinforced by the tendency of commanders to fight the last war they knew before they ascended to positions

of power. Many of the opponents thought the strategic approach in Vietnam of graduated escalation with pauses for reflection was correct and what we ought to do in the Gulf War. I disagreed vehemently as did General Schwarzkopf.

**20) 45 seconds after the war started on January 16, 1991, you reportedly said : “the war is over, we won”. Why were you that confident? Does the war seem scripted to you then?**

It was one hour, not 45 seconds. I was sitting in Checkmate in the basement of the Pentagon along with the Secretary of the Air Force and several other senior officers as well as my fellow planners. H-hour was at 1900 16 January Washington time. We were all watching CNN. At just about 2000, I commented that I was getting a little worried as the power in Baghdad should have gone out. I had no sooner made this comment than the CNN broadcasters announced that Baghdad had just gone dark and that perhaps the Iraqis had turned off the power at which time everyone in the room shouted, “ No they didn’t—we did ! ” At that point I pushed my chair back and said something to this effect : “ The war is over—we have won. There is nothing the Iraqis can do to prevent us from doing everything we need to do to realize our objectives. ” I felt very confident as the war was planned against Iraq as a system and the electricity going off as planned told me that an irreversible collapse had begun and the attack plan was working as designed.



Colonel Warden with the people who took part in the Gulf War planning effort

**21) You are not convinced by the final launch of the ground offensive. Do you think that the coalition could have won by the simple use of air power?**

Yes.

**22) Regarding the evolution of air warfare since 1991, drones are perhaps the most innovative element. Targeted assassinations with drones seem to fit with your theory. How do you assess their use today? Do you think they are revolutionizing the art of air warfare?**

Drones have multiple uses and are quite impressive but it is not clear to date they have revolutionized air warfare in the same way as did stealth and precision.

**23) In the mid-1990s, you were involved in a debate with Robert Pape, who was more in favor of strikes on armed forces in order to win. Have the 21st century conflicts changed your point of view?**

I don't think Bob Pape had a very clear understanding of the kind of strategic war that we saw in the Gulf; he didn't understand how difficult and expensive it is to destroy armed forces; and he also did not realize how conceptually easy it is to replace destroyed fielded force. We followed his concept in Vietnam, Iraq 2, and Afghanistan with results that were less than sterling.

**24) Do you think air power can have a decisive effect in COIN?**

If a "COIN" conflict can be resolved by military means, then airpower can be decisive.

**25) How did you react in 2006 when the EBO theory was blamed for the Israeli difficulties against Hezbollah?**

I don't have enough knowledge of the details to comment on this question but I do know that a lot of the opposition in the US was by people who really did not understand it and were enamored by old concepts of force-on-force warfare.

**26) Are you surprised by the way Russia uses its air power over Ukraine?**

It was my understanding that the Russians had carefully studied the first Gulf War and I assumed that they had adopted many of the same ideas. What it looks like, however, is that they are replaying their WWII use of airpower but with insufficient numbers and with the same misunderstanding of strategic attack as they had shown in WWII.

**27) You embody the offensive spirit of air power. However, in your latest article published in *Aether* no.1, you discussed Strategic Defense. Is it a sign of the times? How could air power be a part of it?**

In my *Aether* article, I was addressing what I think needs to be done to defeat a genuine peer competitor who by definition has the capability (and almost certainly the will) to attack our strategic centers of gravity and is inclined to strike first. If a peer competitor conducts a competent parallel attack first strike, the

chance of survival is very low—unless you can blunt his attack sufficiently to give you the opportunity of launching your own parallel attack while protecting your people, critical infrastructure, and long-range attack capability. A big part of strategic defense must be aerospace forces and almost certainly some updated version of President Reagan’s Strategic Defense Initiative (also colloquially known as “Star Wars”).

**28) The idea that technology could solve a lot of problems has been developed in a lot of your writings. How could AI transform air power according to you ?**

Modern technology sensors collect an extraordinary quantity of data the majority of which is not relevant but it is very difficult for a human being to find the wheat amongst so much chaff. Thus, it would seem that AI could be invaluable in finding and presenting key information when it is needed.

**29) You have a unique personality. It won over but also disturbed some of your superiors in the USAF. How do you think a military organization, necessarily hierarchical, can better draw on people’s qualities akin to yours?**

The 19th century Prussian army apparently had a three-echelon decision system where a commander gathered representatives from the next three lower echelons of command for open discussion—and even argument—prior to issuing orders for a forthcoming operation. In this way, the commander had a good chance of getting novel ideas while ensuring that everyone attending had a really good understanding of the plan and also had a real commitment to it since they had participated in its creation. This is called “open planning” in my strategy practice and it really works.

