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The French Air Force: Transforming to Prepare for the Future

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The French Air Force: Transforming to Prepare for the Future

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The Air Force Combat System

Denis Mercier

Général d'armée aérienne, Chief of Staff of the French Air Force.

This special edition of *Revue Défense Nationale*, dedicated to the *Salon du Bourget*, is published at a pivotal time for our Air Force. Confronted as it is by commitments without precedent, which go well beyond what is expected of it in the majority of its operational functions, the Air Force is conducting the modernization of its combat system.

A reactive and operational air force

The Air Force is permanently committed with great reactivity to the three missions assigned it is assigned in the *Livre blanc sur la Défense et la Sécurité nationale* (the Defense White Paper), which are deterrence, protection and intervention. Its reactivity in terms of permanent operational readiness is measured in minutes. It is measured in hours for intervention anywhere, at any time, on a broad spectrum of operations, going from humanitarian missions to high intensity ones—and the same goes for the airborne component of the deterrence. Moreover, we have the possibility to conduct and execute from mainland France all of these missions in the third dimension over, beyond and from our national territory in order to reach those areas of interest defined in the *Livre blanc*.

The Air Force can fulfil these commitments because its capabilities, structures and human resources form a coherent body, centered on competences that are put to the test daily. With confidence in this model, and in order to guarantee maintaining general coherence in a context of successive reforms, the Air Force has built a strategic plan focused on the year 2020 and looking beyond into the future. This vision is founded upon four pillars that will be mutually supportive: modernization of combat capabilities, simplification of structures, development of partnerships and improving the status of the airmen. The vision places the highest priority on the human factor, which is primordial in this busy period of multiple operational commitments and profound restructuring.

The coherence of this architecture will allow the Air Force to take innovative measures and will strengthen the commitment of its personnel in continuing its transformation, whilst assuring the operational commitments assigned to it.

C2 at the heart of air operations

Command and control (C2) capabilities for air operations are at the heart of our combat system. They are the capabilities which ensure the success of commitments under French command, whether internal or external, and across the entire spectrum of air operations. An air force that has hundreds of aircraft but no robust C2 system does not have a real combat system.

With our tested chain of command, we are today capable of associating sensors and effectors in order to achieve the desired effect. This C2 capacity gives us the ability to conduct all Air Force missions over national territory from the National air operations centre (*Centre national des operations aériennes*, CNOA) at Lyon–Mont Verdun, at the same time as missions supporting the various French air operations in Africa.

Sovereignty, economy of assets and reactivity. Operating 24 hours a day and 7 days a week, these C2 structures allow a limited number of assets to intervene separately, for national operations, such as *Sangaris*, *Barkhane* and *Sabre*, or for an operation led for the European Union, for example, *Eufor RCA*. Simultaneously, the CNOA conducts a very wide range of operations in the third dimension over national territory every day: permanent ones, like protection, life-saving at sea and the permanent security posture, or occasional ones, like special cases of air security, or Hephaistos, the cross-ministerial operation for fighting forest fires.

This expertise allows France to be a framework nation for the conduct of air operations within the Alliance (when the NATO Response Force is alerted) and to integrate immediately into the command structures of the coalition which is developing over Iraq. Finally, it is this on unique C2 capability that the air bases depend to conduct their missions.

The air base:
a very different combat system

The air base is the second key to success of air operations. For the Air Force, it is a very special combat system that permits the conduct of any type of operation from bases on mainland or forward-positioned bases.

Following the Cold War, the détente on our borders and the increased numbers of distant commitments caused a change in the organization of our bases towards more organic taskis. Today, the new strategic order in Europe, together

with the greater reach of new carrying vehicles, is compelling us to bring the air base back to the center of operational action. The permanent missions given to the Air Force are conducted without respite on and from our air bases, but the bases are also the stepping-off points for joint operations overseas. Libya, Mali and Iraq have fully demonstrated the relevance of considering our bases as combat systems, ever ready to project power at very short notice over a broad range of missions. In the same way, NATO reassurance missions conducted after the crisis in Ukraine mobilized the AWACS airborne command and control system, operating out of its home base at Avord.

The system that is the air base is therefore at the heart of a network that can be activated 24 hours a day, 7 days a week and 365 days a year. Its ramifications are not only joint, but also inter-ministerial and inter-allied. Interaction with this network therefore extends to making available installations and personnel on air bases to handle, for example, urgent requirements for transport of organs, aid to populations following natural catastrophes and turn-round of foreign aircraft. Other than our air bases, no aerodrome in France operates round the clock.

Training: a guarantee of versatility and reactivity

Activity on our air bases includes that essential feature to the conduct of our missions, and also to the training of our forces. This is the third key to success of air operations and also the condition that they be conducted in complete safety.

Activity related to flying is necessary to maintain front-line units at the highest level of versatility, capable of first entry missions whatever the nature and threats of the theatre. Modern means of simulation are an essential complement to that air activity, but can never replace it: an air force directing its efforts towards an 'all simulated' training would sooner or later be confronted by serious loss of competences.

Given that, we need to focus all of our efforts on fulfillment of this activity. In spite of the continual improvement in our procedures, air activity has seen constant decline over the past decade. It has therefore been necessary to rethink not only maintenance ways and means of but also the training of our aircrews. This is what lies behind the SIMMAD's *Cap 2016* project and the differentiated training of combat aircrew that are presented in this volume.

The aim is to ensure the Air Force's ability to react immediately within a wide range of environments and missions while keeping long-term capability. In the end, the response to this double challenge relies on the quality of our airmen.

Airmen: the wealth of the Air Force

The officers, NCOs, airmen and women and civilian personnel of the Air Force constitute its wealth. It is their commitment, their reactivity and their professionalism, which ensure our combat system can reach its full potential.

While activity forms the structure that ensures the performance of the Air Force, both in training and on operations, the human factor remains at the centre of our preoccupations. Be in no doubt: it is the airmen who are the wealth, force, reactivity, competence and spirit, the very lifeblood of our Air Force.

That is the reason why the Air Force strategic plan puts the human at the heart of its action with a single leitmotiv: more dynamic, personalized and guided management of competences.

Individualization of competences has an important part in this. By following these competences in a personalized manner, the specific skills and employability of airmen will be developed. All the projects aim at emphasizing the competences acquired by each person, while taking account of the reduction in size and control of our workforce. With the 'diplomation' project, for example, it is our ambition to provide every airman with the opportunity to obtain a higher-level diploma than that the one had when entering the Air Force.

Modernization of our human resources model will also be achieved by making professional advancement more dynamic, and opening it up to external organizations. We need to identify, attract, generate and enhance the status of talent. This is the thinking behind the project which is unifying all our officer training, and will be set in place from this summer at the *École de l'air* in Salon-de-Provence. This transformation will allow every cadet officer to have personalized training according to his abilities, whatever his type of recruitment, internal or external.

Beyond that, we have defined a format for evolutionary human resources in which every airman has to set out his professional plan. We are putting in place what we call the 'Y' model, one which offers complementary opportunities for career paths within and outside the Air Force. This model will rely upon openness and extended partnerships with civilian society, as well as on better recognition of skills, competences and the diplomas held by airmen.

Finally on this topic, the maintenance and retention of our human capital is a major theme of our strategic plan. The personalized management of human resources that we are establishing is above all a matter of command and leadership, accountable for responsible, transparent and constructive dialogue between airmen. In the face of heavy operational demands, it is equally important to keep an eye on improving the conditions of work and life of our airmen, on strengthening the esprit de corps and making more dynamic the exchange of views.

To put these policy paths into practice the human resources function has to be modernized, better performing and simplified. Above all else, it must be adopted and pursued by all airmen.

Capabilities and equipment

To modernize the Air Force and its airmen also means rethinking with them our preparation for the future. Quite clearly it is the overall system—C2, air bases, training facilities and human resources—that will lead to optimization of assets, and not the other way round. Developments in materiel, training and concepts therefore have to be on the back of the coherent construction just mentioned.

In this spirit, we are going to create this year a center of military air expertise—the Air Warfare Center (AWC) at Mont-de-Marsan. It is a major reform, bringing under a single command responsible for satisfying the forces, all who deal with innovation, be it in equipment, doctrine or training. The mission of the AWC is better preparation of our forces, better adaptation of our capability for operations and clarifying preparation for the future. It will be a real conveyor belt between the combat units, the staffs and the command, and will draw the entire Air Force into a dynamic of innovation, nurtured by the feedback from our operations. It will also be characterized by its openness.

Openness and partnerships

To be effective, a combat system must not be closed. All the capabilities deployed by the Air Force open up opportunities for partnerships in different fields, such as preparation for the future, support and training.

These opportunities for partnerships lie quite naturally with the other armed forces or ministries, but are equally available to industry and internationally. The AWC, for example, is quite logically open to the other forces and directorates, but also to industry and higher education. These many partnerships fall under the heading of innovation in the same way that we are developing the smart base at Evreux. Cooperation in a European or NATO context is already well established and covers a very wide spectrum, including extending the European Air Transport Command (EATC), common maintenance standards (EMAR), Personal Recovery, single European sky (SES) and the integration of our air defense into the NATINAMDS network (NATO Integrated Air and Missile Defense). Among the most symbolic projects, we are developing with the Ministry of national education an important project concerning social cohesion.

In short, an Air Force transforming to prepare the future

Innovation has been in the genes of the air arm since its creation. This innovation can take many forms, technical, tactical or organizational. Through good understanding of the nature of the combat system that the Air Force represents, it is possible de encourage this innovation and develop it.

The Air Force is today starting to see the benefits of modernizing its combat system—a modernisation that fits into its strategic plan called *Unis pour 'faire face'*. Giving more detail about the most symbolic projects within this modernization, this special edition of *Revue Défense Nationale* should help you to understand better the challenges presented by the complete transformation of a weapons system.

Enjoy your reading!

The permanent commitments of the Air Force

Les Cahiers de la Revue Défense Nationale

Deter and Protect: Two Permanent Missions of the Air Force

Philippe Steininger

Général de corps aérien, Commander of the Strategic Air Forces.

Exactly 75 years ago, France capitulated under the blows of an invading Nazi army, which in just a couple of weeks had routed the combative, but less modern French forces. A few weeks later on the other side of the Channel, a handful of British airmen symbolised the resistance of an entire nation by putting a stop to Hitler's unacceptable expansionism in Western Europe.

It is from these two acts in the tragedy that was Europe in the nineteen forties that the murdered France drew the lessons which structure our defence today. In 1961, a single command in charge of air defence of the home territory was created, which developed into today's air defence and air operations command (*Commandement de la défense aérienne et des opérations aériennes*, CDAOA). In 1964, General de Gaulle—no stranger to that troubled period—ordered the creation of the strategic air forces (*Forces aériennes stratégiques*, FAS) to establish our nuclear deterrent and to underline an absolute refusal ever again to suffer an invasion of our territory. As a result of these decisions, for the past 50 years the Air Force has had a notable place in the two permanent defence missions: protection and deterrence, which mobilise more than 5,000 airmen in France every day.

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The position held by the Air Force in the missions of protection and deterrence within our defence structure is quite remarkable. It is deeply involved in each of them and must carry them out to a high degree of reactivity. With regard to protection, the very nature of ever-changing threats in the third dimension demand such reactivity along with the need for liaison with other players in the public sphere.

To ensure the protection of our airspace, we must in just a few minutes be able to detect, evaluate and, as appropriate, deal with any threat that might develop on its approaches and this, given that 12,000 aircraft fly over our country

every day. The attacks of 11 September 2001 are enough to remind us of the absolute necessity for a country like ours to be able to respond to this requirement, whose principal demand is reactivity in the face of a potentially threatening situation. Thereafter, we must have ability to build an accurate picture of the threat in a very short time from contacts with many units, each of which holds a piece of the solution. This was amply and publicly demonstrated during the night of 17 February 2014, when our air defence chain had to manage the entry into our airspace of an Ethiopian Airlines Boeing which was transmitting an electronic code that indicated a hijack. Fifteen minutes after entering French airspace this airliner, whose intentions were unknown, was intercepted by a Mirage 2000 which relieved the Italian Typhoon that had been shadowing the Boeing up to that point. Less than an hour later, after the co-pilot (who had isolated himself on the flight deck) had asked for political asylum in Switzerland, the airliner landed in Geneva and the passengers were safely released. In this short space of time, the CDAOA had been in liaison with the ministries of the interior, finance, transport and foreign affairs, and with the authorisation of the Prime Minister was able to manage the incident. Such an action is peculiar to the armed forces.

Maintaining the permanent nuclear deterrent posture fixed by the President of the Republic, and the related timescales for increasing alert states cannot be allowed the slightest hitch. Although they cannot be detailed here for security reasons, the deterrence mission also imposes considerable demands on reactivity.

These demands on reactivity and on an effective information network themselves define the particular position of the Air Force in the way that it understands and takes on the permanent missions of protection and deterrence. Air defence constitutes yet another peculiarity because of the direct chain of command linking the Prime Minister to the crew of an aircraft conducting an intercept. In the deterrent role and on instruction by the President of the Republic, the strategic air forces must be in a position to plan a nuclear strike in liaison with the Chief of the Defence Staff in a very short timescale whilst at the same time ensuring the safe and secure arming of their aircraft. Quite apart from the order to fire that the President might transmit to the crews, it is clear that in the deterrence field there is a privileged link between the operational level and the highest authorities of the state.

How does this speciality of the Air Force actually operate within its units on a day-to-day basis? Almost every air base can offer part of the reply. Surveillance of the skies and the capability for intervention in the third dimension rely on the support of a permanently active organisation which, under the authority of the National centre for air operations (*Centre national des opérations aériennes*, CNOA), can call into action four centres of detection and control, combat aircraft on various air bases, an in-flight refuelling capability, the *E-3F* airborne detection system, specialised helicopters with embarked marksmen and, if needed,

ground-to-air assets. Permanently available are pilots, engineering staff, air traffic controllers and personnel of all specialisations—in particular, those needed for the protection of our air bases.

Realistic and intensive training is conducted almost continually on the Strategic Air Force bases so that personnel remain at the highest operational level. Exercises in increasing alert levels are regularly conducted using real weapons, and four times a year a nuclear strike exercise is conducted over one night, which mobilises several dozen aircraft and around a thousand personnel. In addition to that, the units involved in the deterrence mission conduct an exercise per week on average, each covering one or more of the phases of increasing nuclear alert state. The very nature of the mission demands that rigorous checks and controls of the operational state of personnel have been put in place, which mean that each person is routinely tested on all aspects of his job (such as system knowledge, procedures and intelligence among many others) and the results of each simulated ASMP firing are reported to the commander of the FAS. This is a necessary part of the price of maintaining the operational standard required of the nuclear deterrent.

Quite apart from the culture of excellence and reactivity that is common today among airmen everywhere, the missions of air defence and deterrence that the Air Force has supported for over 50 years have given birth to a unique network of command, communications and conduct of operations which is also used to the fullest extent by the third defence mission, intervention. The demands of permanence and reactivity linked to protection and deterrence have given air bases and Air Force C2 centres their ability to change instantly from a peacetime situation to a time of crisis and to operate within a network. It is in this way that air operations in the Sahara-Sahel region are today being conducted from the CDAOA operations centre in Lyon–Mont Verdun.

The start of the Libyan conflict in 2011 offers a further concrete example of how the value of the Air Force's expertise in its permanent missions adds to its intervention capability. Our country went into Libya alone on 19 March 2011, relying on its Air Force to transform political positioning into real acts. In committing its combat aircraft in Cyrenaica on that day, France was a step ahead of its partners in the budding coalition and managed to achieve a number of precious political dividends for the rest of the conflict. This was made possible by the existence within the Air Force of an **initial entry** capability, which depends on one hand on effective equipment that covers the entire spectrum of use of the air arm, and on the other on the high operational level of the crews, achieved through high-quality training. Nevertheless these advantages would have been of little use had they not been supported by the high level of reactivity demonstrated by the personnel involved in the operations. Together, these skills meant that only 36 hours passed between the vote on Resolution 1973 in the UN Security Council and the take-off of the first aircraft for Libya. That these strikes could be conducted under these conditions, thousands of kilometres from our air bases and just a few minutes

after the completion of the Paris summit on Libya, was ample demonstration of the flexibility of use intrinsic to the air arm, and its support to the collective success. That mission conducted by the Air Force in Libya is not without technical and operational parallel to the type of nuclear mission that the FAS would conduct, were it to be required. There were similar demands on reactivity, independent initial entry capability over hostile territory, the capacity to strike at long range and the ability to operate in coherence with parallel political action. All of these skills are in the genes of the FAS, and over the 50 years of its operational existence they have been transferred with great success to the rest of the French Air Force, with the enormous benefits we see today.

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For more than 50 years, 24 hours a day and 7 days a week, our air defence assets have been guaranteeing the sovereignty of our airspace. In the same way, the strategic air forces have been guaranteeing the nuclear posture that was given to them in 1964 by the President of the Republic. That is tangible proof of the unfailing commitment of the Air Force to the protection of our national territory and to deterrence—the two permanent defence missions.

Independence, freedom and the ability to win acceptance of our values: those are what leads the nation to take the necessary measures to protect itself and to deter any aggressor from interfering with our vital interests. For the Air Force, this directive given by the President of the Republic at the conclusion of his speech on deterrence at Istres on 19 February 2015 means modernisation of the capabilities it calls upon in fulfilling its commitment to the permanent posture of security and nuclear deterrence. And yet this dynamism would be nothing, were it not constantly maintained at the highest possible level by the competence and the motivation of Air Force personnel.

Intervention Beyond our Frontiers: Being Responsive and Sustainable

Thierry Duquenoÿ

Général de brigade aérienne, Assistant Chief of Operations in the Air Defence and Air Operations Command.

One of the prime qualities of air power is its ability to intervene rapidly from the beginning of a crisis wherever it occurs. It is the prompt blow which demonstrates political will. But the complexity of the situation, the diversity of international actors and the desire to confine force to the minimum do not always afford the prospect of resolution in the short term. On the contrary, it is often necessary to remain firmly committed in the longer term.

This is what recent history shows. It is the reason why the Air Force has determinedly adapted itself. It is also the issue in the great changes to come.

The strategic setting: a typology of crises

In December 2010, a protest movement overthrew the Tunisian President. The Arab spring quickly took hold in Egypt and then Libya, where it set off a civil war. Less than a month after evacuating its nationals, France intervened in Benghazi on 19 March 2011, two days after a UN Security Council Resolution.

In northern Mali, the Malian Army was engaged in armed conflict with Touareg rebels allied to Al Qaeda Islamic groups. The weakness of the organs of state paved the way for the terrorists to move on Bamako at the beginning of 2013. Paris intervened on 11 January when the jihadists were at the gates of the capital.

The shock-wave of the Arab spring propagated rapidly along the arc of crisis. Syria also became mired in a civil war which overflowed onto Iraqi territory. In June 2014, ISIS set up a caliphate and threatened Baghdad during the summer. On 19 September France struck in Iraq.

On each occasion the Air Force was engaged within hours of the Presidential decision.

Economic difficulties added to political instability constituted fertile ground for terrorism which spread throughout the Sahelian/Saharian belt. The response to the Malian crisis must therefore be lasting; it must also be regional.

French forces are correspondingly pre-positioned in a region as large as half of Europe.

In the multi-confessional Levant, or Eastern Mediterranean, geopolitical stability depends on the return of refugees and presumes that the Kurdish, Arab, Shi'ite and Sunni communities overcome their rivalries, while respecting the Christian and Yazidi minorities. The various peace processes remain hostages to the strategic relations which link the capitals of the region with Washington, as with Moscow. The connections which exist between terrorism in the region and on its own national territory expose France to a continuing threat.

The involvement of the Air Force with terrorism is destined to last.

How does the Air Force respond to this context of permanent crisis?

The command and control of operations in Africa is carried out in "full rear", that is, from the air base of Lyon–Mont Verdun, using permanent and robust installations and equipment, supported by a permanent security posture.

This new concept provides major benefits in terms of responsiveness (the organization of the staff is instantly adaptable, thanks first of all to the abilities of the air defence and operations command (CDAOA) and secondly of the whole Air Force), of operating costs (no major deployments of personnel, equipment or support), of capabilities (using individual reinforcements of specialists) and of the ability to sustain operations while preserving a high level of theatre expertise.

This concept is, however, dependent on effective liaison with the core of the joint-service command, as well as with other actors.

Although the planning and centralized command of air operations permits the optimization of the regional response demanded by the extent of the areas of operations, exchanges of messages and large amounts of digital data have become the norm. Also, high-capacity secure satellite communications are vital to connect commanders and operators.

The defensive digital effort is now integrated into the cyber defence context, with information and communications systems (ICS) supported by joint networks with a high degree of redundancy. Tactical data links, recently deployed in theatre, are force multipliers which have also enabled the coordination of air operations to be improved. Operating these systems remains a complex matter, requiring the mobilisation of highly specialized teams. The responsiveness and sustainability of the Air Force depend on ICS resources which are interoperable with those of allies, foremost among which are the countries of the Atlantic Alliance.

For its part, in order to guarantee the responsiveness and effectiveness of its chain of command, NATO has specified and put in place the resources, procedures

and an organisation for command. This standardisation has enabled it easily to integrate the resources and experts placed at its disposal by the contributing nations, under the heading of The NATO Force Structure. Today, NATO benefits from the development of this overall interoperability, built up by the preparation procedures and alert posture of the NATO Response Force (NRF). This standardisation also facilitates the integration of the contributory air forces into ad hoc coalitions whether under Alliance command, as was the case in Libya in 2011, French command, as in the Sahelian/Saharan region since 2013, or American command, as in the Levant today.

Beyond the problems of command, the effectiveness of air power rests on its capacity to react anywhere in a very short time and in a sustainable manner. To achieve this, the Air Force has a network of air bases and projection capabilities appropriate for rapid reaction. Whether they are permanent, in France or in other countries, or projected, these bases constitute the principal combat element indispensable to the operation of the air component. Hence, operations in Libya were principally conducted from bases in Metropolitan France. They have since been conducted from pre-positioned bases in Africa for Operation *Serval/Barkhane*.

The air base continues to evolve towards a format allowing continuity from peacetime to crisis while optimising resources for operational activity. Aided by support units on projection, deployed air bases benefit from the appropriate structures for the operation of all the equipment necessary for the mission. More precisely, the operation of sophisticated aeronautical equipment requires a responsive logistic function, based on a planning centre capable not only of guaranteeing a permanent and high degree of readiness, a measure of responsiveness, but also a rapid regeneration capability.

An optimum balance must be found for each equipment for the stock level of spare parts, the transport function, the allocation between operational units in France or deployed, support units and the industrial base, state or private. Naturally, the optimum point will be different according to the type and cost of the equipment. The efficiency of the logistic function, which is a combination of operational performance and technical and budgetary feasibility, is a major challenge as operations proliferate and diversify.

But above all, the various external commitments with which the Air Force must contend represent a real challenge in the area of human resources, in a context marked at the same time by large reductions in numbers and by the need to cope with an increasingly complex environment. As with the other services, but with an urgency enhanced by the cutting-edge technology which characterises it, the Air Force must launch a campaign of recruitment, individual and collective training, employment in Metropolitan France and in operational theatres, and of operational maintenance as requirements and working methods change.

Consequently, to have personnel available at all times, competent and sufficient in number, capable of maintaining the sustained effort of external operations, while also carrying out internal missions, is a strategic issue for the Air Force.

Changes in the short term

All these changes have been made necessary by the context of multiple and changing crises, which constitute a framework for engagements for the years to come. This implies a continuation of the approach already undertaken in all areas. In some of these, such as equipment or human resources, the horizon is a short-term one.

The Air Command and Control System (ACCS) will enable command and control of operations from a unique system, both on national territory and in external theatres of operation, in a national or multinational setting. The flexibility of use of its work stations, the modularity of its operations rooms and the experience gained by its personnel on a multi-purpose system will improve the responsiveness and adaptability of the command and control structure in the event of a new operation.

The A400M for its part will revolutionize military air transport. Its greater load-carrying capability over a longer distance will enable most theatres to be served from its base at Orléans without trans-shipment and with a reduced number of aircraft. Hence, the airdrop operation on Timbuktu in January 2013, which required five C-130 Hercules and C-160 Transall aircraft from Abidjan, could have been accomplished with three A400M Atlas from France.

The surveillance of a target by a drone requires long flight endurance, made possible by an adequately-sized human team. The desired performance depends on this. Today, some missions last five days without a break. To increase this performance, and even if the theatre is distant, the possibility of piloting from fixed installations within France is under study to reinforce teams on external operations (*Opex*) without delay or supplementary deployments, in periods of particular need.

Command structures require a considerable number of specialists with a range of skills. The need to pass from an empirical use of this resource to a formalized establishment and management system, fed by a pool of personnel adequate in quality and quantity, is obvious, all the more so when personnel numbers are shrinking, the technical skills demanded are increasing and demand for them from other services and allies is rising. The aim is to plan what can be planned while facilitating the management of the unexpected.

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In sum, the responsiveness to cope with the suddenness of crises and the ability to endure on numerous fronts constitute two issues that appear contradictory. To resolve them is nevertheless the challenge which the Air Force must take up in order to fulfil its operational obligations.

This task is only possible thanks to new equipment which is continually adapted or renewed, to methods and structures which evolve continually, and above all, to the remarkable skills and energy of all of our airmen and their support.

This is what is demonstrated flight after flight, crisis after crisis.

The Strengths and Weaknesses of Versatility

Yann Leboulanger

| *Colonel*, directing staff at the *École de Guerre*.

Over the past twenty years, versatility of military assets has become a structural principle of armed forces. The variety of recent commitments, and the broad spectrum of missions that they imply in the face of increasingly sophisticated and ever-changing threats, means that military forces must necessarily have great flexibility and great reactivity. Such flexibility and reactivity are essential to give the military chief his freedom of action.

Versatility: a dream come true with Rafale

The concept of versatility is not new – indeed, in the years between the two World Wars two major new ideas in the field of military aviation were tried out:(1) Giulio Douhet's 'battle plane' introduced the idea of a bomber that was capable of destroying targets (towns) deep behind enemy lines whilst continuing the dogfight with the enemy, and in the nineteen thirties France sought to develop the BCR, an aircraft capable of fulfilling three missions: bombing, fighting and reconnaissance. Apart from an absence of doctrine, the main thing to note about these early dreams of adaptability and versatility is that it was essentially the lack of mature technological capability which prevented them from coming true.

During the Cold War, the concept of specialisation of air assets was the vogue, and the specialised nature of air forces of the era was manifested in two fleets: first, the fighters, designed to confront attacking aircraft, and then the bombers, whose job was to deal with land targets.

In the mid nineteen eighties, at a time when the United States consolidated their policy of specialisation with what was to become the F-22 Raptor, the new generation air combat fighter, the French military staffs went for multi-role versatility. The technology then available, along with budgetary constraints and the consequences of oil crises, led to the design of an aircraft capable of conducting all air missions and at the same time reducing the number of machines required. Thus began the ACX project, which developed into Rafale.

(1) Yohan Droit, '*Le concept de polyvalence du Rafale*', *Défense et sécurité internationale*, No. 63, October 2010.

The multi-role aspect of Rafale suited the needs of both the Air Force and the Navy (the *Aéronavale*) and in addition to allowing the replacement of some eight different aircraft types – the Jaguar, Mirage IV, Mirage F1, Mirages 2000C, 2000N and 2000D, Super-Étendard and the Crusader – a single aircraft type could now conduct a wide range of missions from reconnaissance, ground attack and anti-shipping, through air superiority to nuclear strike. This versatility, more commonly referred to as multi-role capability, has allowed modernisation of every aspect of French fighter aviation whilst at the same time enabled a considerable reduction in numbers as dictated by an ever-tighter budget. Throughout its recent deployment in French military interventions in a wide variety of modes of action, sometimes in the course of a single mission (swing role), Rafale has demonstrated its agility and flexibility of use. It contributes to the fundamental freedom of action necessary for the command of modern operations, whose missions in today's complex world have to be organised and conducted within short timescales. Moreover, the uniformity we now have in our in-service air assets has led to considerable simplification in the support required, and hence greater efficiency in the logistic and technical issues concerning operational maintenance of these sophisticated machines when they are deployed thousands of kilometres from our borders. It is here that versatility shows its enormous advantage in overall cost of ownership.

A break with the strategy of assets

It is worthy of note that, over and above the superb technological prowess that results from the high level of knowhow of the French aeronautical industry, Rafale is also the incarnation of a break with the strategy of assets.(2) France discarded the concept of specialisation in favour of the concept of versatility, a move which inevitably carried with it a considerable risk at a time when no other air force had considered such a revolutionary change of direction. To call it a revolution is no exaggeration: it was a cultural one above all, because the human being is at the heart of the new concept. Versatility in equipment cannot be achieved without versatility in man. The arrival of Rafale necessitated a profound structural reform among fighter squadrons, and a redefinition of the levels of knowledge required by aircrew: a common 'basic' skill base was defined, and a 'reference mission' adopted to express a higher level of expertise regarding a particular mission. The establishment of this multiple-role versatility thus led to a rethink of the culture of units originally established for specialist fighter or bomber roles. It also had a resounding effect on initial training, for the training curriculum has been revised in order to reflect in particular the demands imposed by the management of a complex combat system. The versatility of the Rafale also necessitates a higher level of training to maintain and develop the new and essential skills: in place of the

(2) General military strategy, according to General Poirier, depends on two strategies: operational strategy (use of forces) and the strategy of assets (equipping those forces)

180 hours of fighter pilot activity annually, which is the general norm within NATO, a multi-role Rafale pilot needs 250 flying hours, of which 70 can be completed on a modern simulator.

This 'multi-role revolution' in military aviation is now being extended to areas other than fighters and is appearing in other forms.

Tactical and strategic military air transport is currently undergoing fundamental change. The A400M, of which France received the first example in 2013, is the first truly multi-role transport aircraft, capable of conducting a broad range of tactical and strategic missions and of in-flight refuelling. The future Multi Role Tanker Transport (MRTT) is intended to renew current strategic transport fleets (A340 and A310) and also the tanker fleet (currently C-135). These new aircraft, the A400M (Atlas) and the A330 MRTT (Phoenix), with their extended capabilities, will also require a rethink of their concept of use and of the structural organisation of the units and the personnel that will operate them.

Air operations command is itself also progressively adopting the concept of multi-role versatility. In order to be reactive and flexible, and at the same time to achieve a reduction in the cost incurred by the deployment of personnel on exterior operations, modern technology has allowed the Air Force to go for directing French air operations from the national air operations centre (CNOA), sited in Lyon–Mont Verdun. Although historically, this centre has been dedicated to the direction of air operations on French territory, it is already in charge of air operations in the Sahel and Sahara regions of Africa – particularly for Operations *Barkhane* and *Sangaris*. Beyond that, the setting up of the Air Command and Control System (ACCS) programme will soon allow sovereign and external missions to be conducted by the same personnel, using the same equipment, all perfectly interoperable with NATO centres, and using NATO procedures.

A final example of the development of the policy of versatility lies in the consideration by the service staffs of a future helicopter, known as HIL (*Hélicoptère Interarmées Léger* or Light Joint Helicopter), which is intended to replace five current in-service types (Dauphin, Panther, Alouette III, Fennec and Gazelle). The start of the project has for the moment been put back to the next cycle of the military programming law, which means beyond 2019.

All of this shows that the Air Force has committed firmly to its decision to elect for the versatility offered by multi-role aircraft and for advanced technology in its strategy of assets. It is the response chosen to support a double conviction, that of the need to maintain a winning technological upper hand with respect to the adversary and that of the unpredictability of future military interventions.

Versatility is not everything: the risk of a piecemeal force

That said, technological superiority and the great versatility of materiel and personnel it allows comes at a price. The costs of acquisition and maintenance (in the sense of force generation) of military equipment never stop increasing: they do so more rapidly than the GDP of the country yet at the same time defence budgets remain under great pressure. The more pessimistic foresee a budgetary impasse on the horizon, which they fear may lead to the emergence of somewhat piecemeal forces. In the nineteen seventies, when he was secretary of the US Army (and before he became the head of Lockheed Martin), Norman Augustine said much the same in referring to the methods of the Pentagon and rising costs, that if they did not change, the Pentagon budget would only pay for a single tactical aircraft by the year 2050.

The high price of versatility may well lead to a piecemeal Air Force lacking in depth, and which in the end would no longer have the capability to react to the diversity of its simultaneous interventions (which are constantly increasing in number and in different theatres of operation) or, at the very least, would no longer be able to remain committed to its various missions in the long term. To alleviate this weakness in versatility, the Air Force is putting in place directed training—an adaptation of the concept of versatility that integrates a form of relative specialisation, which will allow a capability to be maintained in the longer term: some of the Rafale crews will therefore receive limited and adapted training for the less complex phases of an operation which in turn will allow a reduction in their combat aircraft activity. On the other hand, they will receive more quality air activity time on a modern aircraft, achieved via the combat pilot training scheme known as Project *Cognac 2016*.

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Given the unknowns of the character of future operations and the future size of national defence budgets, the decision to elect for versatility appears as a hedge against strategic uncertainty. In particular, it allows French air forces to offer the military commander the greatest range of options, based upon technical superiority and in a format adapted to the situation. But the versatility of all that is 'multi-role', all too often limited in popular perception to considerations of equipment alone, is nothing without versatility of the man and women who put it all into effect. The real challenge to preserving the operational level of the French Air Force lies more than ever in maintaining a high level of training of its versatile personnel.

Innovation: adapting the Air Force to today's demands

Les Cahiers de la Revue Défense Nationale

The Need for a Strategic Plan: Progress Report on *Unis pour 'Faire Face'*

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Why a strategic plan?

The Air Force is a young service, very multi-purpose these days, and is notable for its responsiveness. Since its creation 80 years ago it has continually adapted its organisation in order to be operational at all times in the face of successive transformations affecting the Ministry of Defence.

Hence, at the end of 2012, the Chief of Staff of the Air Force, Général (Air) Denis Mercier, decided to lay down a coherent framework for the new joint environment and to promote guidelines for the years to come. This intention and vision materialised in the launch of a strategic plan entitled *Unis pour 'faire face*', with the objectives of giving more direction to airmen in their daily work and to build the Air Force of tomorrow by refocusing on operational matters. As the Chief of the Air Staff said, "airmen have always been able to adapt their organisations, master the latest technologies and innovate to achieve their missions successfully while preserving their identity and their values".

The four guiding principles of the strategic plan *Unis pour faire face*

To implement the plan, the Air Force is depending on four main principles to guide each stage of its implementation:

Coherence first of all: this is one of the key principles of the project, because it concerns placing all of our organisations and actions in a position to support operational activity and missions.

Responsibility in seeking greater delegation of command where some previous reforms have led to excessive centralisation. The responsibility of command must be moved back to the functional centre of the Air Force by avoiding complex and dehumanised organisations needing too much coordination and without a real

leader. This is also an individual responsibility which everyone must apply in daily life in the exercise of his functions.

Innovation to conceive new capabilities and to adapt organisations, in order to be in a position to meet new challenges. The airman must think differently and constantly question himself, which is why innovation must go over old ground, from the experience of the old to the freshness of youth.

The human being at the heart of our actions, in that the men and women of the Air Force constitute the keystone of the whole project. Involving everyone, linking all airmen, whatever their rank, speciality or function, developing skills and building careers are the foundations of the dynamism and robustness of tomorrow's Air Force.

A strategic plan for an operational and modernised Air Force team supported by its airmen

Unis pour 'faire face' re-states the fundamental principles of the Air Force and its central themes, which make it an instrument of power in the service of the nation.

Three missions: The Air Force contributes to the range of strategic functions defined in the 2013 *Livre blanc* (white paper) on defence and national security and has the purpose of playing a major role in the three generic missions laid down for defence: to protect, to deter and to intervene. The Air Force also offers immediate responsiveness for any intervention decided upon by the political authorities.

Four values, anchored in the institution, which are the basis for the spirit and culture of the airman: respect, integrity, service and excellence.

Five key capabilities, which must be possessed and combined to undertake any air action, and which ensure the coherence of a modern and efficient air force in the service of France's obligations. They are: the command and control (C2) of air operations, intelligence, rapid intervention, projection, education and training.

Recent operations have confirmed and validated the approach of this strategic plan in phase with the general transformation of the Services, which is based on four central themes:

– **The modernisation of combat capabilities:** operations demonstrate the need to modernise our operational capabilities but the reductions in scale and the slowing of modernisation have led to choices being made within the five key capabilities described above, in accordance with the priorities defined in the *Livre blanc*. Current constraints have also led the Air Force to propose some highly innovative solutions, such as the concept of variable training for its fighter pilots.

– **The simplification of structures:** in order to conform with ministerial reforms which involve the harmonisation and simplification of administrative pro-

cedures and decision processes, it was necessary to adapt and simplify the Air Force equivalents to make them clearer and more comprehensible.

– **The development of partnerships:** the Air Force is evolving in an environment where interdependence, which is already natural in the air world, is continually growing and where economic constraints impose cooperation. The widening of partnerships therefore appears as an unavoidable option to maintain or reinforce capabilities, with joint, inter-ministerial, international or civil society partners.

– And finally, **the development of our personnel:** the performance of the Air Force depends on the quality and commitment of its military and civilian personnel. In a context of successive reforms and large reductions in manpower[1] the challenge is to provide guidelines for the them and to generate enthusiasm for the reforms by placing the human being at the centre of our actions.

The Air Force in project mode

The setting up of *Unis pour 'faire face'* was marked by the simultaneous launch of about 40 very diverse projects. Functioning in project mode was a choice which the Air Force adopted in the face of numerous challenges to be overcome and a particularly rapid rhythm of change, which was difficult for conventional staff procedures to absorb. Action in project mode favoured innovation and coherence in the global strategic vision.

In the first two years (2013 and 2014) of the *Unis pour 'faire face'* strategic plan, the transformation of the Air Force was begun in a coherent and innovative way through the development of approaches and the definition of major projects, followed by a launch phase, a process of communication, and acclimatisation to the project and its methods. These two years have seen the first signs of progress on air bases and for air personnel. The Air Force has now entered the third year of implementation of the plan, which will be one of concrete results and its adoption at all levels.

The projects for the modernisation of its combat capabilities are intended to support the overall combat power of the Air Force by integrating the range of new systems, together with the doctrine for their use, and also the acquisition and maintenance of the required skills.

They are thus aimed at increasing the Air Force's competence in the C2 domain (Projects CDAOA[2] 2014, SCCOA,[3] ACCS[4]), improving its intelligence

(1) 15 major units closed between 2008 and 2012 including 8 fighter squadrons; 40% of the combat fleet lost in under 10 years; and 16,000 fewer people over the period 2008-2019—a 25% reduction in Air Force manpower.

(2) Air defence and air operations command.

(3) System of command and control of aerospace operations.

(4) Air Command and Control System.

capabilities (drones, ALSR[5]), reinforcing its mastery of rapid intervention across the whole spectrum of air operations (active antenna for Rafale, Meteor missile, laser AASM[6]), integrating new possibilities in the projection field (A400M, MRTT[7]) and finally applying the principle of variable training to operational preparation, notably with Projects *Fomedec*[8] and *Simulation*.

The Air Force has sought to conform with the process of the simplification of structures which is at the heart of the modernisation of contact with the public and the reform of the Ministry. Under this heading, some major simplification projects have already been or are in the course of being finalised, in particular the CDAOA project which has led to the centralisation and modernisation of the air C2 at Lyon, where the Project 'Command of the air forces 2015' has combined the two large organic commands of the Air Force, while respecting the need to control the manpower requirements.

In addition, considerable efforts have been made especially to prepare the attachment at Balard, adapt the organisation of air bases (Project *BA XXI* and squadrons), bring under one roof expertise within the Air Force in the subjects of concepts, doctrine and experiments (the air warfare centre project) and increase expertise in aeronautical maintenance in operational condition (MCO) based on Simmad (integrated structure for maintenance in operational condition of defense materiel): Project Simmad *Cap 2016*. Finally, the Air Force is organising itself to cope with the restructuring announced by the Executive by optimising the networking of air bases in order to guarantee the operational coherence of the Air Force as a whole (Project Stationn'Air).

At a time of tight budgetary control, and where mutual working has become indispensable, the Air Force is developing a number of partnerships to maintain or increase its capabilities:

- with other services first of all, with several projects which aim at developing new synergies, particularly in the field of special forces;

- interministerially, by proposing cooperation founded on offering the aeronautical expertise of the Air Force (Project Interminist' Air);

- internationally, by reinforcing and consolidating some international partnerships with NATO and the European Union in particular (Projects NATINAMDS and European initiatives) and by developing the capabilities of the Air Force in the area of cooperation and contribution to supporting exports (Project continuum cooperation-*Soutex*);

(5) Light aircraft for surveillance and reconnaissance.
(6) Modular air-to-ground weapon.
(7) Multi-Role Tanker Transport.
(8) Programme for modernised education and differentiated training for fighter aircrew.

- finally, with civil society, by developing an equal-opportunity plan for young people on the basis of existing initiatives supported by experience gained at the *École de l'Air* and by developing synergies in the area of education.

The motivation and commitment of air personnel is a major element in the success of reforms. The Project *Unis pour faire face* is aware of this and plans the career development of personnel by a more dynamic and personalised management of abilities.

To achieve this, several projects have been launched to consolidate management of skills, which must be combined with the validation of acquired knowledge essential for the second part of a career, and to strengthen the airman's identity—a vital component of the training and employment of air personnel, since it is the basis of his sense of commitment.

This development of personnel is the motivation behind the unification of the initial training schools for officers at Salon-de-Provence (Project *École de l'Air XXI*) and also by the promotion of the history and heritage of the Air Force.

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A process under way at all levels of the Air Force

Through the *Unis pour 'faire face'* plan all branches of the Air Force are resolutely facing the future.

We have to innovate in order to adapt, which is why this strategic plan calls upon the initiative and commitment of the airmen who are the players in these projects by motivating them and by constructing tomorrow's Air Force with a fresh vision.

Clearly, 2015 is an important year for the construction Air Force's strategic plan because it has enabled the benefits of this transformation to be validated. Modernisation, human resources, organisation: all dimensions are interlinked with each other and this coherence renders the Air Force stronger, more proactive and more resilient in the face of the operational and human challenges which, like the nation itself, it has to '*faire face*' (face up to!).

Cognac 2016 and *Fomedec*: Innovation and Operational Preparation for Tomorrow

Jean-Christophe Boëri

| *Colonel* (Air), deputy head of the Air Staff Plans Office.

To train is first of all to transmit know-how in order to be ready for the future. To train is to transmit competence. That implies having been able to look critically and pragmatically at the past, at what our forces have done and what could be improved. Once the lessons have been extracted one must be capable of turning them into training, without however being able to call upon on infinite resources, either in time or in money. This is a real constraint these days. Our objective is thus to succeed in transmitting the key strategic skills in a minimum of time, while being sure that the level achieved corresponds effectively to what the combat units demand. The loop must be as short as possible, to avoid allowing any mismatch to arise between teaching and operational practice with modern combat systems.

In the framework of the Air Force's strategic plan *Unis pour 'faire face'* (United to Face the Future), especially under its heading 'Modernisation of Combat Capabilities', Project *Cognac 2016* and the resulting armament programme *Fomedec*,(1) are changing the methods of training fighter crews and pilots. This innovative project will provide answers to **two major issues**: **modernise the training of fighter pilots**, in order to perpetuate it by adapting it to the latest generation of fighter aircraft, and **to have available a pool of trained crews**, able to respond to operational commitments laid down by the Air Force, while generating savings in line with the funding allocated by the Military Programme Law 2014-2019.

The first problem: modernise and perpetuate the training of fighter crews

Our initial fundamental need is to have available as quickly as possible fighter crews (pilots, navigators and weapons systems officers) trained to serve in the Air Force and the Navy in modern combat aircraft of the Rafale type.

(1) Modernised and Differentiated Training for Fighter Crews.