**30) One last question: you seemingly gave one of your subordinates in the General Staff in Washington the task of studying what the air force might look like in 500 years. Is it true? What is your own take on this question, how do you imagine what an Air Force could be in half a millenia?\***

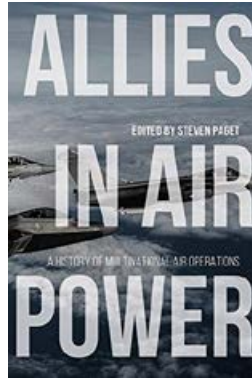
It is true. The idea was not to predict something in detail five hundred years in the future but rather to think in a completely unconstrained way what might be there. Then, given a collection of unconstrained ideas, start working back to see if there was a way to develop some of the capabilities in the here and now. To that end : Participation in the development and protection of the asteroid belts ; effective defense against wayward comets ; practical anti-gravity vehicles and weapons ; quantum entanglement communication—and perhaps transportation ; travel at near light speeds on intra-galactic missions ; moon bases for earth offense and defense ; detection and interception of any attacking air or space vehicle before it can do any damage ; vehicles that operate freely in the atmosphere and in deep space ; ability to deliver weapons, logistics, or people to any point on the globe in thirty minutes or less ; and beam weapons for terrestrial and space combat.

## REVIEWS



# *Allies in Air Power* *A History of Multinational Air Operations*

Steven Paget (eds.)



Read by Pierre Vallée

Edited by Steven Paget<sup>1</sup>, *Allies in Air Power*<sup>2</sup> brings together the contributions of ten specialists in the contemporary history of air operations. Of the eleven articles in the book, the first nine cover the major coalition operational sequences of the 20th century—from World War I to the Battle of France, the Vietnam War and NATO’s Allied Force operation in Kosovo. Only one takes place in the 21st century, with the intervention of the United States, the United Kingdom, and Australia against Iraq and the Baathist regime of Saddam Hussein in 2003.

The last chapter presents a more generalized reflection and departs from the descriptive angle of analysis adopted until then. This contribution, written by A. Walter Don, a professor at the Royal Military College in Canada, focuses on the use and contribution of “*four facets (core capabilities) of air power*”<sup>3</sup> (transport, observation, communication and air-to-ground/air-to-air fire) in the context of United Nations (UN) operations. To do this, she draws on a series of examples, starting with the Turtle Bay intervention in the Congo in the early 1960s, followed by the deployment of the United Nations Humanitarian Air Service after the earthquakes in Haiti in 2011, and ending with the Multidimensional Integrated Stabilization Mission in the Central African Republic from 2014.

1. Professor at Portsmouth University and member of the Royal Air Force College Cranwell.

2. S. Paget (eds.), *Allies in Air Power. A History of Multinational Air Operation* (Lexington: The University Press of Kentucky, 2020): 286.

3. *Ibid.*, 251.

A review of the different examples of coalitions in *Allies in Air Power* highlights several trends and issues shared by the different multinational configurations.

**The effectiveness of multi-national operations is proportionate to the degree of interpersonal interactions**

First, the success of these engagements depends more on human than material factors. While the fluidity of coalition maneuvers is logically facilitated and enhanced by the existence of capability convergence points, it is not enough to add up several air forces potentials from various nations to obtain an acceptable military effectiveness. Coalitions are, above all, a matter of people.

Mutual understanding and respect, friendship and brotherhood of arms between airmen of different geographical origins<sup>4</sup>, as well as a strong “bond of complicity” between political leaders and military leaders, are indispensable links in the smooth running of multinational operations. At the level of military decision-makers, this connivance also leads to the emergence of “couples” whose relationship influences the level of efficiency of the joint operation.

The book lists several of them. During the First World War, the friendly understanding between American (and French-speaking) Brigadier General William Billy Mitchell, Chief of Staff of the Air Service of the American Expeditionary Force (AEF), and French General Paul Armengaud (Liaison Officer to the Air Service) improved training efficiency, facilitated the integration of American pilots into French airfields, but also provided the possibility of quickly and efficiently resolving any differences between their own national interests or respective rules of engagement.

Another emblematic duo emerged during the North African campaign (1940-1943). The close ties between Generals Lewis H. Brereton (United States Army Air Force – USAAF) and Arthur Tedder (Royal Air Force – RAF) accelerated the ordering and delivery of equipment from across the Atlantic, the tactical integration of American units, and the logistical support of bi-national squadrons on the airfields of the allied Western Desert Air Force in North Africa<sup>5</sup>. This symbiosis reached its peak on the eve of the second confrontation at El Alamein in October-November 1942. The transcription of the telegrams sent to their staffs just before the beginning of the battle testifies to a real operational synergy between the two allied air forces<sup>6</sup>.

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4. This is particularly noticeable in the English-speaking pilot communities.

5. The WDAF was responsible for providing air support to the British 8th Army in its fight against Generalfeldmarschall Rommel's Afrikakorps during the African campaign.

6. “*The American [airmen] work very well with our squadrons...They learn from us and we learn from them – I'm glad to see that this analysis is shared [by our American counterparts]*” reports General Tedder to his superiors. “*We're ready for anything [...]. The [British] intelligence has been totally shared with us,*” noted General Brereton on the eve of the offensive; in S. Paget (eds.), *Allies in Air Power...*, 70-71.