The basic training of fighter pilots is currently carried out in two stages. The first part, called pre-fighter specialisation, takes place at the Cognac air base on TB-30 Epsilon aircraft, whereas the second, called fighter specialisation, is conducted on Alphajet aircraft at the Tours air base. The Epsilon and Alphajet are now showing their age. By 2016, the TB-30 will have been in service for 30 years and the Alphajets of the Fighter School for 35 years, without any significant improvements to their on-board systems. In addition, the Alphajet is understandably encountering a rapid inflation in its running costs, especially in its programmed maintenance costs. These aircraft are no longer fit for training crews called to operate the latest generation of aircraft. In fact, the absence of modern systems prevents the early acquisition of skills indispensable for the management of complex systems, such as are used in operations today.

Cognac 2016 is therefore introducing an overall re-working of our crew training. Ideally, it would be based on the acquisition of a modern turbojet type of aircraft, chosen for its low operating costs, capable of high performance and equipped with modern avionics, whose integrated mission management systems follow the same logic as those of the latest generation of fighters. A new training programme would follow, in which simultaneous training in handling the aircraft and its systems, thanks to the increased use of simulation, on the ground and in the air, will enable the training envelope to be extended, while limiting the number of flight hours required. Here, the concept of downloading appears, an integral part of the whole programme. This techno-pedagogic approach will depend on modified avionics which make it possible to simulate in flight the use of equipment and modern armaments such as radars, missiles etc. and will allow the trainee pilot to acquire skills only developed on combat aircraft up to now.(2)

For their part, future instructors will be experienced pilots who will spend 20% of their time in combat units and 80% in training schools, to the benefit of those who will be their fellow crew members in the 18 months which follow. This is the assurance of an ideal correlation between what is expected by combat units in the field, day after day, and what is effectively transmitted to the young pilots.

The new programme will enable fighter pilots to be better prepared for their future environment and will reduce the length of their training by six months, by virtue of combining two phases into one. The training, carried out today on two different types of aircraft, will be on a single aircraft with much more modern avionics and at a much reduced cost. Finally, for the Air Force this will be an opportunity to rationalise its footprint by closing one installation, generating more savings.

(2) Cf. the report of the Centre for Research of the Air Force (CreA): '*Optimisation de la formation du pilote de combat par* downloading' by Julien Donnot and Vincent Ferrari.

A modernised training system open to international cooperation

The training of foreign aircrews by the Air Force also has political implications. Armed with the experience of the successful Franco-Belgian AjeTS[3] programme and many bilateral contacts, *Cognac 2016* will naturally be open to several forms of cooperation. The future school will have the task of training fighter pilots for our partners wishing to benefit from French expertise in the subject of training, and will offer an opening for future and long-term cooperation.

The second problem: create differentiation in training by means of a second circle of fighter pilots

The *Livre blanc* published in 2013 introduced four guiding principles, among which were the differentiation of forces and the mutualisation of capabilities.

In addition to this process of modernisation and rationalisation, the real innovation of the future training programme results from the capabilities of the new training aircraft. Its weapon system, close to that of a modern fighter aircraft thanks to on-board simulation, and its low operating cost will open the way to the **differentiated training of qualified fighter pilots**. The Air Force will thus have available trained pilots in sufficient numbers to cope with its operational commitments, guarantee its sustainability and match our fleet of combat aircraft[4].

This is an essential point. Without appropriate training, that is, the preparation of our air crews to use the powerful weapons which we operate today, the Air Force would not be in a position to respond, with the responsiveness and excellence which characterises it, to the many demands and very short notice which have featured in recent engagements in Libya, Mali and Iraq.

Differentiation in our operational preparation appears to be the only way to maintain at the highest level the operational qualifications of the number of fighter crews required by the last *Livre blanc*, in order to enable the Air Force to fulfil its operational obligations (290 crews).

Based on regular training and suitable supporting resources (supporting aircraft, simulation), it offers the possibility of having available a '**first circle**' of pilots immediately employable across the complete spectrum of operations, while conserving a reserve capability thanks to a '**second circle**', capable of rapid mobilisation, and able to supplement the first group for certain missions, particularly in so-called low intensity operations, giving the Air Force sustainability, the ability to

(3) AJeTS (Advanced Jet Training School): a Franco-Belgian school for fighter pilot training created in 2004. This school is also open to other European nations. Apart from Belgian pilots it receives British, Italian and German pilots.

(4) While the 2008 *Livre blanc* on Defence and National Security fixed a target of 300 fighter aircraft, the 2013 edition specified a total of 225 fighter aircraft for the Air Force and the Navy.

intervene simultaneously in several theatres and more generally to support operations, eg, to reinforce operational command centres.

To employ a second circle of qualified pilots to train future fighter pilots, supplemented by limited activity in combat aircraft[5] is a real innovation, which combines the activity indispensable for pilots fit for combat and basic training activities. The performance expected of the new training aircraft, as well as exercises carried out during instructional missions, will be representative of a modern fighter and will enable instructor pilots to maintain their indispensable skills base.

Cognac 2016: the innovative melting pot of differentiation and mutualisation

Cognac 2016 will therefore ensure the maintenance of rapidly mobilisable operational qualifications at less cost, using an aircraft equipped with weapons systems and its associated simulators reduced to essentials. This project will enable the Air Force to modernise and optimise the training of fighter crews by adapting technologies used in the cockpits of our modern fighter aircraft, such as Rafale, while respecting the operational obligations laid down in the last *Livre blanc*, with high expectations and making major savings.

As a project as ambitious as it is daring, *Cognac 2016* responds to multiple challenges. It will modernise and improve the training of our fighter pilots for less cost, and will offer France opportunities for international cooperation, thanks to a, attractive and high-level alternative to propose to our foreign partners. Finally, and above all, it will allow the implementation of the principle of differentiated training, with the creation of a second circle of fighter pilots; a synonym for meeting ambitious operational commitments in spite of the reductions in the fighter force.

(5) The activity of pilots of the second circle will include 140 flying hours in the *Fomedec* context plus 40 hours in combat aircraft. Pilots of the first circle will maintain a rate of 180 hours in combat aircraft.

Training of the Combatant at the Heart of the Airman's Operational Preparation

Alain Rouceau

Général de brigade aérienne, Director for employment and training, Air Force human resources directorate.

Military personnel, whatever their rank or function, are in essence combatants. They can be ordered to commit themselves to an operation, during the course of which they may have to use violence to constrain or neutralise an adversary. In that, they literally have an exorbitant power to kill, which goes beyond legitimate defence. Although that is quite evident, it is worth repeating here, for it is what distinguishes the military from other professionals who are permitted to carry arms in the conduct of their profession. Even if he has certain particularities, the airman does not escape from that condition. From joining the service until he returns to civilian life, the training of the combatant is placed at the very heart of his maintenance in operational condition.

Initial training as the foundation of the combatant

Because it is notable for its high level of technology, the Air Force has always been confronted by the dichotomy between specialist and combatant. Right up to the last hours of the Cold War and the end of the bipolar world, its specialised ground personnel operated within the limited area of the air base, whose existence it defended. Basic training, centred only on learning reflex and elementary actions, seemed enough. Maintenance of these basic skills came mainly through training exercises for the air forces. Things have changed since then. Whilst aircrews still constitute the spearhead of the air arm's combat capability, they no longer have the exclusivity of engagement in a fight that they had in the past. The development of special operations and their dedicated forces, in particular the air commandos, is a direct evolution of our response to changes in the adversary. But beyond that, all airmen today participate in internal or external operations. Technicians and base personnel therefore share the risk, especially when they are deployed on the ground within complex bases in a dangerous environment where values of humanity, the basis of our society, are often absent. That does not, of course, call into question the participation in our defence structure of the air

combat force: it is the conditions of projection into a theatre far from our homeland, which give it a different dimension.

Initial training is the first hurdle in learning about combat, and is fundamental to establishing the values of the airman. All young people who engage in the Air Force attend courses at the Air College at Salon-de-Provence for the officers, the Air Force NCO's training school at Rochefort or the elementary military training centre at Saintes, for Air Force technicians. These schools belong to the Air Force human resources directorate (DRH-AA). The combatant's initial training aims to bring real skills to the airman in the broadest sense so that, when needed, he will be able to play his role fully during an operational commitment, something he does this more and more often alongside his comrades from the Army, the Navy and even foreign military personnel. This training has to adapt to a context in which the threat is constantly changing, which obliges the schools and training centres to remain in direct contact with reality on the ground.

The techniques of ground combat have seen far-reaching changes. As well as developing the physical capacities traditionally attached to the military trade, such as combat shooting, first aid and its operational derivative, combat rescue, techniques of close operational intervention now form part of these fundamentals. Legal aspects, awareness of the threat of IEDs and cyber security complement the package which leads to the 'passport' for the combatant.

Calling on its heritage, the Air Force underlines four symbolic values of the air community: respect, integrity, service and excellence. These are introduced from the very beginning of soldier training and lead the airman to understand the sense of his engagement, help him to see how he fits into the institution and to reflect upon his own responsibility. Whether he is an officer, and NCO or an airman, these values help to forge in him the ethic that will guide him in his decisions and future actions.

In short, initial training has to be considered as the founding act of the combatant—we speak of it as initial certification—and its objective is clear: to make the airman rapidly employable at all times and in all places after he leaves the training school. For all that, these fundamentals have a limited life and it is therefore essential to keep them up to date and to build on them in further training.

Maintenance in condition: guarantee of operational effectiveness

So that knowledge and skills acquired during training or experience keep their full value, they must be used regularly if they are not to fall into obsolescence. This is even more the case when we look at high-level expertise. And yet it is not always easy to put special abilities to use quite simply because the situation does not lend itself to them, hence the importance of continuation training and exercises. The first difficulty in answering the question of validity is to determine how

long it will be before the automatic reactions no longer work. This time aspect has to be considered at the programme design stage, since it drives the content and rhythm of training. The second difficulty, independent of the first, concerns how to take into account feedback from experience. The most recent operations have shown that potential adversaries' modes of action are changing rapidly. We therefore need to be reactive by building a system of modular courses that are easily adaptable. The third touches on our capacity to deliver such continuation training: we need to have available qualified instructors, materials and the appropriate spaces in which to conduct it. This is probably the most difficult problem to solve, since units and air bases do not necessarily have these facilities.

The Air Force has therefore organised itself to give the best response to these issues and has defined a minimum threshold of competence through the individual operational preparation of the combatant (POIC) and the boosting or acquisition of more specific knowledge through a system of bringing personnel up to speed before deployment (MCP). Initially limited to the Afghan theatre, MCP has gradually become a compulsory pre-deployment element for all personnel. Together with initial training, POIC and MCP form a coherent, logically linked continuum of combatant training.

So, initial training in the schools teaches the fundamentals and POIC builds on them through its physical, combat and legal preparation. The latter is also a factor in making personnel responsible for their actions, which takes on such importance in their 'maintenance in condition'. POIC generally takes place on the air base to which the person is posted or attached. MCP occurs just before deployment. Ideally, it will boost skills acquired during initial training and POIC, and teach additional information regarding the theatre of deployment, including the rules of engagement in operation. Currently it takes place at the military basic training centre (CFME) in Saintes and at the training squadron of the air infantry commandos (EFCA) in Dijon.

Creation of the single centre for operational combatant of the Air Force (CPOCAA)

In line with the directions given in the *Livre blanc*, the 2014-2019 Military programming law and the *Unis pour 'faire face'* project, studies were begun in 2013 into adapting training arrangements in general, and those dedicated to operational preparation of the forces in particular. Combatant training has a particular place in this, in view of the challenges described above. Training issues are and will remain crucial, as much for initial military training as for the operational preparation modules. Airmen are confronted by ever more demanding theatres, which, above and beyond a solid basic training (a situation which led to the generalisation of instruction on shooting, for example), necessitate highly specialised and technical preparation in fields such as knowledge of rules of engagement, mastery of

personal weapons and first aid actions. For obvious reasons of economy of means, this teaching has to be performed in periods as short as possible, which leads to devising the most rational possible organisation.

And yet, the input needed for preparation for operations exceeds what is available in the Air Force. Even the joint force organisations do not have the skills and structures for preparing their personnel and have to rely on the individual forces to meet their needs. Hence in 2013 *Martel*(1) courses trained 42% of military personnel from outside the Air Force. At a time when the rhythm and intensity of engagement on operations remain high, it is more than ever essential that the forces grasp this issue firmly.

The final point is that the current Air Force training establishments are spread over a wide geographical area. To this must be added their general dilapidation and the lack of available infrastructure, most of which requires significant investment in the short term.

Within the *Unis pour 'faire face'* strategic plan and the stakes involved in establishing the training and continuation training plan for all airmen, we need to have a fundamental rethink of the current concept of combatant preparation across the entire spectrum, from initial and continuation training to that for specialist commandos and operational preparation.

The new concept will follow the directions given in the strategic plan: simplification of structures and processes, modernisation of operational preparation and improving the status of the airman through the transmission of values and training by commitment.

The CPOCAA will be a new player in the field of training and preparation of the combatant and eventually the centre for incorporation of military air technicians (MTA). It will be responsible for putting the concept to work in close collaboration with the officers' and NCOs' initial training schools.

The CPOCAA is one of the first tangible acts of the *Unis pour 'faire face'* strategy, and will be created by the merging of the EFCA in Dijon and the CFME in Saintes. The CPOCAA will be inaugurated in the summer of 2015 and sited in Labouche d'Orange, which has been vacated by the 1st REC (overseas cavalry regiment of the Foreign Legion). The site in Orange offers a number of advantages, as much in terms of the quality of the installations rendered vacant by restructuring within the French Army as in overall geographical coherence with the rest of the Air Force's establishments.

(1) MCP specific to the Afghan theatre.

On its creation, the CPOCAA will be manned by 150 permanent staff, and will accept 4,000 students annually (with a peak of 550). It is a unit of Air Base 115 and is organically subordinate to the CFA.

It will conduct initial military training of all MTAs, specialised training of commandos, the *Griffon* course (preparation for the *Vigipirate* security measures) and MCP courses. Synergy will develop progressively with the officer training school at Salon and that for NCOs at Rochefort, particularly for training through commitment.

In a similar way to technical and academic education, combatant training has seen a remarkable transformation in the space of just a few years. Taking into account experience gained from the latest operational engagements, its designers have taken care to put into it new and tested techniques to allow the airman, whatever his position, to draw on resources and find in them the mechanisms essential to his mission. The logic of the continuum henceforth guarantees him the hitherto unequalled coherence that the single centre for preparation of the combatant brings to bear.

Air H XXI or a Human Resources Strategy to Meet Twenty-First Century Challenges

Claude Tafani

Général de corps aérien, Director Human Resources of the Air Force.

A century whose shape is characterised by new areas of confrontation such as cyber warfare, by the arrival of equipment which will revolutionise our modes of action (MRTT, A400M, drones and the like) and by the duality of civil and military norms. A century which brings an acceleration of tempo and which elevates 'continual adaptation' to an axiom. A century which relegates to the dustbin the organisation of work which we have followed for the last 30 years. A century in which personal and professional development has become established as a theme for all generations.

How do we build a human resources (HR) vision with an operational rationale in step with this new strategic and societal context?

In the first place, it is necessary to remember that the basis of the military condition remains unchangeable, whether from the perspective of obligations, constraints or compensations. In the second, we must define the areas of effort needed, which go beyond the simple numerical approach of troop numbers. This approach has been harmful over many years in terms of the overall coherence of our capabilities. These lines of effort, which will nourish HR policy over the next five years naturally fall out from the *Unis pour 'faire face'* (United to Face the Future) strategic plan.

They concern:

- forging the skills and abilities of airmen(1) to meet the specific requirements of the Air Force's missions;
- placing competence at the centre of the HR chessboard;
- making social cohesion the lynch-pin of collective performance.

(1) The term 'airman' designates the whole range of Air Force personnel: men and women, civilians or military, on contract or career, volunteers and reservists (operational as citizens) working within the Air Force or another entity of the Ministry of Defence.

Skills and abilities to meet the requirements of the Air Force

The Air Force conducts missions characterised by **their permanence** (nuclear deterrence, protection and the security of national territory). This characteristic demands responsive command and control systems, permanently staffed by competent personnel. These must be motivated and numerous, able to cope with the alert measures and reinforced as required by operational reservists. The Air Force must also be in a position to **intervene immediately**, to project forces to external operational theatres and to intervene from or on national territory. This immediacy implies continuity of functioning from peacetime into time of crisis. It is the tangible expression of the 'statutory adage': available at all times in all places.

The **air base**, a permanent and responsive **combat system**, is a workplace, a home for air personnel and is the keystone of the Air Force organisation. It is the focal point for all the resources, the energies and the abilities necessary to accomplish missions. **This tightly-knit organisation implies an autonomy and responsibility on the part of the commander and requires the integration of all the participants who come together to support the mission.**

This integration of the support of the operational contract of course needs the employment of personnel outside the Air Force. Nearly 10,000 specialists are posted out of the Air Force (25% of its population). They remain airmen above all. They carry within them the 'air' understanding of the issues at stake in the mission. **Also, the professional career progression of most military airmen follows a system of alternating postings throughout their career**, based on periods spent in the forces, in operational or other support units and on the staff.

This logic of integration can be seen in the Air Force's choice to place competence at the centre of the HR matrix.

The aim is to generate, to follow and to capitalise on the talents of every individual to build tomorrow's Air Force. In other words, to optimise the available resources in a fast-changing environment.

Following on naturally from the way in which the Air Force conceives and conducts operations, overall competence is not the simple sum of individuals' abilities. It is much more than that, for in this context 1+1=3. In fact, the planning, preparation and accomplishment of the Air Force's missions are based on an integrated approach to specialisations. To meet the challenge of operational tempo the Air Force has the ability to constitute coherent units rapidly and anywhere in the world, made up from scattered and disparate elements. This replaces the concept of projectable pre-formed units with the idea of constituent abilities. This concept bases its actions on not on the geographic collocation of the participants or a simple grouping of specialists but on the integration of them.

This philosophy at the heart of the command and control of air operations exists also in maintenance in operational condition (MCO). The matrix structure of Simmad(2) is the most notable example.

The Air Force's organisational vision thus fits in with the convergence of the hierarchical model with the "free enterprise" model. Although the prime objective certainly remains to undertake the allotted missions, this HR model aims to develop innovation, creativity, imagination and above all, initiative. It therefore participates in the devolution of command associated with the organisation of autonomous air bases and with the high degree of delegation which exists in the Air Force, the keystone of its operational effectiveness.

This approach to expertise is at the heart of the professional development of Air Force personnel, that is, at the centre of a career progression offering them individual career paths, which are both motivating and varied, and which develop the individuals' acquired knowledge.

At the junction between the individual management of know-how and an unavoidable collective logic, **professional development in the Air Force rests on a continuum** balanced between the areas of military training, specialist training and development relating to promotion. This optimised training, just in time, at the right cost and to meet the need, is based on recognised and diploma-earning training within the Ministry of Defence, but also in the private or public sectors. In fact, the abilities of personnel are notable for their dual civil/military application inherent in the universality of the aerospace world.

This characteristic gives rise to two approaches to the subject of HR:

- to be the leader on the national or international stage in certain areas of excellence such as aeronautical maintenance, drones or navigational training;
- to make the employability of air personnel recognised outside the Air Force as part of a move to continued professional progress 'in/out'.

That presumes creating strong links and developing partnerships with the world outside the Air Force, whether state or private. This desire for openness, which runs through the *Unis pour 'faire face'* plan, currently takes the form of a dynamic policy for the operational and citizens' reserve, including the growth of an inverse reserve(3), by the awarding of diplomas(4) and by the introduction of a new HR model.

(2) Simmad : an integrated structure for the maintenance in operational condition of the aeronautical equipment of the Ministry of Defence. The organisation is matrix-based and its heart is the subdivision of the total air fleet. Each officer in charge of a part of the fleet is the guarantor of the technical, logistic and contractual coherence of the equipment in his area of responsibility. He is the orchestra leader for MCO and is responsible for the availability of his fleet.

(3) Inverse reserve: periods of temporary service by air personnel in partnered civil firms.

(4) A principle which creates conditions whereby each airman who engages in the scheme can obtain a diploma at a higher level than he held on entry to the Air Force.

This model offers opportunities to pursue a career within or outside the Air Force throughout his professional life, by embellishing professionally acquired experience. Redeployment is not seen as a beginning or an end but as a natural professional development process for each person. It is also synonymous for dynamic career prospects and is renewed for personnel who continue to serve within the institution.

This personalised management of skills and knowhow meets the legitimate need for acknowledgement and for personal development common to all personnel. It is a source of motivation and generates an investment in return and a strong commitment by personnel to service to the mission. However, it only has an influence on the collective performance when a spirit of cohesion provides the cement.

To achieve this the Air Force has available two complementary levers: the strengthening of the airman's self-identity and a renewed policy for the conditions of service of personnel.

Four values provide a framework for the self-identity of an individual: respect, integrity, service and excellence. These four values inspire his daily actions and provide direction to his commitment. They reinforce team spirit for confronting the fog of transformation and for overcoming friction between and within groups.

Boosting the airman's identity also works through symbolic bonding actions (among which, instituting an airmen's day, an airmen's' newspaper, a contacts card[5] and a virtual airbase[6])

Complementing these, the service conditions of personnel are more than ever considered one of the priorities of the senior command of the Air Force. Beyond the traditional factors inherent in military life and commonly managed jointly, they must be in step with the features of our system of combat, namely, the air base: permanence, place of preparation for combat, of projection and of living.

The identity of the airman and the policy of his conditions of service effectively instil a solidarity between all personnel and participate in the emergence of a true 'air' spirit.

The Air Force also confirms its determination to remain in step with societal aspirations and is signed up to the 'RSE/RSO[7] approach. The principles of mixing of the sexes and strict equality between men and women solidly anchored in air units are thus confirmed; the campaign against harassment is strengthened

(5) Designation of referents charged with ensuring the passage of information between the Air Force and personnel working outside it. The object is to compensate for their relative isolation.

(6) A social network intended to create sharing communities within the Air Force.

(7) RSE/RSO: social responsibility of an enterprise (or business)/ social responsibility of organisations.

by the installation of a programme for the prevention of psycho-social risks and the like. In the same way, the Air Force actively participates in the Forces-Nation link, notably thanks to the plan for equality of opportunity. The development of the Aeronautical Initiation Certificate is particularly symbolic. On the occasion of this award, young airmen meet young secondary school pupils to encourage them to discover the aeronautical world.

This civil partnership underscores the natural and sustainable openness of the relationship between the Air Force and the Nation.

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Today more than ever the performance of the Air Force relies above all on commitment, the quality and the development of its personnel. The priorities of Air H XXI of the Air Force are resolutely directed towards the human being, highlighting his value and preserving of his abilities, rather than to considerations of personnel numbers.

To be able to meet its operational contracts, the Air Force is more than ever committed to a positive, forward-going process, open to the times in which it lives, aware of its values and strengthened by the quality of its men and women.

Command and Control of Air Operations From Metropolitan France: the Benefits of Full Rear

Jean-Jacques Borel

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An Immense and Open Theatre

A quick glance at the application of air power reveals two fundamental characteristics. First, the Air Force deploys, operates and supports forces at an ever-increasing distance from Metropolitan (i.e. mainland) France. Second, it is tasked with the command and control of aerospace operations over considerable areas of responsibility. Today, large resources are deployed in the Sahelian/Saharan belt (SSB) in order to combat the terrorist threat and to help states in the region to restore their national sovereignty. This environment extends over the immense territory of the Sahel G5: Mauritania, Burkina Faso, Mali, Niger and Chad. This represents the area of interest of the joint force of Operation *Barkhane*.

At the same time France actively contributes to the support of the International Support Mission to Central Africa under African Control (MISCA) in the Central African Republic. Here, the Operation Sangaris force has the task of re-establishing security in the country, restoring humanitarian aid and facilitating the creation of an electoral process. As a result, the joint force is deployed over the whole territory and depends on air transport within the theatre for its mobility and for the offensive means to contain any outbreak of violence.

Finally, the development of the very worrying security situation in Nigeria has led the Air Force to provide regular intelligence support to the authorities in Abuja.

The area of responsibility of the air component for Central and West Africa (AFCO) has progressively reached the size of Europe and is 6,000 km from France. When a Rafale takes off on an alert from N'Djamena to support troops in the North of Mali, it will cover the distance of a trip from Athens to London.

The enemy that the forces in Africa are fighting today is scattered throughout the Saharan and sub-Saharan region. From this point of view, the extension

of the Operation to the whole of the SSB is perceptive. Driven by diverse motives and financed by jihad money, the terrorists benefit from an immense and totally permeable environment without real state control or frontier posts. It is also interesting to note that the jihadists of the Sahel are remarkably discreet. They communicate with care and melt easily into the population. The detection of the Katibas (jihadist companies or battalions) is the result of painstaking collaboration between the *Barkhane* force, the Special Operations Command, the services and the countries concerned.

Our troops must therefore confront an evasive and highly mobile enemy. This has an immediate impact on the plan of campaign and the strategy employed. It is continually necessary to regroup the deployed forces in a flexible way and at short notice, in order to track down the enemy wherever he is to be found. The forces have developed a formidable support network spread over the SSB, capitalising on several decades of diplomatic and military cooperation. Hence, the Air Force has a network of runways and bases, some in remote areas and sometimes with difficult access. It is also able to rapidly establish new bases, thus ensuring reactivity for redeployment of the force. On this point, the recent example of Madama, in the North of Niger, is interesting. In just a few months specialist engineers constructed a runway and a camp in the middle of the desert. The base is now operational and has become an essential pivot to continue the fight in the region of the Salvador Pass and along the Libyan frontier.

Reducing the C2 footprint in-theatre: the Full Rear concept

Based on current operations, it appears that the ratio of combat troops to those in the command structures is becoming unfavourable. The development of technology, the multiplication of actors and the imperative need for joint operations are imposing an increased need for coordination. The command and control entities in the theatre therefore have a tendency to put on weight rapidly. However, the volume of forces engaged was decided during the initial strategic study and is unchanged. One of the principal methods of dealing with this consists of reducing the size of the C2 resources deployed. In 2014, the Air Force decided to repatriate its C2 organisation to Lyon. Lest there be any misunderstanding, the original reasoning for this was *not* based on budgetary restraints. Decentralised control in full rear offers an **immediate response** to the air component. In fact, the original idea was to exploit the command and control of the permanent air security posture available in France. This is designed to get an aircraft in the air in seven minutes and respond to the political authority in real time. In addition, it is **permanently manned**.

The Air Force has thus developed synergies in using the National Centre for Air Operations (CNOA) for the purpose of external operations. Of course, it

was necessary to adapt certain procedures, modify some tools and develop new skills. But on the whole, the new vocation of the Centre was achieved very easily.

It is important to underline that this concept is only viable if liaison elements are implanted at the right level within the operational and tactical command structures (land and special operations in this case): these assure integration with air operations.

It is obvious that the dimensions of, and distance to the theatre place severe constraints on the air transport fleet. The A400M, which is making its debut in Mali, offers a 70% increase in load-carrying capacity and a 50% improvement in range. But for the moment, the rhythm of operations is dictated by the number of C-160, C-130 and Casa CN-235 aircraft available in the theatre. Their limited numbers form an unavoidable factor in the tempo, and more generally in the conduct of the campaign. At the time of the advance on Kidal in 2013, it was necessary to adjust the progress of the soldiers to the replenishment possibilities.

To resolve this equation of high demand/limited resources the Air Defence and Air Operations Command (CDAOA) decided at the end of 2012 to create a Regional Air Movement and Coordination Centre in Lyon. After two years of operation the results have proved very positive. The Centre has enabled the in-theatre transport resources to be used more efficiently by **centralising planning** and **optimising rotations for freight**. Without it, it would not have been possible to coordinate the use of foreign resources, such as the Spanish Casa C-295, which are vital to us today. Furthermore, the same reasoning has been applied to the use of the refuelling aircraft. American support from the air base at Moron in Spain, is conducted from Lyon.

A second lesson from the exercise of C2 in full rear mode is that it has permitted the rationalisation of air assets while conferring unexpected flexibility. Following Operation *Serval* in 2013 the benefit of using a single element to support other task forces deployed in the SSB was clear.

Centralisation has allowed the optimisation of the use of aircraft while providing a clear vision of the overall picture, and thus has enabled each force commander to be fully advised. In particular, it offers the sharing of aircraft between theatres and defines areas of effort as a function of the progress of operations. By having an overall view of the air component spread across such a large region, COMJFAC can flesh out his thoughts on the creation or adaptation of the air campaign. As a result, this offers a better integration of air power with the joint operation.

The adoption of the full rear concept has direct consequences for our human resources. It has proved one of the major lessons for the Air Force: it allows more efficient use of the pool of Air C2 experts.

These experts have acquired rare and much sought-after skills after a long training process (notably at CASPOA,[1] the C2 School) and operational training and service. Unfortunately, this resource is limited, and the pool of available personnel is a critical factor which must be carefully considered before each new operation.

As functioning in full rear no longer requires the deployment of complete command structures, the gain in skilled manpower is immediate. Today the C2 Centre in Lyon functions with half permanent staff and half reinforcements from the rest of the Air Force. The challenge is to ensure a constant quality of service in spite of personnel turnover. This is ensured first of all by giving each officer the fundamentals of C2 as taught during CASPOA courses. Thereafter, key posts are allocated to permanent staff. The role of these officers is essential as they know the history of the operation, have mastered procedures of their area and have established a solid network of contacts. They therefore ensure the robustness of the whole structure.

The current trend in operations is to call for a growing number of communications links with operational theatres. Nowadays, it not unusual to find that half of a detachment is composed of CIS specialists.

This is due to the multiplication of sensors (prime among these are drones and other intelligence gatherers), actors on the ground and also the effect of technological levelling. Each jihadist has a satellite phone, remote control fuses for improvised explosive devices and drives with a GPS. He is even able to threaten our soldiers and their families on social media. By investing in the areas of communications and cyberspace, they oblige us to reinforce our presence.

The implementation of full rear has another justification. In order to exercise effective command and control of a detachment over such distances, it is necessary to have a faithful perception of the situation in the theatre, in particular the Recognised Air Picture. This is why traditional CIS systems such as satellite links, real-time video, tactical data links and on-line dialogue are essential for the conduct of operations. Since the deployment of L16 JRE (Joint Range Extension) in the SSB, it is possible to transmit orders directly to aircraft in flight from Lyon. These tools must be thoroughly reliable and ready for use. This is one of the challenges of full rear.

Although remote command offers an advantage in manpower terms, it also presents risks. By having access to the tactical situation of the moment, the commander of an operation will naturally have a tendency to take decisions in place of the infantryman or pilot on the spot. This pitfall is exacerbated today by the profusion of technological marvels that accompany our operations and

(1) Analysis and Simulation Centre for the Preparation of Air Operations.

provide a clearer and more detailed perception of the situation on the ground. When visiting the CAOC at AFCENT[2] one has the feeling of an absolutely techno-centred view of operational command. This leads to taking decisions only through the prism of technology. Subordinate echelons could then progressively lose their sense of responsibility.

This is a pernicious mistake, which must be avoided for two reasons. Above all, when a commander falls into the trap of micro-management, he is no longer capable of maintaining the distance necessary for influencing the strategy of the operation. In addition, when the subordinate echelons no longer see themselves entrusted with responsibilities, the human resource is no longer employed effectively. This wastes the available expertise, both on the ground and in our C2 structures.

The provision of full rear for space support to operations

The space dimension merits particular attention, in the conduct of operations in general and in the application of air power in particular.

The availability of a space capability in full rear gives an autonomous perception of the space situation. In this respect, space offers a wide field: listening and electromagnetic surveillance (ELINT and COMINT[3]), reconnaissance (by our satellites and those of our adversaries) and overflight and coverage of enemy radars. With these, command and control of these assets from France, notably by CMOS (Centre for Military Observation by Satellites) and COSMOS (Operational Centre for Military Surveillance of Space Objects, which operates the GRAVES[4] space surveillance radar), provides guidance for the planning and execution of the operation. For example, it is possible to synchronise strikes with the timetable of overflights by observation satellites, in order to keep political authorities informed.

This space capability requires a reliable transmission network for sending and receiving data. In addition, sufficient access to a satellite channel has become a major prerequisite for operations. But data transmission can suffer environmental constraints. In particular, solar perturbations represent a frequently misunderstood domain. These can have a powerful effect on electromagnetic emissions such as radar, GPS and SATCOM. It frequently happens that an AWACS loses its ability to speak to Metropolitan France following a solar eruption. To anticipate this situation, a team of specialists is based in Lyon and provides a daily estimate of these perturbations to the various force commanders.

(2) Combined Air Operations Center, Allied Forces Central Europe.
(3) Electronic Intelligence et Communications Intelligence.
(4) Large Network Adapted for Space Surveillance.

Finally, an essential contribution for the combatant is an estimate of the precision of positioning by satellite, GDOP (GPS Dilution of Precision). The notion of GDOP, familiar to airmen since the arrival of munitions guided by GPS, has been progressively passed to other components. Now, all potential GPS users, from the Forward Air Controller to the Battle Group is informed daily of the imprecision factor, which can vary by a factor of ten.

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The sources of crises which are currently developing in the Middle East and Africa, opportunistically bringing together jihadist groups and terrorist movements, present us with a new kind of threat: one that is diffuse, spread over several thousand kilometres and adapting to the latest technology.

To confront such threats, we must be able to deploy a force capable of combat in all environments, including space and cyberspace. To meet the need for flexibility and responsiveness of such a force, in particular its air component, the decentralisation of C2 in full rear is appropriate. It enables us to concentrate in one place all the expertise necessary to analyse, plan, programme and conduct air operations.

The Twenty-First Century Air Base: Putting the Mission at the Heart of the Organisation

Jean-Marc Régnier

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"You have to maintain a culture of transformation and stay true to your values" (Jeff Weiner).[1]

Improving operational effectiveness in a state of constant change

The Air Force is in a state of transformation towards the new format it needs to align with the requirements of the latest *Livre blanc* and the military programming law covering the years 2014-2019, and is doing so in an environment of great change in the ministries. It is gearing up to modernise its capabilities, and is at the same time facing up to the exercise of its new responsibilities regarding reform of wider functions, such as finance and human resources, and changes in common and specialised support chains.[2] The drive for this transformation is an overall strategic plan called *Unis pour 'faire face'* (United to Face the Future). Key structural elements of this plan covering nearly 40 projects are modernisation of the Air Force, simplification of its structures, adding value to the airman and opening up to external collaborators.

Within this framework, the aim of the BA XXI project is to implement the *Unis pour faire face* plan at the air base level. It is also intended to ensure long-term improvement in the operational performance of air bases, which count more than ever as essential combat tools of the air arm.

This project is also complementary to the CFA 2015 plan, which aims at simplifying command structures and bringing the air forces support command and the air forces command together under a single hat in line with yet another project, *Stationn'Air 2019*. The latter covers the strategy for densification of our air bases and networking them together, and is being effected in parallel with the arrival of new equipment in order to create functional centres such as Rafale, A400M, combat training and so on.

(1) American businessman, Director General of LinkedIn since June 2009.

(2) Mainly for governing maintenance in operational condition of aeronautical equipment.

The twenty-first century air base will be more connected to its environment and more interdependent with support services, whilst remaining a place for positioning of people and equipment, training of forces and conduct of missions over and from the French mainland. One of the challenges of transformation is being able to guarantee balance over the long term in a reactive organisation which has not only to be in a position to conduct protection, deterrence and immediate intervention missions, but also to extract every potential from a changing environment whilst remaining in full control of associated risks.

Professionalisation and rationalisation—the driving forces of transformation

In his work *De la démocratie en Amérique*, Alexis de Tocqueville wrote that because the past no longer lights the way to the future, we walk in the shadows. In terms of mastering the environment of air bases, is it useful to have a look at changes in the recent past which have affected how they function.

With the advent of all-professional armed forces, the Air Force experienced the emergence of ways of operation inspired by the business world. On its air bases, Air Force, military and defence department civil personnel put into place new working practices that are more standardised and today regularly evaluated. Management tools widely used in the civilian world have been transposed into the Air Force environment as sets of rules that govern flight safety in maintenance and control of risk in a broader sense, performance measurement and cost analysis.

This major change went in parallel with imposition of the far wider-reaching changes occurring within the state as a whole. The organic finance law has introduced the concept of performance and evaluation to the public sector, from which the Air Force does not escape. Further to that, the adoption and application of the general revision of public policies (RGPP) has added budgetary and organisational dimensions to the previous managerial and legal rationalisations. As a result of the past two military programming laws, the Air Force has reduced its manpower by nearly 25% and has reduced the number of air bases from 48 to 23.(3)

The military framework of the Air Force—its values, symbols and commitment to the task—have been put to a severe test by these notions of productivity, control, efficiency, standardisation and contracts which have been key elements of successive transformations. The transformation conducted under the pressure of budgetary, organisational and regulatory constraints has created new relationships between airmen on the air bases, between airmen and personnel of the other forces and support services and also between military and civilian personnel. The exercise of operational command has also had to be reconsidered in the face of increasing independence in support action. Henceforth, contracts will

(3) In mainland France: includes those with and without aircraft and schools, but not detachments. Closure from the point of view of the Air Force does not necessarily mean closure of the base itself (eg Creil in 2016).

often replace demand by authority and will require joint negotiation to establish service contracts.

Two areas in particular illustrate the necessity, opportunities and risks of such a major transformation that has been going on within the Air Force for nearly a decade.

• In the field of specialised support, putting mechanics into aeronautical technical support squadrons (ESTA)[4] has led to substantial gains in manpower, overall improvement in efficiency and, in the majority of cases, both—totally coherent with the aims of the RGPP. This move has also been the guarantee of greater compatibility of the organisation with the flight safety rules. But beyond the synergy that as been achieved, this transformation has created very large units and the question now is how to deal with the link between mechanics and aircrew. Studies are underway on how to strengthen this link and induce pride in service to airborne missions and also how participation in external operations and exercises should be handled.

• The second field concerns common and specialist support: cross-service action and pooling have enabled objectives to be achieved in rationalisation and professionalisation of support trades but on the other hand have led to loss of integration in the Air Force command structure and within air bases.

It follows that these new forces need to be kept in check, for they are likely to have an effect on operational preparation, training and projection of forces. Ultimately, the risk is that they could adversely affect the ability of air bases to be constantly ready and sufficiently reactive to mobilise weapons systems and personnel for deployment on today's form of external operations, launched and conducted from mainland France.

BA XXI—essential support to the operational mission

The BA XXI project is aimed at refocusing airmen, personnel from the other forces, support services and defence department civilians on the operational mission by putting in place a permanent and simple to understand organisation which can capitalise on what already exists. BA XXI therefore puts the meaning of the mission back into the heart of the organisation by emphasising the air base as a permanent and reactive combat system for the permanent defence missions of deterrence and protection, and for intervention missions.

In terms of organisation, two main directions are shaping this reformation: optimisation of technical-operational dialogue, and greater understanding of how

(4) Since 2006, the operational support level of the Air Force relies on some 15 of these ESTA (*Escadrons de soutien technique aéronautique*), units which represent the technical heart of the Air Force.

needs should be expressed, together with follow-up action and provision of common and specialised support.

The creation of air squadrons is the most visible element of the measures aimed at optimising the technical-operational dialogue. Such a structure under the direct authority of the air base commander allows for local prioritising of activity between the operational units and their subordinate technical support units. The squadron commander is responsible for conducting the necessary activity for preparing the forces under his command, and for their employment. He is the locally responsible person for holding operational contracts.

General tasking of activities in an air base with their required support, in both normal times and times of crisis, is henceforth the job of the second in command. To achieve his task, he calls upon a newly-created office (BIS/MA), which interfaces with support services and controls activity in general. This is quite a change when compared with what went before, since it confers on the second in command of the base a new responsibility of ensuring local coherence between support activities. This role involves formalisation and prioritisation of the needs of the air base, preparation of planning priorities, help in drawing up service contracts that have been approved by the Air Staff, and also conduct and measurement of quality of service received. It does not therefore reintroduce any idea of subordination between the Air Force and the support services but aims more at giving a sense of action and mobilising everyone's energies towards accomplishment of the operational mission.

Many years ago, the decree of 25 March 1852 on decentralisation said essentially that government is best done from afar, administration is best done close to home. Indeed the performance of the new organisation relies in great measure on the creation of a local dialogue between all the stakeholders through the setting in place of a functional staff supporting the base commander. Thus there is a fundamental role for the comitology set up by base commanders to ensure the essential dialogue with the support services takes place, which puts *Bisma* at the heart of the performance of the air base, given its interface function with the common and specialised support services.

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From now on, it is important that collaboration between the Air Force and the support services be established to allow consolidation of *Bisma*'s performance and to define closely the profiles and skills needed for the weapon systems they manage. This common effort must also ensure that the supported units are able to express their needs correctly and that the expected services are delivered in the required timescales. The author Antoine de Saint-Exupéry wrote that everyone is responsible for everyone; each is solely responsible; each is solely responsible for everyone. In this spirit, the BA XXI represents for the Air Force the final step in the reform of support entirely focused on its *raison d'être*—the operational mission.

Maintenance in Operational Condition: a Challenge for the Aeronautical World

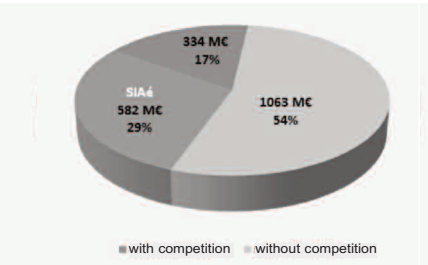
Guy Girier

Général de corps aérien, Director of the centre for the integrated structure for maintenance in operational condition of defence materiel (Simmad).

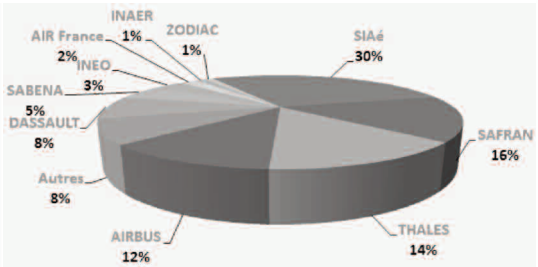
The object of maintenance in operational condition of defence aeronautical materiel (MCO) it to permit the air forces to conduct the activity necessary for all the missions entrusted to them as well as for their operational preparation. It is a particular challenge for the Ministry of defence, which is putting high priority and effort on the activity of these forces for the coming years. The state budget for this maintenance and repair is some 2.5 billion euros annually.

The Chief of the defence staff delegates to the Chief of the air staff the contracting authority for this function, to cover the air assets of the three forces and also the General directorate for armament (DGA), the Gendarmerie, the civil defence organisation and the customs service, which together represent a fleet of 1,300 aircraft of 46 different types. This activity generates around 315,000 flying hours annually through coordination of the technical, logistical and contractual activities, and by calling upon the operational contracting authority of the forces and the state aeronautical industrial service's (SIAé) connections with industry in both public and private sectors, which include designers, repairers or manufacturers.

By way of illustration, the figures below show payments made in the year 2014.



Division by state industrial sector



Division by company

To achieve this, the state has a single delegated contracting authority, the integrated structure for maintenance in operational condition of defence materiel (Simmad).

Since its creation, and despite continuing financial constraints, regular technical challenges, a constantly changing industrial base and ever more demanding conditions of operational use, this structure has been able to generate the air activity necessary to maintain French aviation at the correct operational level to allow the forces to conduct their numerous permanent or unprogrammed air operations with success.

Operational activity is a priority for the Ministry of defence, as stated in the military programming law, and considerable funds are allocated to achieve it. In order for the aeronautical MCO to attain the required level of activity within available resources, an overall modernisation programme called *Cap 2016* has been set in motion. It broaches a number of topics for development, including governance, partnerships, organisations, human resources, and technical and financial procedures, and is centred on the following themes:

• Aeronautical MCO is an overall mission with numerous facets but always retaining its operational nature whose more effective governance is henceforth controlled by the Air Staff;

• Simmad is improving its efficiency in the three essential trades which are inseparable from its structure, technical, logistics and contractorisation, by calling upon modernised methods and tools;

• In order to improve cost control of materiel throughout its life cycle, there is a need to organise and create more flexible coordination between all stakeholders—Simmad, DGA, the forces and industry. Bringing the operational world closer to the industrial world should therefore enable best advantage to be had from the recent transfer of Simmad to Aquitaine, where it is in contact with the command of the Air Force at the heart of a region known for its aeronautical expertise.