Finally, the concord between the three main air leaders involved in the 2003 intervention in Iraq—the American T. Michael Moseley (USAF), the British Glenn Torpy (RAF) and the Australian Geoff Brown (Royal Australian Air Force – RAAF)—allowed them to align quickly on the desired end state and on the sharing of their air assets during *Iraqi Freedom*. Not only was Washington able to rely on the availability of its allies’ capabilities (without encountering obstructions or restrictions of a political nature from Canberra or London), but these two partners were gradually given a significant role in the accomplishment of certain offensive missions ordered by the Air Tasking Order issued by the Combined Air Operations Center<sup>7</sup>.

On the contrary, during the Pacific War (1941-1945), the brutal approach of the general commanding the Southwest Pacific Area, the American Douglas MacArthur—an attitude described by the author as “*divisive*” (p. 85)—proved to be counterproductive and generated tensions that had consequences for the relationship between Washington and Wellington. Moreover, for the Royal New Zealand Air Force, the under-use of New Zealand military resources by the American high command made them feel overlooked and not considered for their true value. They deemed that they were voluntarily kept away from information of military interest relating to Japanese advances and American movements in the Pacific. It took all the intelligence and diplomatic skill of Admiral William Hasley Jr. who was appointed Southern Pacific Commander (SOPAC) at the end of October 1942, for American-New Zealand relations to warm up. On 8 November, Admiral Aubrey Wray Fitch, commander of COMAIRSOPAC, sent a cable to the RNZAF Chief of Staff, Air Commodore Victor Goddard, assuring him that “*his resources would very soon be called upon*” to participate in the fighting. The American admiral closely associated Group Captain Sidney Wallingford—RNZAF, attached to COMAIRSOPAC—with the preparations for the capture of the Japanese decisive point of Rabaul in Papua New Guinea (Operation Cartwheel). The foundations of a unified bi-national command within COMAIRSOPAC were laid.

In the end, as one of the contributors summarizes it, one of the “*ingredients*” for successful joint actions is to associate leaders who are able to show “*tact and compromise*,” a personality trait that sometimes implies being at ease to be able to “*speak candidly*” in order to evacuate all tensions and avoid mutual misunderstandings<sup>8</sup>.

7. For example, the British *GR4s* had a greater range than the American F-15Es (1,400 versus 1,200 km). The Tornado even proved to be “the only aircraft with enough range to reach Kirkuk at the beginning of the operation,” recalls a planner at the CAOC. In addition, the RAF had the only effective stand-off precision air-to-ground weapon in its arsenal: the Storm Shadow. Apart from the GBU-37 dropped from USAF B-2 Spirit bombers, no equivalent existed on the American side, which compelled General Mosley to regularly use the British missiles fresh off the production line. For its part, Australian experience - combat-proven alongside American forces since Vietnam; see “Magpies and Eagles” (142-167) - soon led to an evolution in the scope of missions assigned to the Royal Australian Air Force from strictly defensive objectives to offensive air-to-ground strikes against opposing centers of gravity.

8. *Ibid.*, 71.

## **The increasing importance of the material factor in joint operations**

The capability parameter is the other key factor in achieving an effective coalition. The way in which this issue is approached throughout the book evolves as the examples follow one another. While most of the articles dealing with the pre-1939 period stress the importance of all the actors involved in an equitable sharing of resources, the entry into the Cold War with the consecration of the role of the United States as the natural “framework nation” of the joint operations transforms the analysis. The main issue becomes the way in which the countries will place themselves under the lead of the Americans. In sum, if the “pre-1945” chapters depict how two countries manage to pool their forces, those that follow focus more on the efforts of the partner states to best insert their resources into the common pot under American command.

In this specific framework, where coalition action is directed by the American “*framework nation*”, the capability parameter raises two inseparable sub-questions: it can be understood as the ability to make available to the leader certain indispensable (fighter), crucial (tanker) or high-value (missiles) assets, but also as the ability of air structures of different nationalities—sometimes of common industrial origin—to work together. In other words, which air assets should be made available to the coalition in order to be assigned a political role; and how can we ensure that these same assets, once inserted into the multinational system, play the score of the coalition orchestra in harmony?

While the first question can be exemplified, for instance, by the added value of the Australian Canberra over Vietnam or the British *GR4* over the Iraqi desert<sup>10</sup>, the second question is regularly assimilated to problems concerning the interoperability of air systems. In the end, interoperability conditions the efficiency, fluidity and effectiveness of a coalition maneuver: a high degree of interoperability allows, in the words of Aristotle, “*the whole to be greater than the sum of its parts.*”

For air forces from different nations, one of the most obvious ways to achieve a satisfactory level of interoperability is to share identically manufactured aircraft. For example, during the First World War, one of the factors that favored the acculturation of American pilots to French procedures was the provision of French-made aircraft within the Air Service, facilitating training—sometimes

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9. As part of the major engagement hypotheses, the *French National Strategic Review* (2022) foresees a “coalition support” role for the national armed forces for the benefit of a leading nation - probably the United States.

10. The possession of so-called “enabler” capabilities (UAVs, tankers, intelligence production resources, etc.) or specific know-how enables medium or regional powers to influence the dynamics of operations. For example, during the Vietnam War, the ability of Australian pilots to carry out bombing raids at a ceiling of between 300 and 900 metres in all weathers (particularly under cloud cover during the monsoon season) from their Canberra aircraft - where the majority of American bombers maintain a minimum flight altitude of around 3,000 metres - and their capacity to carry more bombs than the USAF’s B-57s represent an operational advantage in terms of precision and firepower, on which the American staff relied heavily.

carried out in Franco-American tandem on two-seaters<sup>11</sup>. Today, the preeminence of the United States in the global aeronautics industry, as evidenced by the export of American aircraft to many countries, provides Washington with the opportunity to exchange information more easily with its allies or partners. This Atlantic bias creates a common “made in America” capability language that fosters multinational exchanges.

Nonetheless, this American offer is not without consequences for the countries that choose to respond to it. Beyond the legal consequences induced by the presence of American components in a combat architecture—summarized by the problem of the extra-territoriality of certain American laws (including ITAR) - this choice forces these countries to constantly ensure good interoperability between their systems and those of the American armies, at the risk of undergoing a technological downgrade that would affect the final “degree of interoperability” and of appearing like a ball and chain in the coalition system<sup>12</sup>. The risk of technological and financial “headlong rush” in order to follow the new standards imposed by the United States is a serious one.

Resistance to American capability changes, or taking them into account too late, can also lead to negative external effects, sometimes deadly. This is particularly the case when a coalition system implements different versions of friend-or-foe identification systems. During the Korean War, the implementation of a new Friend and Foe identification system within the American air architecture led to several fratricidal shootings between American *B-29s* and Royal Navy aircraft. This blind spot regarding the threat classification constrained British aircraft, at the American High Command’s request, to remain “*out of gun range of B-29s*.”

This capability incompatibility was also noted in the field of communications systems, and was also clearly visible in the exchanges between the French *Daguet* force and the rest of the coalition forces during the military deployment of the First Gulf War. It was also evident between the main contributors to Allied Force—the United States, the United Kingdom, France, the Netherlands, Italy and Germany—in Kosovo. For Mr. Burczynska, this last conflict was perceived as a trauma for the North Atlantic Treaty Organization, which noted several shortcomings in terms of interoperability and decided to launch a series of efforts to make up for these deficits. This took concrete form in the famous Defense Capabilities Initiative initiated at the NATO 50<sup>th</sup> anniversary summit in 1999<sup>13</sup>.

11. Of the 6,624 aircraft in the AEF throughout the conflict, 4,879 were of French origin (mainly *Nieuport 28s*, *SPAD XIII*s, *Breguet 14s* and *Salmson 2A2s*), i.e. nearly 80%. This equipment was part of the Boelling contract to equip American forces sent to the European theater.

12. This idea was the driving force behind the retrofit programs for French air capabilities initiated in the early 2000s to make them compatible with the American Link 16.

13. According to the Fact Sheet published after the 1999 summit, the Defense Capabilities Initiative focuses on five areas: the ability to commit forces, deploy them to a theater of operations, provide logistical support to the projected force, ensure survivability in degraded environments, and ensure effective and interoperable C3 (Command, Control and Communication).

## **The multinational operation in face of the linguistic challenge**

Finally, several contributions highlight the “simple” barrier that the use of several languages within the same coalition can constitute. While the use of a common language does not remove all obstacles in terms of understanding, it is a considerable facilitator for integration, and to avoid certain pitfalls.

For example, during the First World War, the acculturation of American pilots from the American Expeditionary Force to the metropolitan theater was carried out by French instructors who spoke little if no English. Though this barrier does not seem to have influenced the dynamics of operations and was overcome by the inventiveness of the instructors (the training sessions relied on the use of wooden models to facilitate the understanding of tactics and flight formations), it was an additional obstacle to good cooperation between the French Air Force and the Royal Air Force during the Battle of France in May-June 1940; or during the Vietnam War, between Australian pilots of the 2nd Squadron and local JTACs during target designation or during countdown procedures prior to strikes.

Moreover, the variations in accents within the English-speaking pilot community were sometimes an obstacle to mutual understanding, as in the radio exchanges between American and British airmen—but also between British crew members of the different constituent nations of the United Kingdom during the Korean War. In Vietnam, the rapid turnover of personnel and the recurring problems of understanding between Australians and Americans led to several notable frictions in air-ground coordination and the fluidity of order transmission<sup>14</sup>.

Other issues are addressed on the sidelines throughout the various chapters: the weight of the Rules of Engagement (ROEs, particularly in Vietnam), international humanitarian law, the role of red card holders, the need to combine different national interests (the “national caveats,” essential to understanding *Allied Force* in Kosovo), the problem of coalition logistics (particularly with regard to on-board systems for air-to-air refueling)<sup>15</sup>,... The reader may be surprised by the lack of attention paid to these issues, as they are nowadays structuring parameters for all air operations and are proving to be real challenges in the context of coalition operations.