More tangibly, the Cap 2016 modernisation plan aims to improve the synergy between those who act for the MCO along four axes of progress:

• **Develop the expertise of the aeronautical MCO** in order to optimise MCO processes for:

– Giving some future perspective to state industries by anticipating SIAé's workload across the military programming period (or 5 years as a minimum) via a permanent working group on state maintenance;

– Optimising plans for maturity of new material currently being deployed through better synergy between state and industry, by creation of state-industry

collaboration mechanisms, for example, for Rafale, Tigre, NH-90, A400M, and MRTT;

– Developing expertise by setting up a college of experts around a core of those holding responsible in-service support (RSS) positions to conduct studies into critical aspects of planned maintenance of materiel. In 2014, this college began studies aimed at reducing the number of non-repetitive breakdowns, at optimising maintenance plans for air fleets and at the long-term maintenance of ageing fleets;

– Establishing, in liaison with the RSS college, prospective studies for the aeronautical MCO. This will use the ministry's study processes (such as upstream studies) to evaluate concepts and processes, and validate the advantages of new technologies to the MCO.

• **Seek scope for manoeuvre** to guarantee the activity of forces:

– Renegotiate current contracts to ensure their coherence with the activity of the forces across the programme period. In 2013, programme contractual minima were reviewed for Rafale Care, Mirage 2000 Care and Tigre, among others. This work was continued in 2014 on orders related to conditional tranches of current contracts.

– Establish a common reference base by a file of 'justification of need' and the associated papers detailed for each fleet.

– Make use of cost analysis and identify a rolling three-year plan for needs, to feed into decisions on renewal of major contracts in order to optimise the workload of the DGA's cost analysis office.

– Develop contractual engineering;

– Update the Simmad costing model as part of the process of modernisation of MCO.

• **Modernise the tools**:

– Rationalise IT within the aeronautical world in coherence with the introduction by 2016 of the COMP@S IT system, to be associated with ATAMS. These tools will allow MCO to operate across all forces and services with a common system of references and procedures;

– Put in place a predictive management system for work, manpower and skills, which will favour better management of critical skill sets within HR directorates and will support study into skill transfer, particularly in the field of purchasing.

• **Optimise the organisation of Simmad** in line with Ministry objectives. In particular this will include:

– Rationalisation of the technical function: this inherited the technical functions of the three services in summer 2013 and the establishment of best practice

opens up opportunities for rationalising technical expertise teams (EET) in line with the maturity of the various fleets;

– Reorganisation of the logistic function in line with work on the supply chain under way by the forces' central staff;

– Improving understanding of the Simmad organisation by reducing the number of fleets and identifying the staff desk officers associated with major functional liaisons;

– Improving internal management of Simmad by better governance between its two centres though better continuity of its essential functions (to ensure coherence between the physical and the financial at all levels within Simmad by introducing finance staff into the fleets), creation of the C5 (a limited management committee with the director, assistant directors and assistant colonels), establishment of information control tools and the development of internal and external communication by an informative newsletter.

This plan will strengthen Simmad's position as the integrating authority for aeronautical MCO, through vastly improved relations with the Central Staff, individual forces staffs, DGA and SIAé.

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Aeronautical MCO allows necessary and sufficient activity to be generated for permanent or exterior operations and for training of the air forces, in the right place, at the right time, and in adequate measure. This activity has to be generated within the budget allocated by the military programming law, which means that every margin for manoeuvre has to be sought continually, and as early as possible.

At a time when partnerships are being sought to support an ambitious operational objective, the challenge will be taken up by boosting the important benefits of Simmad and by bringing together all the stakeholders under a common vision of the future which respects the principles of:

– simplicity (in governance and management),

– reactivity (the essence of air action),

– coherence (by developing what is inherent in the business),

– partnership (between Forces, Simmad, DGA and industry),

– optimisation of performance (to obtain scope for manoeuvre).

Air Warfare Center: Optimising Force Preparation and Adaptation to Operations

Richard Reboul

Général de division aérienne, commanding the Centre for military air expertise.

Because no military operation can now be planned without defensive, logistic or assault aviation, the Air Force continues contribute to victory from the very first day, in those theatres where it is committed alongside other national or coalition forces.

Despite the ever-present uncertainties concerning such commitment (such as the occurrence of crises, their development, the duration of the commitment and its legal framework), and despite the many types of commitment (mode of action, for example, strategy to be used, the adversary or the coalition), the Air Force continues to apply a shock wherever it is needed. Support from the rear is, of course, essential to the conduct of long-term operations and therefore to obtaining the desired military effect, nevertheless the ability to create that shock is the privilege of front-line forces. This capability requires that commanders and forces on the ground receive doctrine, tactical fighting expertise and reliable, robust and available materiel.

In this geopolitical and military landscape, one thing is certain: operations today are integrated, guaranteeing to the commander the availability of a choice of effective, economic, flexible and reactive modes of action. There is therefore a need to know how to combine the different types of action and to shift rapidly from one to another.

Moreover, for the soldier, the multiplicity of theatres and of long-range deployments requires an ability to familiarise himself quickly with his combat environment. It is therefore absolutely necessary to be able to train him to act in a diverse range of tactical situations, and to teach him how to learn. To carry that out requires also that he maintain an adequate and certifiable level of skill in order to operate in such diverse situations. The standard level of tactical knowledge must at least allow further training in order to regain the desired level, and in a compatible timescale, for any forthcoming commitment.

It is possible, though, that asymmetry in a commitment could see the shock capability reduced or even eliminated by the rules of engagement imposed by the law and proportion. Using affordable off-the-shelf technology may permit coalition forces to gain a rapid advantage over their adversaries at modest cost and in short timescales compared with the usual long programme times. We therefore need to manage our procurement practices for such equipment in order to perpetuate them whilst keeping them flexible and interoperable with other equipment. Procurement of capabilities we lack through a system of 'urgent operational requirement' is one solution, yet it does not guarantee within the forces the perpetuity of equipment that was considered non-priority by the normal procurement system.

Maintaining our reactivity in such circumstances obliges us to reconsider our preparation for the future in order to fill the gaps in our weaknesses. Which is why, with the objective of better preparation of our forces and better adaptation to operations, the Air Force has this year established a centre for military air expertise (*Centre d'expertise aérienne militaire*, CEAM) at Mont-de-Marsan. This is a French version of an air warfare centre (AWC), sited at the heart of one of the finest operational and aeronautical environments. Its creation is not intended to challenge the expertise and prerogatives of operational and organic commands: it simply aims to offer them a compact, better integrated and more innovative tool which is wholly dedicated to the procurement of new capabilities.

Better Preparation of Forces

The contraction of the Air Force carries with it a dilution of operational expertise, which is learned and expanded within front-line units. The essential challenge is to conserve it over time, to cultivate it and to broaden it. In order not to suffer a threshold effect, the Air Force has decided to concentrate such expertise at the CEAM, creating a pool that will be preserved. This pooling favours the development of such expertise insofar as having everyone in the same place encourages exchange of ideas, thought and understanding of the challenges that arise. And yet broadening of expertise does not happen without feedback from experience, and looking to the future cannot happen unless there is the ability to feed the writers of doctrine with the capabilities offered by new equipment or modes of action. This is why the tactical centre (*Centac*) of the air forces command (*Commandement des forces aériennes*, CFA), already established at Mont-de-Marsan, has joined the AWC to bring it the essential doctrine and feedback expertise that *Centac* already holds for the entire Air Force.

Modern integrated operations require specific training for front-line forces. Such training has to be multicultural so that understanding of the mechanics of action is as exact as possible. Tactical skills of front-line forces depend on understanding of what all components present can together bring to the action. Thus the AWC will have the responsibility under the authority of CFA for designing two

types of training. The first of these is fundamental, and is aimed at improving the understanding of the battle space by the youngest personnel, before their first armed commitment. The second relates to expertise and is for tactical experts in those combat units chosen by CFA. Their aim will be to feed units' experiences back to the AWC and to establish a multicultural network of nominated people whose job it is to broadcast best practices to our combatants. Tactical oversight and strategic vision of course remain the privilege of operational commands and the Air Staff.

Operations tend to deprive forces of the essential organic regeneration needed for maintaining the skills required at the upper end of the spectrum of actions for which we have to be prepared. Training activity must where possible achieve the greatest added value. It therefore lies within the AWC's remit to put such force training into context by creating the necessary environments for the acquisition not only of elementary mechanical actions but also of the skills to manage extremely complex situations with proven flexibility. As an example, the AWC will not only have to continue to offer forces realistic C2 environments, but also firing ranges with a minimum possible of constraints which offer representative and realistic targets and firing situations which are compatible with combined operations.

Better Adaptation of our Capabilities to Operations

Future capability must be built on what are seen as probable engagements, and yet such forecasting cannot alone ensure that the Air Force takes the right procurement or doctrinal decisions: there has to be some experimentation to support them or, on the other hand, to question them. It is for this reason that the CEAM brings its 80 years of experience to bear on the design and conduct of experiments at the AWC, the Air Force's battle laboratory. The trained personnel that man the lab will put future doctrine and equipment functions to the test on a purpose-built real terrain, with interaction between experienced military operators in order to make the necessary simulations as realistic as possible for the requested demonstrations.

Ground-based capabilities must also be developed and honed, then offered to operational commanders. Such capabilities appear with the arrival of new materiel and equipment and may be developed to suit other designs, bringing with them novel modes of action. For successful development, tactical documentation for use by the CFA for training purposes has to be written, as does doctrine that is compatible with the operators' existing knowledge. It is already the case that CEAM and *Centac* together support the development of such ground capabilities. The marriage of the two organisations will strengthen the effectiveness of recommendations passed to the staff headquarters and will support requests from forces regarding the capabilities they need to achieve operational taskings.

Application of the laws of armed conflict and political constraints mean that rules of engagement need to be written for each theatre and changing circumstance. This is the responsibility of the the head of the defence staff (*Chef de l'état-major des armées* - CEMA). These sometimes rather limiting rules for use of forces lead the experimental centres to devise new arrangements to ease the task of front-line forces. Such arrangements in particular allow a reduction in intervention time through better understanding of the tactical situation, and can also increase the employability or effectiveness of the weapons deployed. In both cases, responsibility lies with the CEMA. His responsibility is derived from receiving reasonable proof that the laws of armed conflict are being applied and also from his need to reduce to a minimum the risk to the military personnel he sends into combat. It follows that CEMA is the sole person qualified to decide upon the necessity to make available to the forces new equipment whose reliability, availability and safety are key factors influencing his choice. In this we depart from conventional procurement procedures, since operational necessity rules and lives of soldiers are at stake in the immediacy of action. The AWC is ready to present the necessary elements to the military chief to support his decision. It is thereafter left to staff headquarters to request the usual programming players—industries and the DGA (*Direction générale de l'armement*)—to supply proof of adequate levels of safety and reliability. This new method, which is gaining ground, allows not only a drastic reduction in procurement time but also in cost, and in addition guards against excessive incorporation of high-tech and over-specification. It therefore has virtue for all concerned without calling into question the legitimate position of each player. Furthermore, it is in tune with the spirit of innovation of the AWC, which is a melting pot of ideas necessary for invention with a unique command, whose enthusiastic nature is to bring innovation to those engaged in operational commitments.

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By creating an AWC at Mont-de-Marsan, the Air Force has given itself an economic set of tools, dedicated to the better preparation of its forces and to better adaptation of its capabilities to current and future commitments. Resolutely focused on operations, its single mission is to bring to front-line forces the operational capabilities they need. It therefore has to supply reliable and available equipment and materiel as well as a doctrine adapted to our command capabilities and to the skills of our personnel in all the ever-changing theatres of operation today and into the future. The AWC will also contribute to forces' training by making available to them realistic and in-context environments. When new equipment and procedures are needed, the AWC is ready to offer original solutions to commanders, which allow time savings in the conduct of operations and also a reduction of the risks run by our personnel.

The Smart Base Project: Interacting with the Environment

Joël Rode

Général de division aérienne, Deputy Inspector of the Air Force.

Your Smartphone is connected, your car and your television are connected, the doors and shutters of your home can be connected, and tomorrow your refrigerator, your running shoes and even your toothbrush will be connected! Whether the need is real or artificially created, studies tell us that by the mid-2020s, each of us will own several hundreds of connected objects. There will of course be a few concerns about management and protection of the billions of billions of pieces of data uploaded every second to the cloud, but overall the technology of connected objects is expected to alter our environment in the same way that information technology revolutionised society in the nineteen-nineties.

Already, whether you live in Courbevoie, in the suburbs of Paris, or in Mulhouse, you will have noticed that your daily life has changed. You download a free application to your smart phone and in a couple of clicks you have access to all the information you need about your town—timetables, activities, transport and so on—which is now available on dozens of web sites. Additionally with these urban apps you can easily find a parking place, give your opinion on the state of traffic or tell the town hall about some problem. In doing so, you fall with ease into the role of citizen-actor of a smart city.

Because our air bases are small towns, a study of how smart cities operate from an office in the air staff headquarters would have some sense. But when the Chief of the Air Staff (CEMAA) asked for a conceptual smart base, we took on something altogether broader than he was seeking. Consideration of a smart base involves imagining how new technologies and innovative approaches could lead to improvement in the operational capability of our bases, the quality of support and the working and living conditions of our airmen and their families, by a thorough look at ways of interacting with all players in the defence business as well as greater opening of our bases to the civilian world.

The genesis of the smart base project

On our bases, airmen of all ranks have long sought to improve their day-to-day lives and those of their crews, as well as increasing the effectiveness of

the missions entrusted to them. For over 25 years, the Ministry of defence has awarded a prize for innovation to those who have found and developed smart ideas, often in technical fields. Yet other ideas have never seen the light for lack of funds or other means and initiatives have fallen dead in the water because they were considered to have touched upon areas too remote from operational matters. To study these ideas, and to understand why they succeeded or, on the other hand, what were the pitfalls that put a stop to other initiatives, forms part of the approach encouraged by the CEMAA. To give but one example among many others, two bases have re-established collective crèches after somewhat complex local administrative negotiations. All French bases need this type of family social service, and the experience of those who have succeeded should be of help to those who are attempting similar initiatives.

The Air Force is not the only armed force to favour innovation or to seek to do things differently. Meetings with upper management of the other forces, directorates and services of the ministry have shown that the defence ecosystem is teeming with new ideas, of which some have been turned into programmes. Through the joint committee structure, the information is often held within the Air Staff and yet is not used for want of personnel or time. The smart base initiative therefore consists of analysing projects started by other players in the defence world and putting them into the context of airmen's missions before setting them to work on air bases. As an example, the joint staff (EMA), general secretariat for administration (SGA) and the general directorate for information and communication systems (DGSIC) are together studying the possibility of establishing teleworking for military personnel. The idea will have to be limited in scope, be subject to quotas and kept under close surveillance, but is nevertheless very interesting! Would teleworking be of greatest use on a base? Perhaps not, but that remains to be demonstrated. We have suggested that a full-scale evaluation of this project be conducted on an air base as soon as it is sufficiently mature.

Our forces have long been used to the principle of inspections and operational checks. More recently they have learned from the civilian world the concepts of internal checks and audits but are less used to the principle of cross-checking. Large companies allow, even almost systematically impose upon themselves, the presence of one or two outside observers during their strategic meetings such as management committees and risk evaluation committees. We are not at that stage, but ten years ago, when the Air Force sought to learn from looking outside its own boundaries, it created the ADER group, a network of personalities from the civilian world qualified in a wide variety of fields. Its members, officers of the citizens' reserve, participate in opening up the Air Force to its external partners though innovative projects. They are contributing to the thought processes on smart bases, and also helping us to establish closer links with the state education system and to open our bases to the world of business. They might also allow us access to funds destined for innovation or sustainable development within other ministries or in

Brussels. Additionally, our bases amount to a very valuable and diverse capital asset because of their runways, their surface area and the knowhow of the airmen. Better exploitation of this capital will help us to obtain what the defence budget will not allow. The members of the ADER network will help us to capitalise on every opportunity in this initiative. Initial studies will be focused on one base in particular, that at Evreux, in the department of Eure.

Evreux: the first smart base demonstrator

The desire for pragmatism will be seen in an incremental approach to the concept. The main pillars have been identified as operational effectiveness, living conditions of our airmen and opening-up of the bases. Around these three main axes, the end state remains uncertain but will be defined as experience is gained and as a result of more precise studies which will be conducted during the experimental phase due to start at the end of 2015 on air base number 105 at Evreux. The future of the base is assured within the planning assumptions of the Air Force, and as a major aeronautical platform sited less than 100 kilometres (60 miles) from Paris, it will become the showroom for the concept.

Several projects have been identified for inclusion in the first stages of this test phase:

• The *Auxylium* project received the prize for participative innovation in 2010, and has since been established by the general directorate of armament (DGA) as a reactive experiment operation (OER). *Auxylium* started life as an end of course project by a French Army Lieutenant, and brings together localisation of a soldier's position, modern communication techniques and secure data transmission using hardened smart phones in the context of land combat. All this using off-the-shelf technology at reduced cost. This innovation will be tested by the end of 2015 by commandos on the base at Evreux and is expected to lead to increased priority support for the *ComTact* programme or to highlight a new need.

• The 'use of fluids' device (OSF) project is a system of detectors developed by the defence infrastructure service (SID), which will be progressively deployed in areas under Ministry of Defence influence during 2015. With the agreement of SID, Evreux will be one of the first bases to receive the equipment. The aim of OSF is to improve the management of water, gas and electricity consumption. This experimental phase should also lead to one of the first full examinations within the Air Force of performance in terms of energy use and conservation, in order to meet the economy and ecological targets set by governmental environmental policy.

• The major operators who are working with is called urban smart are offering free applications for smart phones, which work with 'enhanced reality'. They offer a great number of services to users who download the apps: cinemas,

theatres and transport are covered, of course, but with a Bluetooth connection in your car, they give you your position, guide you towards whatever activity you have put in your diary, show where parking places are vacant and can allow you to report any problem in the town, such as a faulty traffic light, a damaged bus shelter or overflowing rubbish bins. It is only a small step from that to a military application, aimed at general information for base personnel, access to digitised documentation, participation in the life of the base or announcing an alert. What could be easier?

• If these and future applications were to be connected to the same data server, itself capable of linking together the various functionalities, you would have a multi-service gateway which would revolutionise the daily life of military personnel…and hence of our airmen. This latter point is the objective of the forces' support service (SCA): to achieve a radical modernisation of support to the forces in liaison with other players. Personnel of the Air Force are proud to be contributing to the experimental phase of this initiative.

Opening bases to their local environment

To improve synergy with the civilian world, the Air Force is establishing an organisation for opening up its air bases to actors in the local community. Airmen and their families are firmly at the heart of this initiative.

One project, for example, that has been shelved up to now, foresaw the installation on an air base of an electricity generator, which would draw its energy from an urban biomass treatment plant. A project like that, accompanied by free electricity supplied to the base, would achieve at least three objectives: budgetary savings, sustainable development and integration of the base into its local infrastructure. The project will now be reconsidered in liaison with the directorate that deals with the forces' history and heritage (DMPA).

The Chamber of commerce and industry (CCI) of Eure has shown great interest in opening the Evreux air base to commercial civil traffic. This is another possibility that will be studied again, taking into account, of course, the operational constraints that could limit the initiative but in a spirit of willingness to find ways to make greater use of the three-kilometre-long runway, which is of huge capital value to the region.

The CCI is also looking to make use of the Air Force's 600 experts in aeronautical information, control and communications systems, who have recently arrived on the base at Evreux. A partnership has been established in order to create next autumn a sort of regional digital 'nursery', which will be founded on the introduction to the air base of one or two start-ups in the field of IT. This colocation of experts is sure to sow the seeds of fruitful exchanges.

Those airmen who have been designated to study these projects will do so with the necessary prudence to preserve the capital estate that is entrusted to them. The experimental period at Evreux, in association with all the stakeholders, will therefore allow identification of opportunities to be seized in the short or medium term, the synergies to be put in place to be in a position to achieve the long-term objectives, and which matters should be put aside for now.

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The smart base concept is in its gestation period. It will advance step by step, remain focused on the airman and his missions, and follow an innovative and incremental approach. Whilst the major lines and needs have been clearly identified, the details of what will be necessary to put theory into practice will come out of permanent interaction between the airmen whose job it is to define the need, local actors, and those who, within the various services and directorates of the Ministry of Defence, will honour the commitment.

By putting into practice all or part of this ambitious concept, which aligns perfectly with the *Unis pour 'faire face'* (United to face the future) project, the Air Force will continue maintain its place in the defence of France, whilst keeping its ears open to the airmen who it will ensure remain connected to the society in which they live.

The Air Force post-2020: looking to the future

Les Cahiers de la Revue Défense Nationale

What Strategies Could Counter Western Air Supremacy?

Corentin Brustlein and Élie Tenenbaum

The first is the Coordinator of the Centre for Security Studies of the French Institute for International Relations (Ifri). The second is the Coordinator of the Defence Research Unit at Ifri.[1]

Since the end of the Cold War, air power has emerged as the prime expression of Western military supremacy; the arm through which the West could intervene almost with impunity across the globe to protect its interests. With the military emergence of Asia and the more general rebalancing of international power, Western air supremacy now apparently being called into question.

Although many changes are the product of a process of technological 'catch-up', part of a global phenomenon of the redistribution of power, other novelties are more tactical and operational in nature. They result especially from the observation, on the part of the West's potential adversaries, of 25 years of force projection by air means. This period of learning has revealed the weaknesses intrinsic in the Western model of limited war, which seeks as a priority to limit risk-taking and the political costs of intervention. The progressive reduction in the margin of superiority in the air domain from which the West benefits is likely, in the medium to long-term, to open up possibilities to potential adversaries seeking to counter Western practices and concepts which, up to now, have only met unsophisticated or less-integrated forms of opposition.[2]

The expected development of anti-aircraft capabilities and their spread are all the more preoccupying in that their integration into coherent strategies risks greatly increasing their effectiveness. An appropriate counter-air strategy could allow an adversary to search the various technical and operational sources to reach military goals adapted both to their policies and their resources. Hence, while the development cost of symmetric and offensive counter-air strategies is likely to remain excessive, numerous alternative options exist, capable of being used in the service of a number of ambitions.

(1) They are, with Etienne de Durand, the authors of the work '*La suprématie aérienne en péril. Menaces et contre-stratégies à l'horizon 2030*'; La Documentation Française, 2014; 256 pages.

(2) Adversaries' progress could emerge in five areas of opposition: air combat, the ground-to-air threat, attacks on air bases, information superiority and irregular combat.

In this way it seems possible to define strategic models combining various developments in capabilities, likely to appear in various forms adapted to the local context in future conflicts. These different strategies have in common the fact that they attempt, each in its own way, to respond to the threat of an air intervention on the part of one or more Western powers.

Total Defence

This is a natural reaction for an actor confronted by an interventionist adversary with tactical and qualitative superiority. Like a hedgehog, for the defender this means 'rolling up into a ball' and raising his spines until the attacker gives up the attack. In order to put such a strategy into practice, the defender must therefore play on two principal factors: the unlikelihood of victory and its excessively high cost. **The unlikelihood of victory** can be demonstrated by an effective and resilient integrated air defence system (IADS), which can continue to inflict losses and costs, even after a long campaign, as well as passive defence measures such as hardening, dispersion and the concealment of infrastructure and weapons systems, which directly increase the chances of survival. **The excessively high cost of victory** can be obtained by the installation of an advanced alert network and multi-layered (long, medium and short-range) mobile SAM (Surface to air missile) systems capable of providing the defence of strategic points. The integration of such a system certainly implies robust C4ISR (Command, Control, Communication, Computers, Intelligence, Surveillance and Reconnaissance) but this will be within the reach of a growing number of actors in the future, thanks to the wider availability of information systems.

This strategy derives advantage from the interests at stake: these are generally limited for the interventionist power. The defender thus plays on the material and human costs, which can quickly become a major obstacle for European powers under heavy budgetary pressures, as well as the political and moral costs, especially those caused by collateral damage and their use by the defender through exploitation of the media.

Anti-Access Strategy

The anti-access strategy is more offensive than the previous one in its aims, which are to use political and military means to **discourage, prevent, or disrupt the projection of forces even before their entry into the theatre of operations**. This '**forward defence**' is based on progress made in terms of extending the capacity for action as well as on the growth of Western vulnerabilities, particularly those connected with dependence on information systems. Anti-access is a strategy integrating political and military elements and can fulfil a function which is deterrent and defensive at the same time. An adversary can lay the diplomatic foundations for an anti-access strategy months, or even years before the start of a conflict, trying

first of all to close off a region by discouraging any operation or political agreement allowing Western forces to be permanently installed there. In practical terms however, the operation begins weeks or months before the operation. The air component of a projection force requires access to air bases in the theatre situated close to the adversary and obtaining overflying rights from neighbouring countries. The adversary can attempt to limit the number of countries accepting the basing of Western air forces, or authorising overflying their territory, by diplomatic approaches or military gestures with blackmail in mind.

After attempts at intimidation, an anti-access strategy will then move to more active options. It will, for example, attack the dependence of projection forces on crucial but scarce air systems (for example, operational and strategic ISR and refuelling aircraft), especially by trying to neutralise them on the ground. Due to the relative availability of long-range strike weapons (ballistic and cruise missiles) and increased precision guidance equipment, it is becoming possible to disorganise and weaken projected forces by striking their theatre bases, the more so since these are large targets whose protection, active or passive, would be extremely demanding. These bases are also exposed to irregular initiatives; commando attacks, suicide attacks, short-range indirect fire ((G)RAMM)(3) and similar. These modes of operation can be combined with cyber attacks targeting national or theatre command and communication systems or indeed further upstream, on management systems for logistic information supporting the projection operation. An anti-access strategy can thus be based on a very varied palette of options—discussed here in a far from exhaustive manner(4)—and can readily exploit the asymmetric aspects of the issues and the weak and vulnerable points inherent in operations by projected forces.

Low-tech global resistance

Although the two previous strategies demanded major capabilities which only a modern state could acquire, the wider availability of a large number of technologies and the diffusion of doctrine nowadays allows irregular or hybrid adversaries to develop a real counter-air strategy. Like the total defence strategy but with much inferior means, this strategy plays on the asymmetry of interests between the Western adversary and the irregular combatant. It does not offer a spectacular victory but seeks a purely negative objective: **the cessation of air operations by wearing down Western will**. Victory for the defender is the absence of defeat, whilst the absence of victory corresponds more or less rapidly to defeat for the interventionist state.

(3) (Guided) Rocket, Artillery, Mortars and Munitions.

(4) On this point, see Corentin Brustlein, '*Vers la fin de la projection de forces ? I. La menace du déni d'accès*', in *Focus stratégique* No. 20, April 2010.

In spite of his limited means, the actor adopting such a strategy can count on a large number of operating modes which can be spread over the whole operational range of air power, while he possesses only a limited degree of technological sophistication. Firstly, by exploiting the opening up of theatres, he can resort to terror and subversion campaigns on the home territory of the intervening power, with attacks on personnel or the infrastructure of the air forces, but also with operations designed to influence public opinion. Further down the chain, this strategy will attack advanced bases in the theatre of operation or close to it. Taking advantage of the terrain or potential supporters in the host country, the adversary can launch attacks on the air forces (as in Vietnam and Afghanistan), whether by means of suicide attacks or, again, attacks from a distance using indirect fire ((G)RAMM) of greater or lesser sophistication. In addition, although threatening platforms flying at high altitude must remain out of range for some time yet, an irregular adversary can now considerably reduce the use of low altitudes for fire support, transport or evacuation simply by possessing modern very short-range ground-to-air missiles (MANPADS). Finally, the effectiveness of air power can also be limited by hiding combatants within the civilian population, tactical mingling between the combatants, the dissolving of command and communication networks or even the use of international sanctuaries.

De-sanctuarisation

Like denial of access, this strategy refuses too much passivity in the face of projection operations and rests on the gamble of acting upstream of the establishment of Western forces in the theatre. Such a strategy ranks above anti-access and clearly belongs in the category of an offensive method of warfare, taking the initiative in an attack to weaken the adversary, in particular his air forces. As distinct from anti-access, attacking sanctuaries has no deterrent function: it directly places confrontation on the territory of an expeditionary power and resorts to surprise to destabilise the Western capability to generate a long-distance air projection force. That can be accomplished by striking critical and scarce platforms (like long-range air surveillance, intelligence gathering and in-flight refuelling) the neutralisation of which, even partial, would have a systemic effect on the projection capabilities of air forces. To reduce the offensive potential of air forces, the option of attrition can also be chosen, especially as Western air forces will be increasingly vulnerable to losses in their fleets of aircraft.

When anticipating a forthcoming war, attacking a sanctuary can be particularly formidable if the adversary keeps a strategic reserve enabling him to resist a second wave of Western attacks. It must nevertheless avoid forcing the West into a strategy of total war. Also, the choice of striking a sanctuary must be coupled with a logic of discrimination of attacks, taking only military installations as targets, and recourse to cyber attacks on protected command networks. Although striking enemy territory generally requires sophisticated means (penetration of protected IT

networks or long-range weapons with precision guidance, for example) a strategy of striking sanctuaries could equally be based on less sophisticated ones, such as kamikaze drones or commando attacks.

Blind and paralyze

This strategy uses a logic of a protracted informational struggle. It is based on the combined exploitation of the adversary's advantage in many domains (IT, electronic warfare, deception or propaganda) and the West's dependence on its armed forces, in particular its air forces, with their associated information flows. Hence, as its name implies, it works in two phases: the first, blinding, consists of **channelling the development of the conflict with a potential adversary by influencing his perceptions and his policy** using disinformation and subversion over a long period. Although blinding aims at avoiding a confrontation, it also prepares the way for the possible conflict by cyber sabotage action, enabling intelligence gathering and the implanting of delayed action bugs offering the means to strike at the heart of the adversary's information systems in the event of escalation.

If it becomes impossible to avoid a conflict, the informational advantage is exploited to control the escalation. Mastery of the digital and electro-magnetic environment can be used for deterrence, by sending signals to the interventionist power, intended to put in doubt its ability to use its air forces in the context of an intervention, and to discourage a transition to armed conflict. If the latter becomes inevitable, the strategy can then enter its paralysis phase: the cybernetic weapons planted in depth in the adversary's information systems are activated to produce massive disorganisation aimed at the armed forces, critical infrastructure or the population. The passage from blinding to shock happens by surprise, making use of the instantaneity, which characterises cybernetic processes. From the military point of view, the objective is to hinder the preparation of the projection operation, by disrupting mobilisation and the collection of intelligence, and to degrade the C4ISR coverage available to the Western air forces, blunting their ability to limit the risks and political costs of the intervention. On the political front, it involves a sophisticated disinformation campaign targeting Western public opinion and aimed at undermining its support for the operations in question.

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These five ideal types of strategies aimed at contesting Western air supremacy are not exhaustive. Their purpose is simply to illustrate the ways in which adversaries, having drawn lessons from Western operations in the post-Cold War period, could try to counterbalance our military advantages by combining capability and technical elements in a coherent and, in some cases, innovative way. No situation of military advantage is immune from strategic debate. The question is therefore not whether the exceptional advantage enjoyed by the West since the end of the Cold War will be contested, but how it will be.

The Future Combat Air System: Perspectives for a System of Systems

Michel Friedling

| *Colonel (Air)*, Head of the plans office of the Air Staff.

During the First World War, audacious men rapidly understood the advantage that the air environment brought to the conduct of military operations and to the achievement of political objectives. Since that time generations of airmen and engineers have invented new ways of use, imagined the capabilities required and gradually constructed the combat tool that we now have and which proves its operational value in combat daily.

In a strategic environment which is undergoing major change, it is more than ever necessary to be as innovative as them in order to preserve for the future the ability to offer the political power and the commander of military operations options particular to the air arm, as well as the capability to provide freedom of action to the other armed forces.

With this in mind, an overall vision is needed for a future combat air system (Scaf) which goes beyond any platform logic and depends on a systemic approach which considers what exists and takes into account new technologies that could lead to breaks with certain current concepts. The heart of such a system will be built on C4ISR(1) architecture, back-to-back with innovative and flexible command and control (C2) concepts, and will integrate means for situational surveillance and intelligence (ISR).

The strategic context and the response of air power

The strategic situation is more uncertain than ever. The trends identified in the 2013 *Livre blanc* have been confirmed by events over the past two years. The possibility of more difficult, more complex, longer and more symmetrical commitments in less permissive environments is also more likely than ever in the future.

(1) Computerized Command, Control, Communications, Intelligence, Surveillance, Reconnaissance.

Moreover, for 20 years regional powers have been developing or have acquired weapons and know-how of the highest order, notably for their air forces, which are now capable of intelligence gathering, planning, conducting and commanding air operations without the support of Western partners. This fact is well illustrated by Saudi Arabia's air campaign at the head of a coalition in Yemen in the spring of 2015.

Latest generation ground-to-air systems,(2) emerging technologies in the field of detection (passive or multi-static) and the cyber threat all call into question the survivability of our platforms, our effectors and our IT systems.

In view of all of this, today's perception that air superiority, and hence freedom to manoeuvre on the ground or the sea, is natural and a given fact must now be seriously challenged. And yet the ability to maintain that air superiority, and to act at will in air, space or cyberspace (all having in common the qualities of continuity, transparency and speed of movement of vehicles or information), is needed more than ever to offer our political authorities a range of options to match our ambitions in terms of defence and national security, as well as our armed forces the freedom of action in all environments.

Scaf, a system of systems

This is the challenge that Scaf will have to address for the entire spectrum of Air Force missions, from protection of airspace to the nuclear deterrent.

It is not a simple question therefore of replacing one platform by another some 15 to 25 years from now. Too often the acronym Scaf or, in English, Future Combat Air System (FCAS), refers to a platform alone. We are not splitting hairs over semantics here, because on the contrary it is a fundamental question, one of concepts which must guide all consideration on what the system will be and the means to put it to work.

For the Air Force then, Scaf refers to an overall capability, an architecture that encompasses the entire concept, a system of systems. It is not just a question of objects—platforms, sensors or effectors—even if they are connected together or in some intelligent combination working in synergy: it is an overall, radically different approach, which has the potential to break away from current concepts and capabilities. Scaf needs to express the state of the art in air, space and cyberspace matters if it is to achieve the expected effects in the most uncertain of tomorrow's tactical and strategic environments.

In the age of information, big data and complex architectures which operate and support information flows, Scaf should be a sort of flexible and well-considered

(2) S-300 PMU2 already widely exported or S-400 (deployed in the Baltic region and partially in Crimea).

'combat cloud' that can flexibly, rapidly and securely gather, handle and distribute pertinent information to the appropriate player within the system. The central nervous system of Scaf needs to have powerful, robust, resilient and flexible C4 architecture (Command, Control, Communications, Computers) integrated with ISTAR capabilities, which it will feed permanently and in real time. That alone is a major challenge.

Such architecture must also be able to incorporate existing and future capabilities, to link command and control centres in a flexible network, together with air bases, platforms and sensors on the effectors, whilst remaining as open as possible. A sort of 'plug, share, fly and fight' architecture, in fact.

Numerous questions arise. The first is to ensure that this vision is not simply an idea or a tempting, though unrealistic concept. On a more practical note, and with respect to what we are doing today, what radical developments are there which in some measure foreshadow this system of systems? How should such a system be structured? What is the place of unmanned combat aerial vehicles (UCAV) and the like in the system, and what would be their missions? What is the role of platforms such as the A400M or MRTT aircraft, beyond the usual missions fulfilled by the current C-160, C-130 and C-135? How do we collect and handle the billions of bytes of data in restricted timescales, and deliver the right information in real time? What networks and what human or artificial intelligence processes de we need to do that? What decision processes do we put into place in the system, and what is the place for the man? In which technologies should we invest? How do we remain interoperable at the joint and combined levels?

It is clear that the replies are not all available and the challenges are enormous.

Major areas of interest

The first is the conceptual aspect. It is fundamental that the expertise of the Air Force in air and space matters is used to guide the engineers through their consideration of concepts, with industry in return feeding the Air Force's thought processes with new ideas about technology. Remembering that it will be a military and, ultimately, a political tool, the Scaf cannot only be the product of technological or industrial considerations. Concept studies have to address all the necessary aspects, notably C2 structures, which merit deeper consideration in order to draw lessons from recent commitments and prepare for those of tomorrow.

They must also be sufficiently innovative and disruptive, in particular by exploring radically new solutions and forward-looking fields of interest. They might look, for example, at new ideas on speed (hypersonic), timescale (exo-atmospheric balloons) and aids to decision-making (data science, artificial intelligence), among others.

Yet they must at the same time be backed up by credible scenarios, simulation and full-scale trials. One of the great advantages of the Air Warfare Centre that has been created at Mont-de-Marsan is that it will be able to contribute to experimentation in liaison with industry of architectures, solutions and ideas in an innovative and interactive manner and in reactive timescales.

At the heart of these concept studies the major theme is C4ISR, which is the integration of a C2 structure with an ISR (Intelligence, Surveillance, and Reconnaissance) capability, so that they work together in harmony and in real time, forming the backbone and nervous system of the Scaf. It is now essential that C2 be capable of distributing control of operations to decentralised levels whenever it becomes necessary, command naturally remaining centralised. The ISR capabilities must be integrated with C2 and geared up to operate in real time. To achieve this, future systems have to be designed with an integration capability for intelligence that is gathered, merged and validated in very short timescales in order to accelerate the tempo of operations. Even more important than the gathering of information and a capability to analyse it later, its handling and distribution in real time within the Scaf, which will be connected to all players operating in or towards the third dimension as well as those in other networks and joint or combined connected systems, is a subject of great importance. Hence the integrated Recognized Air Picture (RAP) and, when developed, Recognized Cyber Picture (RCP) will be highly effective for the military might behind the air arm, drawing their information from the three fluid environments—air, space and cyberspace.

Thereafter, connectivity takes on its own importance. It is the key enabler of the C4ISR mentioned earlier. The ability to increase air transit distances, the distance apart and dispersion of theatres of operation, the need to analyse and to understand the surrounding environment, and that to reduce decision times make it essential to have greatly widened connectivity for the necessary handling of information flows, since at the same time as doing all that the system must offer political and military authorities less restrictive modes of operation to localise targets and guide effectors in cooperation with multiple platforms and multiple sensors. Drawing upon diversified means of communication, the system has to allow for modern services such as messaging, secure chat and the exchange of photos or videos. Using these networks should be transparent to the user, with intelligent equipment that can generate pass bands and information channels automatically.

Survivability is just as important a subject. The issue does not only concern the platforms, but the entire system. With regard to the platforms, though, new generation or disruptive ground-to-air threats such as multi-static radars and passive detection should raise questions about the solutions for survivability that have been studied up to now, the most recent of which have focused on the signature of platforms. The right combination of speed or hypervelocity, manoeuvrability, stealth and electronic warfare has to be evaluated according to context and mission. As for the system overall, cyber threats have to be taken into account as far

upstream as possible in the programme design process to guarantee robustness and survivability.

Research into weapons needs to look at survivability, reach, accuracy and effects – and also cost. Operations continue to demonstrate the need for a range of armaments adapted to missions and operational environments in order to produce the desired effect with minimum collateral damage. Thoughts should be broadened to include consideration of non-kinetic weapons (that is, ones other than directed energy), of the possibilities offered by hyper velocity applied to conventional weapons or even those of kinetic effectors connected to the overall system.

Interoperability will continue to be the major challenge that it is today. It is a force multiplier and a prerequisite for all coalition operations. It risks being adversely affected by the appearance of new architectures and new forms of more secure high-rate data links which connect forces in the land, sea and air worlds. Equally, the arrival of new-generation platforms—the F-35 in particular—is already a matter for discussion in the Air Forces concerned. It is therefore essential to take into account collectively with our national partners and our allies, and as early as possible, the challenges that interoperability presents.

Studies in hand

The numerous studies into concepts and technologies that have been done since the beginning of the century are supporting this thought process.

On concepts, the Sys-UCAV national study, for example, has encouraged thought on the concepts and combinations of unmanned combat drones and manned platforms (combat aircraft). The Cet-UCAV(3) study, begun in 2015, continues this train of thought. The first two phases of the Global System Study (GSS), between 2005 and 2011, explored the same issue within a multi-national framework, involving France, the United Kingdom, Sweden, Italy, Germany and Spain. The third phase, launched this year, is looking in particular at architectures of an overall combat system.

Regarding technology, the question of combat platforms is taken into account through the various planned evolutions for Rafale, and looks mainly at air-to-air and air-to-surface capabilities, the engine, support, man-machine interface, survivability and connectivity, and also at combat drone demonstrators via the Neuron and FCAS-DP projects.

The Neuron project is a UCAV demonstrator, begun in 2006 and developed by France, Sweden, Italy, Greece, Switzerland and Spain. Flight trials began in June 2012 and will end in 2015. They will have tested the stealth of the

(3) Concepts, emplois et technologies de systèmes d'UCAV. (Concepts, use and technologies of UCAV systems).

demonstrator and its ability to deliver a weapon from an internal weapon bay. The aim of FCAS-DP is to prepare, in cooperation with the United Kingdom under the Lancaster House Treaty, a UCAV-type unmanned combat platform demonstrator. During the feasibility phase, started in 2014, studies will concentrate on concepts, architectures and costs, as well as on the key technologies needed to put such platforms into practice. The acronym UCAS-DP might therefore be more appropriate, and could be used for the second phase, due to start in 2016.

For all that, technological studies are not limited to platforms alone, for the fields being prospected are vast. Stealth (electromagnetic and infra-red), electro-optic, infra-red or radar sensors, weapons, active multi-function array radars, on-board computing, data link and communications systems, electronic warfare, propulsion and hypersonic vehicles are all being studied to one extent or another by industry to feed our thought processes on future capabilities.

Concept and technological studies also contribute to the gradual, yet continual construction of the road map that will fulfil the vision of the Scaf.

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Military action in the intangible elements (air, space and cyberspace) presents unique characteristics and offers specific possibilities for defence and national security strategy. It should not be reduced to the role of a key enabler for other players, but should be though of as an entity apart and exploited without intellectual or conceptual restrictions.

The US Air Force, the Royal Air Force and the *Armée de l'Air* are in the top rank of Western air forces, but are at a crossroads. History has taught us that confrontation in or from the third dimension inevitably favours he who has the best equipment and the best technology, and who knows how to use them intelligently and with a fighting spirit. That is the reason why air forces have always been, and always will be forces in which the technology of their equipment fights as much as the men who operate it. History also teaches us that we must prepare for tomorrow's battles, and not prepare ourselves better to fight yesterday's. The strategic situation is more uncertain than ever, and all our convictions about air and space superiority have to be called into question, given new threats that take on many forms, and the appearance of regional actors who are capable of using new equipment and new know-how.

A vast array of collective thoughts and considerations has to be taken into account by the armed forces, the DGA and industry in order to analyse these realities and to extract possibilities for the future of the Scaf. The thinking has to be universal and innovative, a system of systems built around robust and flexible C4ISR architecture that forms the backbone and central nervous system of the future combat air system.

Cyberspace and Air Operations

Christophe Vilchenon

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When, in 2009, he spoke of cyberspace and exo-atmospheric space, the former Chief of the French Defence Staff, General Jean Louis Georgelin asked how we might obtain best advantage from these very special 'spaces' which are now opening to us. How can we to best effect make use of the full potential offered by technical progress, master it and exploit it? To whom should we entrust responsibility for the new capabilities which result from such progress, and how should it be put into service?(1) He added that the complexity of the situations which now confront us requires us in particular to look outside the bounds of our current ways of thinking and to put greater emphasis on an approach that draws upon the mutual benefits of actors and assets.