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14. Several American pilots could not understand the Australian 2nd Squadron call sign “Magpie”. During a flight from Canberra of the 2nd Sqd, an American air traffic controller could not identify his caller. He had to wait for an American F-100 pilot, who has been deployed for several months and is well-versed in the Australian accent, to explain to him over the radio “[that] they say ‘Magpie’ - like the bird - Tweet Tweet!” (152).

15. In terms of air-to-air refueling, there are two main systems in use: “Probe-and-drogue” (a flexible pole deployed at the rear of the aircraft, with a parachute basket at its end) and “flying boom” (a telescopic pole that connects to a receptacle on the back of the aircraft). One or the other system is only compatible with certain aircraft, which tends to limit the interoperability of tankers. On this subject, see “*The refueling challenge*” (188-189) during the first Gulf War. This issue is also discussed in the chapters on *Allied Force* (210-211) and *Iraqi Freedom* (238).

All of these articles have in common their particular focus and attention to the cultural, doctrinal and technical interactions in the operational (planning and organization of forces) and tactical (capability interoperability and acculturation of airmen of different nationalities) domains. While the analysis of political and strategic negotiations is not absent from the subject matter—it occupies an increasing place as we move through the chapters and we are approaching the end of the Cold War—the vast majority of articles (sometimes excessively) quickly evoke the frictions between the various political decision-makers, which tends to obscure the relational factor between statesmen on the course of multinational operations.

Next, this book is resolutely in a historical descriptive perspective which induces two limitations in the reading. Foremost, although the choice of treating a series of case studies offers the reader a diversity of examples never before seen in a single book, this multiplicity is not structured around one or more common strands. The account is therefore more like an addition of historical examples—sometimes unknown, such as the exchanges between the Luftwaffe and the Hungarian Air Force during the Second World War—than a historical study of the “coalition phenomenon” as such. This methodological choice would deserve to be reinforced by an analysis of the evolution of this concept in the 20<sup>th</sup> and 21<sup>st</sup> centuries, as well as by a contextualization of the different examples selected in order to put them in resonance with current coalition engagements.

On this last point, the contributions do not formulate recommendations for today’s analyst and decision-maker. Without falling into the pitfall of “historical lessons”—in other words, a deterministic bias in the absence of proper conditioning—the book lacks perspective or fails to clearly show certain obstacles to avoid. One exception is the conclusion of the book by the editor Steven Paget (only ten pages out of nearly three hundred) and the contribution of A. Walter Dorn on air operations related to the various UN missions, in which the author offers a series of hypotheses and recommendations to promote the emergence of a “UN air force” (pp. 271-274).

Moreover, the study of the proper functioning (or not) of coalition actions is carried out in the context of an armed confrontation. This choice, which is rather logical, nevertheless obscures the rapprochement between the actors involved during “peacetime”<sup>16</sup>. While some coalitions may emerge *ex nihilo*, and bring together actors who are not used to fighting side by side, the majority of them are nevertheless composed of countries that share a common history or close exchanges prior to confrontation. In other words, the study of the determinants of a coalition’s military effectiveness must also take into account the exercises and exchanges between the actors before the confrontation. One cannot understand, for example, the difficulties encountered between London and Paris without considering the different operational cultures between the British Royal Air Force and the young French armée de l’Air, or without taking into account the mutual

16. These exercises can also take place concurrently with operations, as illustrated by the example of the USAF’s FAC University, located in Phan Rang, Vietnam, and tasked with improving exchanges between partners engaged in the war effort.

distrust between the two capitals in the 1920s and 1930s. The same observation can be made when reading the article on Australian-American cooperation during the Vietnam War. The reader may be puzzled by the ease of integration of the Royal Australian Air Force's 2<sup>nd</sup> Squadron into the various American air systems if he does not know the density of exchanges between the US State Army Air Force and the Royal Australian Air Force during the Second World War, amplified with the beginning of the Cold War.

Finally, the match between American and British forces is certainly based on a common culture and values, but also and above all on a long history of exchanges during bi-national or multinational military exercises (notably the *Red Flag*) between the US Air Force and the Royal Air Force. When *Iraqi Freedom* began in 2003, the two countries shared several decades of joint exercises, as well as a number of recent joint operational deployments—*Desert Storm*, *Desert Fox*, *Northern Watch*, *Southern Watch*—which allowed London and Washington to limit certain tensions during their joint interventions in 2003.

Conversely, the difficulty of integrating the French system into the American-led coalition during *Desert Storm* can be explained primarily by political differences, but also by the lack of prior exchanges at the strategic level between the main contributors and the French Air Force. By withdrawing from the Alliance's integrated command in the mid-1960s, Paris distanced itself from an Atlantic bias, which had repercussions on the interoperability of French and American equipment.

Finally, the reader may also question the time frame of the book. The back cover highlights a book that "brings together several experts who trace a series of coalition operations from the birth of aviation to the present day." However, if they are briefly mentioned in the last chapters, one can regret the absence of analysis of multinational air engagements such as those in Afghanistan (*Enduring Freedom* and then ISAF), in Libya (*Harmattan*) or in Syria (whether within the framework of *Inherent Resolve* or the trilateral operation *Hamilton*). While the authors essentially mention the challenges posed by the need to keep up with the American technological pace in terms of capabilities or the French weakness in terms of interoperability in 1991 and Kosovo; the analysis of more recent case studies would have made it possible to confirm or refute certain trends put forward by the contributors.

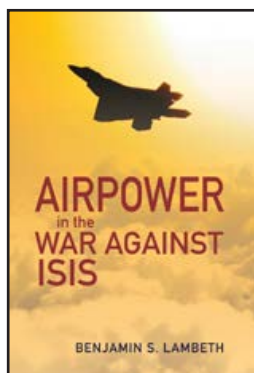
In the end, *Allies in Air Power* succeeds in offering a series of case studies—some of them original—providing a detailed overview of the main moments in the history of coalitions in the 20<sup>th</sup> and early 21<sup>st</sup> centuries. This book adds to a rich corpus and reflection on the subject of coalitions, but which remains dominated by the productions of Anglo-Saxon researchers and which deserves to appear with more vigor in France. This would prove timely, at a time when this type of engagement, "one of the means of expression of air power since the birth of aviation [...] is going to become increasingly solicited."<sup>17</sup>

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17. S. Paget (eds.), *Allies in Air Power...*, p. 286.

# *Airpower in the War against ISIS*

Benjamin Lambeth



Read by Elie Tenenbaum

## **Absolute determination? The air campaign against the Islamic State put in question**

The story of the war waged since 2014 against the Islamic State group (*Daech* in its Arabic acronym) in Iraq and Syria by more than 80 countries is still in its infancy. Multidimensional like all modern conflicts, it includes, in its military dimension, an essential component on the use of air power. In fact, air power was the main instrument of the success of Operation *Inherent Resolve* led by the United States against the jihadist proto-state. This use of air power against Daech is all the more significant because it represents an in-between period, after a long decade of counterinsurgency in which the air force was reduced to supporting ground forces, and before the return to an era of competition between powers, in which it is once again taking on the role of gaining operational superiority.

A Harvard graduate who became a CIA analyst and then a researcher at the *RAND Corporation's Project Air Force*, Benjamin Lambeth has established himself over the past three decades as one of the most recognized experts on air power, particularly American air power, through reference works such as *Transformation of American Air Power* (2000) and a series of detailed monographs on the air campaigns in Kosovo (1999), Afghanistan (2001), Iraq and Lebanon (2006)<sup>1</sup>. It was therefore natural, if not expected, that this tutelary figure would tackle what is the last large-scale Western air campaign to date.

1. B. S. Lambeth. *Transformation of American Air Power* (Ithaca, NY : Cornell University Press, 2000): 352. By the same author : *NATO's Air War for Kosovo: A Strategic and Operational Assessment* (RAND Corporation, 2001) ; *Air Power Against Terror: America's Conduct of Operation Enduring Freedom* (RAND Corporation, 2005): 456 ; *Air Operations in Israel's War Against Hezbollah Learning from Lebanon and Getting It Right in Gaza*, (RAND Corporation, 2011): 442 ; *The Unseen War: Allied Air Power and the Takedown of Saddam Hussein* (RAND Corporation, 2013): 480.

Following a more political posture than one might have been used to, Lambeth makes his general thesis clear from the introduction to the book. The air weapon, according to the author, has been misunderstood and misused by a pusillanimous Obama administration, which misjudged the nature of the adversary—perceived as a terrorist group or guerrilla warfare and not as the proto-state that it was<sup>2</sup>. Conditioned by a decade of counterinsurgency in Iraq and Afghanistan, where the Air Force had been subjugated to ground forces, and obsessed with the risk of a new Middle East stalemate, the American political authorities imposed debilitating constraints on the Air Force at the beginning of the campaign, preventing it from deploying its full potential (interdiction, strategic strikes) through excessive rules of engagement and an operational command unduly entrusted to US Army officers. Conversely, the Trump administration is presented as a salutary counter-model. It sets a clear objective from the outset (the complete destruction of *Daech*) and accepts its military implications (air traffic control teams deployed on the ground, lifting of the most restrictive restrictions).

Once the introduction is over, Chapter 2 offers an extremely revealing overview of the “*narrative*” of the last thirty years from the perspective of the US Air Force (USAF). Triumphant after the Cold War and especially the Gulf War, the USAF was used during the first decade of the 1990s as the Swiss Army knife of military interventions, sometimes sidetracked by political constraints (as in Kosovo, according to Lambeth’s own thesis)<sup>3</sup> but always victorious, with a small portion devoted to surface forces intended to reap the benefits of air power or to stabilize its stigma.

The arrival in office of Donald Rumsfeld and the *Transformation* policy he implemented to have more agile and responsive armed forces capable of striking with precision anywhere in the world seemed tailor-made for the USAF, while the Army is undergoing drastic cuts in its budgets. After 9/11, Operation *Enduring Freedom* over Afghanistan was still based on this logic, while the beginnings of *Iraqi Freedom*, although more balanced in terms of components, allowed for the full potential of strategic precision strikes and interdiction, which was taken to its extreme with the “*Shock and Awe*” concept deployed at the beginning of the conflict.