It is pretty clear that any operation based upon a single component has no place these days. Military people now speak in terms of desired effects: recognition that achieving such effects demands a combination of complementary capabilities drawn from each component within the framework of wholly joint activity.

Insofar as it concerns cyberspace and its impact upon air operations, and to offer a partial reply to the defence chief's questions, the approach here will be similar to that for special operations—that is, it will be considered as an entirely separate component in the study of its interaction with the Air Force in the context of air operations.

The cyber component

Cyberspace is a national priority and one of our country's vital interests. It constitutes a major technical departure and a real operational and conceptual revolution.

Above all, the use of cyberspace allows improvement in the performance of weapon systems. In that sense it is a force multiplier which is increasingly becoming the very heart of those same weapon systems, in that it supports the gathering and

(1) Colloquium on 2 March 2009 on the role of aerospace power in the field of knowledge and anticipation.

exploitation of the information that is essential to strategic decision-making. This being so, 'cyber' can be considered as a new weapon in the armoury of the forces, or as a boost to existing capabilities.

Given, however, that the digital world already feeds every aspect of functioning of the state, be it economic, cultural, diplomatic, or, of course, military, the possibilities afforded by cyber might also be seen independently of traditional modes of action of the armed forces or even as something that lies outside strictly military operations. Depending on the target and the desired effect, which might for instance be to influence the behaviour of leaders and particular populations, or (more physically) to destroy nuclear centrifuges, cyber might be considered as a political tool for use within an overall strategy of projection of power and influence, rather than simply as a weapon with a tactical effect on a battle.

The interest then lies in its ability to produce original and particular effects, such as allowing the passage from a defensive posture to an offensive one without any change to the military assets deployed in an operational theatre, or perhaps to influence the adversary's strategy by forcing him to remain in a defensive posture in order to prevent any initiative on his part, or even to boost the effect of joint force or inter-ministerial action.(2) Cyber could also be perceived as an ideal vehicle for fulfilling the aims of strategic paralysis, by destroying in a targeted fashion enemy telephone, electricity or Internet networks in order to hit his centres of gravity, to strangle his information system and to dismember his command structure in the manner conceived by Boyd and Warden.

As an entirely new and separate component, cyber can be integrated into a joint force unit in the way that fuel or medical services are currently, or could equally be organised like special operations with specialised sub-organisations and skills.

At the same time as offering a new way of planning our future operations, cyberspace poses a problem concerning the protection of our own assets. It is therefore essential that not only must personnel within our planning, programming and conduct of operations structures be in a position to master the possibilities of this new component, but also all those within the forces, directorates and other services have to be concerned by the need for measures of digital hygiene, which are important for operational planning in terms of organisation of the cyber component.

Comparison of the cyber component with special forces in terms of both use and operation allows better identification of the interactions with the armed forces which could exist during operations and in their day-to-day function. To this end, direction and conduct can only be joint, in the sense that there is only

(2) This paraphrases the words of Général d'armée aérienne Palomeros of 9 March 2009 on air power.

one digital environment and also that the Chief of the Defence (hence joint) Staff (CEMA) is its sole operational commander.

Some things cannot be duplicated in a period in which ministerial and national resources are rarer and rarer—notably highly skilled personnel and the equipment they need—which means a joint-force centre has to be preferred. Nevertheless, it is not just useful, but essential, that the land, sea and air forces each retain their own cyber specialists who are available to the joint centre if needed. It is an illusion to think that an Air Force specialist in information systems related to air operations would remain an expert after a number of years spent outside his own service environment, given the rate of evolution of material and techniques in that field. Specific expertise in his field is essential to deal with certain targets, as recent history has demonstrated, including in the field of cyberspace.

As with special operations, it appears necessary to have cyber specialists who have full knowledge of air operations (their cycle, use, limitations and so on) and therefore to make available to the cyber component of the joint ops staff a specialised Air Force unit: a sort of air cyber cell, in the image of the air force parachute commando!

Interactions between the cyber component and the Air Force

Whenever the cyber component is not acting alone, it becomes part of the joint manoeuvre in which complementarity between the capabilities of each component is put to effect on the battlefield in order to achieve the desired politico-military effect. With this in mind, Air Force missions, which are always conducted in a joint force, inter-ministerial or combined (= allied) framework, will have no difficulty in integrating the cyber component and vice-versa.

The cyber component in support of the Air Force

In the same way that air superiority is a prerequisite for ground superiority in modern conflict, information superiority, or superiority in cyberspace, has now become a prerequisite to superiority in all other fields. Thus to preserve this superiority and to prevent the adversary from gaining it, are at the heart of all air strategy today. In recognition of this, the Air Force aims to analyse its OODA loop faster than the adversary does his own.

The cyber component can therefore have an effect on the adversary's OODA loop by slowing it down in the long term either by targeting his weapons systems (for example, in preventing his air fleet from taking off by affecting the engine control systems), or by saturating his communication systems. It could also act on the adversary's understanding of the situation by influencing him to take the wrong decisions, in particular by introducing false data.

Lastly, the cyber component could help prevent strategic surprise, for example by revealing the existence of new weapons (unknown up to that point), and by finding new targets which might be dealt with later by combat aircraft.

The Air Force supporting the cyber component

Situations occasionally arise in which it is not possible to conduct certain actions using cyberspace (or perhaps it would take too long), thus compromising the entire joint planning for the campaign. The Air Force could then unblock such a situation by physical destruction of certain installations—an information system or an independent data source, for example, with the aim of forcing the adversary to call upon another system or data source which is under our control or has been infiltrated.

Knowing that the basic principle of a successful cyber operation is that the adversary does not see it happening, the Air Force might also participate in a cyber operation by diverting the adversary's attention from certain systems or by obliging him to use certain fallback systems or certain functions in order to gather essential information.

Coordination of the cyber component and the Air Force

As in any environment, cyberspace has characteristics peculiar to it, and its use requires above all a state of mind that recognises and understands its limits, possibilities, tempo and modes of action. This cyber culture therefore needs to work its way into the minds of Air Force operators and planners. Adoption of the cyber culture by everyone, and especially understanding of what cyber can do, and how, will improve the effectiveness and planning of operational commitments and allow more precise allocation of responsibility on operations. But simply having this double culture (air and cyber) is not enough: actions in the two environments need to be coordinated in terms of time and physical space in order to make the cyber and air operations cycles more coherent.

Air C2 (command and control) assets must also be coherently coupled to cyber C2 assets throughout all phases of a campaign, which include planning and conduct. If a recognised cyber picture (c.f. a recognised air picture) can be created for a theatre of operations, it will allow the decision makers in each component to share common information in real time.

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Airmen's ability to adapt is essential if we wish not to follow events but to be ahead of them; if we want to avoid being struck by the adversary and instead impose our will upon him. To encourage this quality, I hold it essential that we develop our military culture by advocating the principle of subsidiarity as the basic rule of

behaviour. It is no longer enough to wait for direction from one's superiors before acting. That is why I am encouraging initiative at all levels of responsibility in the Air Force.(3)

This spirit, the words of General Abrial, who was then Chief of the Air Staff, must be that of the Air Force regarding the acceptance of cyber into the French armed forces. In addition to the expertise of its natural environment, the Air Force must henceforth offer the joint staff not only the availability of technicians of a future air cyber cell, but also cross-the-board expertise (such as the creation and maintenance of a recognised cyber picture) integrated within the vision of air power in 2040, a combination of air power and cyber power.

(3) Colloquium on 2 March 2009 on the role of aerospace power in the field of knowledge and anticipation.

Air/Surface Integration: What are the Issues for Operations?

Laurent Aubigny

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The expression Air/Surface Integration (ASI) has become a buzzword within the operations community, in the same way as 'full spectrum targeting', introduced by the British some years ago. However, beyond the slogan lies an operational reality, indeed a necessity, which has come to the fore in the present context of the commitment of our armed forces, characterised by the preponderance of so-called asymmetric operations. This is not a new idea but rather a rediscovery, after being sidelined during the Cold War, of a technique developed during the Second World War.

Although there is not yet an official definition of ASI, either in NATO or France, everyone agrees to differentiate within ASI between Air/Land Integration (ALI) and Air/Maritime Integration (AMI), respectively the effects of the air component on air/land operations (conventional or special forces exemplified by Operation Barkhane) and air/maritime actions in the context of an asymmetric maritime scenario. The CICDE(1) has suggested a definition of ASI as: "a set of procedures implemented at the tactical level, in planning as well as control, to combine the activities of air and ground forces (conventional and special) with a view to optimising joint operations." The NATO Special Operations Headquarters, in its ALI Special Operations Manual of July 2014, describes it as: "the orchestration of air and ground forces to achieve synergic effects on a common target or series of targets".(2)

After a short historical overview which will give an understanding of the reality which this process covers, we will discuss the issues which it represents in operations against an asymmetric adversary - that is, a better synergy between the land, maritime and air actions by substituting integration for the simple coordination of

(1) Joint Centre for Concepts, Doctrine and Experiment.

(2) "The orchestration of air and surface forces to provide synergistic effects on a common objective or series of objectives is referred to as air land integration (ALI)". General Ira Eaker.

the components. Finally, we will conclude with the challenge that ALI constitutes for the Air Force.

Applying the lessons drawn by General Ira Eaker of the US Army Air Force (USAAF) in 1943 during the North African campaign(3) and subsequently in the Italian campaign, 10,000 sorties were carried out from 6 June 1944 in Operation *Overlord* in direct support of the ground forces in contact with the enemy and against the rear lines of communication. Impeding than arrival of German forces and consolidating the allied bridgehead, they resorted to teams of forward air controllers.(4) By way of example of this "close consultation at all levels" advocated by the commander of the 12th and 15th Air Forces, pilots of the 404th fighter group were used embedded in the 6th Armored Division as an Air Support Party during the Battle of Normandy.

But these lessons were quickly forgotten: in 2002 in Afghanistan during Operation *Anaconda*, the weaknesses of integration between the air and ground components re-surfaced.(5) The solutions applied to the difficulties identified rapidly bore fruit during operations conducted in Iraq and Afghanistan in subsequent years. The same approach was used by the Israeli forces after Operation *Change of Direction*(6) (Lebanon 2006) notably to improve the coordination deemed too weak between infantry, armoured and air forces. These lessons enabled much better results to be achieved during Operation *Cast Lead* (Gaza 2009), in a much more difficult environment: urban setting, high density of tunnels and booby traps etc. The British were also aware of a lack of capability on the part of the Royal Air Force and the Army to conduct integrated Air/Land operations during their engagements in Iraq and later Afghanistan. This led them to launch the Coningham-Keyes programme, directed by the RAF, to develop Land/Air/Sea interoperability using tools, procedures and specific formations.

In France, ALI culminated in operations in Indochina and then Algeria, before being forgotten and then re-discovered in Yugoslavia in 1995 (operation *Deliberate Force*). But it was really air special forces (notably the CPA 10 parachute commando) which restored integration to the core of French operations to achieve

(3) "Army and Air Force commanders must work in close consultation throughout all stages of the formulation and execution of the plan, to ensure that the land and air operations interact to the best advantage".

(4) On D-Day, each bridgehead had a Tactical Command Centre embarked aboard a Landing Ship Tank of the Navy to direct air operations against the coastal defences. At the exit from the beaches, two Tactical Command Centres (the British 83 Group Control Centre and its American equivalent from the 9th Air Force) were set up to direct air operations in the two sectors of the battlefield. These were complemented by British and American Rover teams, composed of air and land personnel equipped with VHF radios to provide terminal guidance for the fighter-bombers.

(5) "Insufficient coordination between the land and air components at all levels was also a problem. Operation Anaconda was planned in the first half of February 2002, but the air component did not bring its full planning resources to bear until the last week of that month… Much of the problem seemed to stem from the lack of clear and frequent contact between the right elements of the staffs of the two components". *Operation Anaconda, An Airpower Perspective* by Dr R. Grant, prefaced by General John P. Jumper, Chief of Staff of the USAF (2001-2005).

(6) Cf. Benjamin S. Lambeth: *Air Operations in Israel's war against Hezbollah: Learning from Lebanon and Getting It Right in Gaza*; 2011 (www.rand.org/content/dam/rand/pubs/monographs/2011/RAND_MG835.pdf).

the results required by their missions (action, intelligence, terrain modelling) and to optimise the use of air resources, whether these belonged to the special forces (helicopters of the 4th RHFS and the EH 01.067 'Pyrenees', tactical transport aircraft of the ET 03.61 Poitou[7]) or not (fighter aircraft, Atlantique 2. Reaper or Harfang drones). The quality of the results obtained, especially in Afghanistan and Africa, as well as the support of the special forces for innovation and performance, partly explains why the Special Operations Command (COS) is today alongside the Air Force at the forefront of the experiments and the progress made in this area, both in tactics and technology (in digitally aided CAS[8] and the fusion of multi-sensor intelligence for example).

Renewed Interest in ASI by the Military Community

This interest is not a matter of fashion but is explained by various factors. The first is the context of our forces' engagement. Even though the possible resurgence of inter-state conflict must not be forgotten, we are bound to note that asymmetric conflicts remain the most probable case and the reality of our current operations. These are characterised by total air superiority, at least locally, enabling our air forces to operate without major hindrance and to carry out the full spectrum of their missions, including those which necessitate close interaction with the ground forces. This new context of employment of the air component has also led to a marked increase in the number of CAS/Dynamic sorties flown compared with the number of AI[9]/Deliberate ones in recent conflicts and a greater need to combine the ground force actions with those of the air forces. The mastery of this combination of actions on the ground with those in the sky affords a decisive benefit in the face of an elusive threat, difficult to detect among the population, which decides the place and time of its actions and possesses increasingly heavier weapons. Ascendancy over the enemy can only be achieved if our forces, often spread over very large operation areas with great distances between sources of support, have the responsiveness and the ability to concentrate their actions in space and time. The effects produced by the air component to the benefit of the land operations often prove decisive, especially those which relate to intelligence gathering (ROEM, ROIM[10]), airdrop or the delivery of armaments.

The second factor is connected with the technological developments which enable the air component to respond with more flexibility and efficacy to the needs expressed in real time by the ground forces. Firstly, thanks to the versatility of the platforms, it is now possible for them to carry out several missions successively during the same sortie. The arrival of new systems also allows the sharing in real

(7) 4e Special Forces Helicopter Regiment; 1/67 Pyrénées Helicopter Squadron; 03.61 Poitou Transport Squadron.
(8) Close Air Support.
(9) Air Interdiction.
(10) Intelligence of Electromagnetic Origin/Intelligence of Imagery Origin.

time of a tactical situation and the exchange of data (voice, data, including BFT or FMV[11]) between the components (land, air and sea) and in a particular way between the aircraft and the ground-based part of the air component.[12]

Finally, the last factor is the improvement in target effects brought by the air component: precision of munitions, munitions adapted to the urban environment in particular, the precision of airborne ROIM/ROEM sensors, the precision of airdrops (SOTGH, LMTGHOB[13], loitering and endurance of platforms etc.

What are the challenges of ASI for operations?

ASI exploits the synergies between the land, air, sea and special operations components and gets the best from the air capabilities deployed and from the common features of these components, at a time of manpower reductions, budgetary constraints and strict control of resources. For a force commander, ASI means passing form a proprietarial logic to one of mutualisation, while remaining sure that the effects of the air component will be delivered at the right moment, the right place and with a controlled level of risk. The operations in Africa (*Barkhane*, *Sangaris* and *Sabre*) demonstrate their relevance every day: an air component which works together with the operations of three operational commanders and integrates its effects with the planned requirements expressed in real time by the deployed forces. ASI means transforming a synchronised and deconflicted (ie no fratricide) coexistence between the components under control at the operational level, into an involvement and an more intimate and direct interaction between them, with aim of combining their efforts and their effects in a more fluid and continuous way. This osmosis, which enables the air component to anticipate or even act ahead of requests for support and thus optimise its contribution and its own actions, is transforming the relationship between the force components. Services are provided more or less voluntarily and informally. ASI means finally giving back freedom of action and flexibility in the use of air space in his area of action to a joint force commander by freeing him from the partitioning of air space which is generated by the construction of air/land or air/sea 'bubbles'. These are specified for air and sea operations within which air coordination is no longer the responsibility of a single actor: the air component. This component is generally the only one capable of efficiently organising activity in an increasingly crowded air space. ASI therefore offers better land/air/sea synergy to the benefit of joint campaigns. It provides familiarity and a better mutual understanding between the different actors, greater fluidity in the exchange of information and better sharing of the tactical situation due to modern information and communications systems.

(11) Blue Force Tracker, Full Motion Video.

(12) Air Operation Center, Air Support Operation Center, Tactical Air Control Party, Wings Operation, Deployable Air Information Cell, Control Reporting Center.

(13) High Altitude Remotely Controlled Delayed Opening, High Altitude Low Opening of Equipment.

What challenge does the introduction of ASI represent for the Air Force?

The Air Force must be capable of integrating ASI into its doctrine, the training of its personnel, the development of its equipment and its C2 architecture. For the aircraft, for example, this involves conceiving their equipment with an ASI vision in terms of the precision of optronic sensors, the capacities for ROEM/ROIM integration, SATCOM and FMV transmission in real time, tracking friendly forces (BFT) and the precision of the extraction of positional information and of strike. In the field of C2 architecture it involves having available the organisation, the CIS tools and robust, high-performance GIS[14] served by trained personnel, ensuring the provision on the one hand of coherence and integrity of the ASI chain (JFAC HQ[15] – Air Support Operation Center – FAC), and on the other hand the exercise of command and the operation of the ground-based part of the air component: projectable air bases, construction engineers, air support teams, tactical detection and control teams, ground-to-air systems, defence and protection, deployed elements and mobile tactical detachments, which enable COMJFAC to optimise the air action he controls and ensure his freedom of action.

ASI is thus a major issue in current and future operations. But it is also a structural project for the Air Force, closely linked to the very identity of the airman. In fact, the airman is not solely he 'who pilots an aeroplane' or more generally, someone who goes up in the air. That is not exclusive, far from it. The increasing abilities of drones could result in more and more airmen piloting from the ground. In reality, the airman is above all someone who optimises air operations, following the example of Charles de Rose,[16] who created the first fighter squadron in the world at the Battle of Verdun, in response to the injunction of General Petain: "De Rose, I am blind! Sweep the sky for me." Up to then, fighters operated alone, dispersed over considerable fronts and following procedures which owed more to poachers seeking game than to defined tactical principles. Commandant de Rose, a precursor of ASI, was able to regroup in order to gain the desired effects.

Today, it is no longer a question of air superiority, or of having mastery of the air, in order to gather intelligence for use by ground forces, but of use and optimisation of air power to keep a step ahead of the enemy of the moment. The Air Force has both the assets and the expertise to perform this essential role for the success of operations within a joint force framework and spirit.

(14) Information and communication systems and geographic information systems.

(15) Joint Force Air Component Headquarters.

(16) Charles de Tricornot de Rose (1876-1916), creator of fighter aviation and its doctrine, holder of military pilot's licence No. 1.

When France Arms its Drones

Jean-Baptiste Jeangène Vilmer

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Only three countries currently use armed drones: Israel, the United States and the United Kingdom. Others are developing them, among which China, Russia, Iran, India and Pakistan, whose Burraq armed drone entered service on 13 March 2015. These machines are missile-fitted surveillance drones, which, because they are slow, not stealthy and relatively unmanoeuvrable, can only be used in conquered airspace. The next generation of drones, called combat drones, of which only demonstrators currently exist (Neuron, Taranis, X47-B and Dark Sword), is aimed at rectifying these vulnerabilities. By nature armed, they should enter service after 2020.

France does not possess any armed drones, but it does have Reaper, which if modified can be armed. Reaper drones are currently deployed in Niamey (Niger), as part of Operation Barkhane. This article defends the armament of our Reapers and prepares the ground for a doctrine of use and a campaign of public diplomacy.

Why should we arm our drones?

Armament of drones has become a widespread and irreversible trend because of the numerous advantages it offers, even if it raises legitimate concerns over proliferation. Above all it offers a saving in resources, since our unarmed drones are the sensors, which transmit information to the shooters, the combat aircraft, who follow on to carry out the strike. Armed drones carry out both functions, thereby reducing the cycle and economising on manned aircraft and also on any search and rescue mission which would have to be conducted to recover the pilot, were there to be a crash.

This in no way calls into question the need for combat aircraft because the drone, which is vulnerable to many things (including weather, air superiority, manoeuvrability, speed, power and reliable satellite links), can only replace it in very specific situations, and especially because even if we have air supremacy, the two do not perform the same tasks. For one thing, they do not carry the same

armament, and therefore do not have the same effect. For another, the combat plane has very broad reactivity over an extended theatre, whereas the drone's reactivity is localised over a much more limited area—from which is derived long-term 'permanence', the key characteristic of the drone.

Thus a drone fitted with a narrow-field sensor in this precise case allows the cycle to be reduced, time to be saved and discrimination to be improved since being unarmed it depends on the availability of an aircraft to conduct the strike. But in the time period needed for the strike aircraft to arrive in the zone, the target could have moved into an environment where the risk of collateral damage is far higher. This has happened to our men, who have identified a target's vehicle in the desert, but have then had to wait for a combat aircraft to be made available to deal with it: by the time the aircraft arrived, the vehicle had moved into town. So it is that the non-armament of our drones reduces choice as to timing and place, and at the same time increases the risk to civilian populations.

It also increases the risks to our soldiers on the ground. The British quickly realised that their armed drones acted as force multipliers and protectors.(1) Even the drones used today on humanitarian missions, such as that in the Democratic Republic of Congo (DRC) under the UN mandate since December 2014, might sometimes be usefully armed in an attempt to prevent the abuses that they record.

For what use?

The Israelis and the Americans use their armed drones in armed conflicts and also outside them, to conduct targeted killings. Two US programmes arise from this: the official one of the US Air Force, which struck in Afghanistan, Iraq and Libya, and the secret one of the CIA, which conducted strikes in Pakistan, Yemen and Somalia. The latter is very much at the origin of the controversy which now surrounds the use of armed drones. The British only use theirs, which are operated by the Royal Air Force, in armed conflict situations. The question now is to know whether we can allow ourselves to do the same, because we are confronted by ever more complex situations, particularly in the Sahara-Sahel band.