But very quickly, the stalemate in these last two theaters in an asymmetrical irregular war was to push American air power off the Tarpeian rock. Its nemesis was Robert Gates, Secretary of Defense under the Bush and Obama presidencies (2006-2011), who made it his mission to respond first to the urgency of the Afghan-Iraqi theaters, at the sacrifice, according to Lambeth, of future projects. The drastic reduction of *F-22 Raptor* targets is one example, explaining the resignation of the USAF Chief of Staff, General Moseley, and of Air Force Secretary Michael Wynne in 2008.

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2. On this point read for example S. Walt. “ISIS as Revolutionary State: New Twist on an Old Story.” *Foreign Affairs* 94, no. 6 (11-12/2015): 42-51.

3. B. S. Lambeth. “*NATO’s Air War for Kosovo*”, *op. cit.*

Once this politico-military framework has been established, Lambeth finally turns his attention to the “*complicated East*” with a rapid summary of the Iraqi conflict (chapter 3). He takes up without particular nuance the thesis of moderate conservatives such as John McCain by castigating Obama’s choice of a “*premature withdrawal*” (p. 44) which allowed the rise in power of the jihadist phenomenon from 2011 on. In fact, the latter’s removal depended largely on the fragile political balance imposed by the United States on the then Prime Minister, Nouri al-Maliki, forcing him to abandon his sectarian policy, which he was quick to resume as soon as the American factor was removed from the equation. Reinvigorated by the civil war in neighboring Syria, the Islamic State in Iraq (and now the Levant) group was indeed notoriously underestimated by Barack Obama, who compared them, after their capture of Fallujah in 2014, to an amateur basketball team<sup>4</sup>.

The book finally gets to the heart of the matter with Chapter 4 devoted to the “*laborious start of the air campaign*” in the summer of 2014. With the capture of Mosul and the Iraqi Kurdistan offensive, Washington eventually authorized the use of air power under the command of CENTCOM. Lambeth goes into detail about the lack of a clear strategy and Obama’s overly cautious formulation of the goal of “*degrade and ultimately destroy*” *Daech*. But the main interest lies in the numerous testimonies of *Inherent Resolve*’s pilots and staff officers, reporting their growing frustration at the refusal of political authorities to give them fire permits when the theater was full of targets — and routed partners. The result was a slow start with only 7 “*strike sorties*” per day, 70% of which were canceled. The author compares this to the 1,000 sorties per day during Operation *Desert Storm* — even though the context is fundamentally different.

While this rate is gradually increasing (20 sorties per day in the fall of 2014), it is constrained by rules of engagement that seek to prevent collateral damage at all costs while prohibiting the deployment of forward air controllers that could better control risks. Overall, Ben Lambeth takes a very harsh look at the beginning of the campaign, sometimes failing to take into account the political constraints that led to the choices made by the Obama administration, as well as the international context — the contribution of allied countries such as France and Great Britain is only mentioned very incidentally and without giving rise to an analysis. Moreover, one would have liked the author to explain the role of these first strikes in the rescue *in extremis* of Erbil, the Yezidis of Sinjar and then the Syrian Kurdish town of Kobane in September, which were notable successes of air power, even if applied sparingly.

From the year 2016 the exercise of air power becomes progressively “*more effective*”: this is the thesis of the fifth chapter of the book, which evokes the increase in the volume of strikes (with a hundred sorties per day from the summer

4. On this, read the summary done by M. Hecker and E. Tenenbaum. *La guerre de vingt ans : djihadisme et contre-terrorisme au XXI<sup>e</sup> siècle* (Paris : Robert Laffont, 2021) : 448.

of 2015) and the diversification of targets. While USAF pilots were confined in early 2015 to “*cratering roads*” as part of “*terrain denial*” (their “urban renewal period” (p.73) as one pilot interviewed ironically recounts), they were later authorized to strike oil production sites or Daech cash deposits. The CFACC’s internal battle to increase the share dedicated to ISR compared to CAS is a major point in this respect. On the other hand, one regrets the lack of reflection on the deployment from 2016 of artillery contingents (American, French, British) for fire support purposes and its possible impact on freeing up the air force for strike tasks in greater depth.

As best it could, and despite all the limitations Lambeth put forward, the air campaign eventually brought coalition forces to the doors of the Islamic State’s two capitals, Mosul in Iraq and Raqqa in Syria, whose battles were launched in 2016 for the former and 2017 for the latter. This is the subject of Chapter 6, which traces the essential stages from an air perspective. However, part of the analysis is taken up by the debate over the route of the FSCL (*Fire Support Coordination Line*), which the author considers outrageously advantageous for the ground component, which thus reinforced its pre-eminence over the tactical conduct of the campaign.

The arrival in power of the Trump administration in January 2017, in the midst of the battle for Mosul, is presented here as the decisive inflection that allows for victory, the latter assuming for the first time the objective of “*annihilation*” of the adversary and the lifting of the most critical restrictions on fire authorizations. While this chronology is worth discussing, it is surprising that the author does not link the evolution of the ROE to the tactical stalemate on the ground — Iraqi combatant units are suffering spectacular casualty rates, which in turn lead to a less parsimonious demand for fire support — and above all to the humanitarian consequences for the civilian population, with tens of thousands of people trapped in the besieged capital.

In fact, according to independent NGOs such as *Airwars* or *Amnesty International*, the number of civilian casualties related to the coalition would have gone from a few hundred during the first months to more than 6,000 in the final phase of the battle, due in particular to changes in fire authorization procedures — if they can be criticized, these figures would at least have deserved to be discussed by the author<sup>5</sup>. Without passing moral judgment on these decisions, it would have been relevant to discuss their consequences. Nothing is said throughout the book about the exploitation by *Daech* of the human shield technique — in the city or on strategic sites such as the Taqba dam — and the dilemmas it raises for the CFACC cell. The same criticism could be made of the account of the battle of Raqqa, conducted in even more precarious conditions than Mosul with few forward controllers on the ground, while a recent study by the *RAND Corpora-*

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5. “At Any Cost: The Civilian Catastrophe In West Mosul, Iraq.” *Amnesty International*, (2017); “Iraq: Airstrike Vetting Changes Raise Concerns.” *Human Rights Watch*, (2017).

tion showed that despite the coalition's real efforts to limit collateral damage, a "margin for improvement"<sup>6</sup> did exist in this area.

The final phase of the campaign against the "territorial caliphate" of *Daech* spans from the fall of Raqqa in late 2017 to the capture of Baghouz on the Euphrates River in the spring of 2019 and the death of the "pseudo-caliph", Abu Bakr al-Baghdadi in October of the same year. This period is described as a "victorious endgame" leading President Trump to announce the withdrawal of U.S. troops at the end of 2018, and then after having reneged in the meantime, a second time in October 2019, as Turkey launched an offensive against the positions of its Kurdish allies of the PKK/YPG in northeast Syria. The author, who had been so critical of the Democratic administration's lack of a coherent strategy, on the other hand fully validates the trajectory, albeit erratic, of the Trump presidency.

The last chapters of the book are more thematic: in Chapter 8, the author returns to the few technical and tactical innovations of the campaign. These are in fact limited, the systematic use of guided munitions and a generalized ISR being now a given (for the time being) not called into question. Nevertheless, the increased role of electronic warfare and innovative methods of technical intelligence for targeting purposes, such as the exploitation of social networks and open sources more generally, heralds practices that will be confirmed in Ukraine. The first deployment for combat operations of the *F-22 Raptor* is also the subject of an interesting development regarding its role in degraded electromagnetic environments, notably due to Russian anti-aircraft defence.

And for good reason, an analysis of Russian air power in Syria, contemporary with the American campaign, was an expected point, especially since the author began his career with a series of monographs on Russian air forces in the 1990s<sup>7</sup>. However, the reader will not find in the chapter devoted to him the comparative study one might have hoped for (including in terms of civilian damage, for example), but rather a fairly precise (though not without omissions) account of the interactions between the American and Russian air forces in the Syrian sky. One can thus read with interest the accounts of American pilots facing Russian aircraft and the mechanisms of aerial deconfliction adopted. Various "incidents" are recounted, including the Russian reaction to missile strikes on Khan Shaykhun in April 2017, to the bombing of Wagner Group positions in Deir ez-Zor in February 2018 or to the destruction in flight of a Syrian Su-22 by a US Navy F/A-18 in June 2018. On the other hand, there is surprisingly not a word about the April 2018 air raid (known in France as Operation *Hamilton*), nor any prominent elements about electronic warfare in the face of jamming or the integrated air defense system.

6. M. J. McNerney et al. *Understanding Civilian Harm in Raqqa and Its Implications for Future Conflicts* (RAND Corporation, 2022): 138.

7. M. Simpson et al. *Road to Damascus: The Russian Air Campaign in Syria, 2015 to 2018*. (RAND Corporation, 2022): 104. ; P. Grasser. "Conquering and Securing the Syrian Skies." *Vortex*, no. 2 (2022): 153-182.

To conclude, Benjamin Lambeth returns one last time in his last chapter to what he considers the main political and military lessons of the campaign. First of all, he considers that the ROE were too restrictive — 75% of strikes were canceled during the first months of the campaign for fear of collateral damage — but once again without any real effort to understand the political reasons for such restraint and the real consequences of “*freeing up*” the potential of the air power. He then points to a misreading of the nature of the adversary: the Islamic State was not a guerrilla group but well and truly a potential state that was therefore open to a campaign of strategic strikes — which indeed seems to have been the case at the group’s peak between 2014 and 2017. Finally, the author returns once more to the choices made in terms of command, and the fundamental mistake — sometimes taking on the appearance of a narcissistic wound — for the USAF not to have been entrusted with the preeminent place it was entitled to in the operation. In short, if this book exposes the irresolution of *Inherent Resolve*, wants to be (and sometimes succeeds in being) a vibrant plea for air power with unpublished sources and forceful arguments, it sometimes suffers from over – zealousness or from a lack of concession.













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