The difficulty is general: the definition of armed conflict is ambiguous, a declaration of war has never been a good indicator of a state of war (France has never declared war since the Second World War), and the evolution of conflicts, particularly with the multiplication of transantional non-state armed groups (such as ISIS and Boko Haram) puts many situations into very grey areas. Beyond those considerations, if our target crosses a border into a state with which we are not in a situation of armed conflict, would we refrain from hitting it if the opportunity

(1) *The Security Impact of Drones: Challenges and Opportunities for the UK*, Birmingham Policy Commission, October 2014 (www.birmingham.ac.uk/Documents/research/policycommission/remote-warfare/final-report-october-2014.pdf).

to do so presents itself? And if we strike, do we do so with or without the consent of the state in question?

In a confused regional context, to adopt the British rule, that the RAF only uses its armed drones in an armed conflict situation, might not be enough. In exceptional cases we might be led to conduct targeted killings outside a recognised armed conflict. Such strikes could not be attributed to the French Air Force which, like the RAF, can only intervene in official theatres, so they would be attributed to the DGSE, the Directorate for external security. While the killing of Ahmed Abdi Godane, the then chief of Al-Shabab, was by a US missile on 1 September 2014, it was made possible by intelligence supplied by the DGSE about the vehicle in which he was travelling. If the DGSE had been able to operate an armed French drone based in Djibouti, for example, it would have acted itself. So why not give it the means to do so?

This occasional recourse to targeted killing would pose legal problems. Regarding jus ad bellum, the Americans claim that they are in a non-international armed conflict (NIAC) against Al-Qaeda and its associated forces, but a NIAC without defined territorial bounds, or transnational, which allows them to strike anywhere. In this the United States calls upon a certain interpretation of self-defence, which in principle we do not share. Against this doctrinal approach, we prefer an approach by exception that recognises the illegal character of the action whilst justifying the exceptional violation of law in certain operations. It must always be stressed that such exceptions do not create any precedent. This was argued for the 'illegal but legitimate' intervention in Kosovo in 1999, and that into Syria would have been justified in the same way, had it happened in September 2013.(2)

With regard to jus in bello, in principle the Americans and Israelis have quite strict criteria—imminence of threat, primacy of capture, conformity to international humanitarian law—but they are interpreted rather loosely. In reality the criterion of imminence disappears since, according to the official US interpretation, which is in any case not consensual, this condition does not require the government to know that a specific attack will take place in an immediate future. It could include people who plan attacks in a 'continual' manner, simply by being affiliated to 'Al-Qaeda or its associated forces'- which is not easy to prove since these organisations do not exactly issue membership cards. The replacement of imminence by affiliation removes the time element from any response.

Another problem in US policy is the practice of signature strikes, which do not target an individual who has been identified in advance (that would be a personality strike) but any group of presumed militants, based on apparently questionable behaviour. It was the increasing number of these signature strikes, for the

(2) For a defence of the approach by exception against the doctrinal approach, see Jean-Baptiste Jeangène Vilmer: *La Guerre au nom de l'humanité. Tuer ou laisser mourir*; Puf, 2012; p. 227.

most part in Afghanistan and Pakistan from 2000 onwards, which led to numerous abuses and which is largely responsible for the worldwide controversy over CIA strikes, controversy that has spilled over to the means used, that is, the armed drone. The US government has since then taken account of the counter-productive character of the industrialisation of targeted killings: there are fewer and fewer strikes (122 in Pakistan in 2010, 73 in 2011, 48 in 2012, 27 in 2013, 22 in 2014 and at the time of writing 5 in 2015)[3] and the proportion of signature strikes has been drastically reduced.

France can draw lessons from the US experience in order to define its own identity. France would in any case be more discreet and parsimonious in the use of its armed drones for the simple reason that it would have very few of them—bear in mind that we have 3 Reaper: the RAF has 10 and the USAF will have 346 by 2016. Apart from that, we recommend that France adopt a more restrictive approach to targeted killings, limited to personality strikes against high-value targets, a very restricted list of leaders of terrorist organisations we are fighting which pose an immediate and demonstrable threat to national security, and when the state in which they ate situated does not have the will or the capability to eliminate the threat.

Why communicate?

The armament of our drones, which would have such advantages, has not happened because there is a resistance to it which has become embroiled in a broader debate carried along by numerous NGOs, the UN and certain states (note the hypocritical, yet repeated complaints by Pakistan). In the United States, the population is broadly convinced of the legitimacy of drone strikes but there is nevertheless a persistent and even growing proportion of opponents.[4] The Senate Select Committee on Intelligence is also demanding greater transparency on the procedures and standards that control targeted killings. This opposition has demonstrated its value, since it has pushed President Obama to rein in his policy on Pakistan, recognise (ie publicly) the existence of the CIA programme and promise a certain number of changes, among which a military preference—in other words, for strikes to be conducted by the armed forces.

This debate has already raised concern in the European Parliament, which is 'seriously preoccupied by the use of armed drones outside the framework of international law',[5] and to believe that it does not worry the French public would be burying one's head in the sand. The rare opinion polls show that the French are more opposed to drones than the Israelis and Americans of course, but also more

(3) New America Foundation (http://securitydata.newamerica.net/drones/pakistan/analysis.html).

(4) Tom McCauley: *US public support for drone strikes against asymmetric enemies abroad: Poll trends in 2013*, in *Dynamics of Asymmetric Conflict*, vol. 6 No 1-3, 2013; p. 90-97.

(5) In its resolution of 27 February 2014, adopted by a very large majority.

than the Pakistanis, Indians, Chinese, Nigerians, British, Poles and the Germans, for example.(6) One only has to read the press and watch TV to be aware that the debate exists and that it is largely due to a double linking of ideas—on one hand the armed drone and the CIA's use of it (the Chamayou syndrome)(7), and on the other the armed drone and autonomous lethal weapon systems (the Terminator syndrome).(8)

Resistance is both external (public opinion) and internal, because within the armed forces there is a cultural split between at least two military ethics, some contending that there is a problem in remotely waging a war in which the soldier has no need to show physical courage, others that there is none. To gain the measure of this double resistance it might be useful to arrange some opinion polls on the idea of arming our Reapers and to bring the whole of our armed forces into the discussions with specialists who are already persuaded of the need. Our policy in these matters must be better coordinated, firstly within the Ministry of Defence, then with other ministries.

How to communicate?

The priority has naturally to be to demystify the machine by explaining again and again what a drone is, and what it is for, and by countering the anti-drone propaganda, which is proliferating because of ignorance and paranoia. If we did arm them, we would have to stress what separates us from the Americans sufficiently well to refute the confusion of ideas in the public mind, but without doing it too head-on so as not to damage diplomatic relations. It would also be necessary to give a reminder that when used in an armed conflict these machines, which are piloted by genuine Air Force pilots, are subjected to the same rules of engagement and the same constraints as any other aircraft.

After that we have the issue of targeted killings: we have to consider the measures needed to satisfy the democratic requirement for transparency and responsibility. Firstly, communicate either before a strike on the processes and standards of targeting (who decides what, how and to what criteria), or after a strike has occurred (identity of the person, cause of the strike—which means what constituted the immediate threat, why it was not possible to capture the person or neutralise him any other way). In a letter to the US Federal Prosecutor, three members of the Senate Select Committee on Intelligence made a distinction between

(6) *Pew Research Center: Global Opposition to US Surveillance and Drones, but Limited Harm to America's Image*, 14 July 2014, p. 5 (www.pewglobal.org/2014/07/14/global-opposition-to-u-s-surveillance-and-drones-but-limited-harm-to-americas-image/).

(7) Jean-Baptiste Jeangène Vilmer: *An Ideology of the Drone*, in *Books and Ideas*, 6 November 2014 (www.booksandideas.net/An-Ideology-of-the-Drone.html).

(8) Jean-Baptiste Jeangène Vilmer: *Terminator Ethics: Should We Ban 'Killer Robots'?*, in *Ethics and International Affairs, Online Exclusives*, 23 March 2015 (www.ethicsandinternationalaffairs.org/2015/terminator-ethics-ban-killer-robots).

the list of strategies to combat terrorism (the playbook), of which several sections should stay secret, and the list of rules (the rule book) that the government follows in such situations and which should always be available to the American public.[9]

Secondly, we might also imagine the setting up of systems of monitoring. Two types are possible[10]: on the lines of the US Foreign Intelligence Surveillance Act (FISA), one which would authorise strikes before they take place, except in urgent situations, which would be analysed afterwards—in either case, the deliberations would be classified secret. Or possibly on the lines of the Israeli model, which has been operating for several years: on demand of the Supreme Court a thorough post-strike enquiry into a targeted killing is conducted by an independent body.

The problem with these measures of course is that they can affect military effectiveness. The more the process and norms are precise and known, the better able the adversary is to bypass them and restrict our action. Because of this, there is great value in 'strategic ambiguity', which means not being clear about one's position and which has a deterrent effect in this and many other fields. On the other hand, excessive ambiguity, a lack of information, risks arousing suspicion and even hostility with regard to an ill-understood policy. The British have grasped this and recommend keeping the public informed as much as possible.[11] The challenge then is to make available certain information in order to increase transparency and a feeling of legitimacy without at the same time affecting national interests. Reveal enough to reassure, but not enough to handicap operations.

(9) Ron Wyden, Mark Udall and Martin Heinrich: *Letter to the Honorable Eric Holder*; 26 November 2013 (www.wyden.senate.gov/download/?id=C48CD5E5-EF15-4A44-A1BF-2274E5B1929A&download=1).

(10) Diane M. Vavricheck, *The Future of Drone Strikes: A Framework for Analyzing Policy Options*, *CNA Occasional Paper Series*, September 2014 (www.cna.org/sites/default/files/research/COP-2014-U-008318-Final.pdf).

(11) *The Security Impact of Drones*, op. cit., p. 83.

A Challenge for French Deterrence: Modernising the Airborne Component

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Consideration of the modernisation of the French nuclear deterrent needs to take full measure of the significant changes that are occurring today in order to look ahead towards tomorrow's likely strategic stakes and challenges, and to develop techniques which will continue to guarantee the credibility of the deterrent message. The speech by the President of the Republic at Istres on 19 February 2015 set the scene for this exercise and gave a statement of the international strategic context. The latter needs to be put into perspective in order to understand the challenges presented by current developments, particularly in view of the renewal of the airborne component of the French deterrent and the choice between modernisation based on stealth or hypervelocity.

Evaluating the strategic context in 2015

After the publication of the 2008 *Livre blanc*, which revealed that a break with the taboo that use of nuclear weapons represents was improbable, and that of 2013 which spoke of an increased risk of uncontrolled escalation leading to a break with that same taboo, the President of the Republic offered two observations on the same lines: states which up to now had possessed nuclear weapons and which professed the urgency of their disarmament, have actually increased their capability with the development of new nuclear components. In parallel, he said, tactical arsenals are being strengthened, which leads to the fear of the threshold of nuclear use being lowered.(1)

In November 2014, the US Secretary of Defense, Chuck Hagel, announced billions of dollars of additional funding to be allocated to maintaining and modernising the US nuclear arsenal. He said, *while our nuclear arsenal remains safe, secure and effective today, the reports tell us we must take action now in order to ensure*

(1) *Discours sur la dissuasion nucléaire – Déplacement auprès des forces aériennes stratégiques*, Istres, 19 February 2015 (www.elysee.fr/declarations/article/discours-sur-la-dissuasion-nucleaire-deplacement-aupres-des-forces-aeriennes-strategiques-istres-3/).

that remains the case in the future,(2) which is consistent with the colossal effort being undertaken to renovate the infrastructure dedicated to this research in the United States, and is far from the sentiments in a speech in Prague on 5 April 2009.(3) The most recent SIPRI studies identify two types of effort being undertaken in nuclear states: one relates to the sophistication of the weapons—*USA and Russia continue to reduce their arsenals but at a slower pace than a decade ago and have extensive modernization programs underway for their remaining nuclear delivery systems, warheads, and production facilities*—and the other to an increase in arsenals—*China, India and Pakistan are (…) expanding their nuclear arsenals*.(4)

To these various defence policy directions we need to add the relatively new fact that certain state actors have no hesitation in raising the issue of nuclear deterrent. It is of little surprise that North Korea threatens this regularly in its communication,(5) but perhaps more surprising is that Russia reiterated the question after the events in Ukraine. On 29 August 2014, when reminding everyone that Russia was one of the greatest nuclear powers, President Putin said that his country never stops strengthening that potential and will continue to do so for the future, not to threaten anyone in particular, but so that the country might feel safe, live in peace and have the ability to put its economic and social plans into action.(6) A documentary transmitted in Russia on the TV channel *Rossia 1* on 15 March was another opportunity to mention the nuclear option specifically, '*for which we are ready*', he said.(7) On the same date, Keith Payne, in a tribune in the *Wall Street Journal*, wrote: *In January prominent Russian journalist Alexander Golts warned, 'The West has forgotten how it had used nuclear deterrence to coexist with the Soviet Union. Now it will have to open up that playbook once more*'.(8) In writing this, he reminded us that peaceful coexistence also incudes the art of showing that we do not lower our guard.

Despite its uncertainty, the strategic context does show the return of the central position of nuclear deterrence for state actors who have it, and that they

(2) Dan Lamothe: *Pentagon to overhaul nuclear weapons programs following reviews* in *Washingtonpost.com*, 13 November 2014 (www.washingtonpost.com/news/checkpoint/wp/2014/11/13/pentagon-to-overhaul-nuclear-weapons-programs-following-review/). On 15 March 2015, Keith Payne writing in the *Wall Street Journal* gave the figure of '$15.9 billion nuclear modernization budget for fiscal year 2016, up slightly from 2015' for the Department of Defense (www.wsj.com/articles/keith-payne-the-nuclear-utopians-are-wrong-1426457846).

(3) See William J. Broad and David E. Sanger: *US ramping up major renewal in nuclear arms*, in *New York Times*, 21 September 2014 (www.nytimes.com/2014/09/22/us/us-ramping-up-major-renewal-in-nuclear-arms.html).

(4) See the paper Nuclear Forces on the web site of *Stockholm International Peace Research Institute* (www.sipri.org/research/armaments/nuclear-forces). It is worth noting that China is both modernising and increasing the number of its weapons.

(5) On this, see Emmanuel Nal: *Doctrines nucléaires : spécificités du Pakistan et de la Corée du Nord*, in *Revue Défense Nationale* No. 776, January 2015, p. 50-55.

(6) Leparisien.fr, *Nous sommes une puissance nucléaire : le sous-entendu de Poutine*, 30 August 2014.

(7) Isabelle Mandraud: *Poutine dit avoir agité la menace nucléaire en Crimée*, in *Le Monde.fr*, 16 March 2015 (www.lemonde.fr/europe/article/2015/03/16/poutine-dit-avoir-agite-la-menace-nucleaire-en-crimee_4594166_3214.html).

(8) Keith Payne: *Why the nuclear utopians are wrong*, in *The Wall Street Journal*, 15 March 2015 (www.wsj.com/articles/keith-payne-the-nuclear-utopians-are-wrong-1426457846).

are bent on developing it in an asymmetric manner—research into stealth and hypervelocity contributes to illustrate this option—and/or symmetrically, with increased numbers of launch vehicles and warheads.

Challenges in modernisation of the air component

Permanence and reactivity, and also accuracy and power: the air component offers these precious functions that complement those of the ocean-going strategic force. The presidential speech at Istres highlighted one in particular. The President said that he could not exclude the possibility that an adversary might be mistaken about the boundaries of France's vital interests, and wished to give a reminder that France could, as a last resort, make known its will to defend its vital interests by giving a warning of a nuclear nature, whose objective would be to restore deterrence.(9) The visibility of the air component forms part of the credibility of the deterrent,(10) and the performance of the ASMP-A missile and of the aircraft that carry it give the political power a massive retaliation strike capability or, on the other hand, an alternative which could avoid the 'all or nothing' choice in response to an attack on the nation's vital interests.(11) The ASMP-A renovation programme has a planned life of 25 years and went to the study stage in the summer of 2014, with an intended start date at the beginning of the 2020s, when it will continue to be carried by Rafale. The programme will deal with obsolescences and will incorporate minor improvements in certain aspects of the missiles' performance in order to adapt them to known anti-missile missiles, thus increase the probability of success when fired.(12)

Beyond the timescale of this programme will be the successor to ASMP-A for which studies have already begun. The President indicated on 19 February that for the successor, the most demanding technologies will be called upon in order to be ever more effective in the fields of speed and stealth. During the colloquium marking 50 years of deterrence at the Ecole Militaire on 20 November 2014, the Minster of defence had already announced that a number of audacious designs are to be be explored, which call upon the forefront of technological development in the areas of stealth and hypervelocity.(13) These speeches repeat one of the major

(9) Op. cit., *Talk on nuclear deterrence*, 19 February 2015.

(10) 'If I can see it by means of one of our satellites, then others can, too. This capability to increase alert state and to deploy progressively is thereforte visible. That said, we know when the satellites pass overhead and can therefore choose the time slots in order to move undetected.' the words of General Patrick Charaix, Commander of the strategic air forces, on nuclear deterrence at a hearing of the National defence and armed forces committee, 15 April 2014 (www.assemblee-nationale.fr/14/cr-cdef/13-14/c1314042.asp).

(11) *Ibid*.

(12) *Ibid*, General Denis Mercier.

(13) *Discours de clôture du colloque pour les 50 ans de la dissuasion*, 20 November 2014 (www.defense.gouv.fr/ministre/prises-de-parole-du-ministre/prises-de-parole-de-m.-jean-yves-le-drian/discours-de-cloture-du-colloque-pour-les-50-ans-de-la-dissuasion) and *Cahier de la RDN* (*50 ans de dissuasion nucléaire : exigences et pertinence au XXIe siècle*), April 2015.

points of consideration of the ASN4G cruise missile, which will replace the ASMP-A (with a speed of Mach 3 and a range of some 400 to 500 km), by highlighting the alternative and debate between stealth and hypervelocity. The 12 July 2012 report by the Senate committee for foreign affairs and defence mentioned two projects under study: Camosis, a development of Onera's[14] Mars project, which should fly at a 4,000 to 5,000 kph and double the performance of the current ASMP-A, and Prométhée, a super ramjet missile, with a speed of some 7,000 to 8,000 kph,[15] said to quadruple the current missile's performance.[16] A more recent report from the National Assembly committee on national defence and the armed forces, date 7 October 2014, states of these two projects that one focuses on improvement in stealth and the other on speed with the aim of reaching hypervelocity, which means Mach 7 or 8 (around 8,600 to 9,800 kph), which would make the missile difficult to intercept by enemy defences.[17]

To understand the challenges of this choice, we need to look at the scale of the technological problem in relation to developments in detection capabilities (such as the AESA system and passive radars), in the context of widespread exploration into hypervelocity by other strategic players, and also in consideration of the implications for future carrying vehicles.

Stealth and hypervelocity: scale of the problem in 2015

As it happens, a debate between stealth and hypervelocity could have some surprises in store: why one more than the other, and why not both, for example? There are many reasons for that. Quite apart from the cost of development, each option has characteristics whose technical compatibility is far from certain at high levels of performance. Stealth requires particular materials and designs which do not necessarily suit the demands of hyper-speed, given the high temperatures to which the aerobic missiles will be subjected.

The stealth of a carrying vehicle or weapon is defined by the difficulty of its detection be the adversary's defence systems. Developing stealth of an aerodyne requires work to reduce the traces that characterise it and that constitute its **signature**. These may include its radar reflective surface area (or surface equivalent radar—SER), its magnetism, and its thermal and acoustic output. Two types of modern radar device tend to make even more complex any successful stealth design: the AESA (Active Electronically Scanned Array) and passive radars. The main

(14) The national office for aerospace study and research.

(15) Jean Guisnel: *La dissuasion selon François Hollande*, in *Le Point.fr*, 20 February 2015 (www.lepoint.fr/editos-du-point/jean-guisnel/la-dissuasion-nucleaire-selon-francois-hollande-20-02-2015-1906586_53.php).

(16) *L'avenir des forces nucléaires françaises (Rapport d'information No. 668)* ; Commission des affaires étrangères et de la défense du Sénat, 12 July 2012 (www.senat.fr/rap/r11-668/r11-6681.pdf).

(17) Geneviève Gosselin-Fleury and Philippe Vitel: *Mission d'information sur le contrôle de l'exécution des crédits de la Défense pour l'exercice 2013 (Rapport d'information No. 2249)*; Commission de la défense nationale et des forces armées, 7 October 2014 (www.assemblee-nationale.fr/14/rap-info/i2249.asp).

development in new generations of SAM (Surface to Air Missile) systems is without question the rapid introduction and widespread use of AESA radars. Where older ones worked on a single frequency and waveform, these electronically scanned radars allow for rapid frequency changing, which leads to extension of the spectrum by frequency evasion, a technique known as *Frequency Hopping Spread Spectrum*. This gives a considerable increase in the rate of calculation and allows the vast amount of data received from the electronic scanning to be taken into account.(18) The spreading of the spectrum and the increase in the angle scanned by the radar in turn allow an increase in the range and accuracy of the data received and also the ability to track several targets simultaneously and independently. In an attempt to fox AESA systems, jamming has to be applied to a far broader spectrum of frequencies, which then compromises stealth.

To this constraint must now be added that of **passive radars**, which do not have their own transmitters, and are therefore silent (in radar terms), which makes them highly discreet.

The passive stealth of aerobic vehicles depends on the use of special materials and specific geometry, and is based upon avoiding very precise waveforms, mainly within the X band (8-12 GHz) of the EM spectrum.(19) It was not originally devised to counter a multi-static radar system—that is, one in which there are several transmitters physically separated from the receiver. Even if the applied stealth technology manages to reduce the signature for one frequency, the vehicle may still be detected, since reduction of signature in one band of frequencies can lead to a much greater on in another part of the spectrum. The physics of metric and ten-centimetre wavebands (30 to 500 MHz—more commonly known as UHF and VHF), will naturally give rise to increased SER when in resonance with the vehicle, quite independently of the latter's design or the material from which it is constructed. The use of VHF waves by TV aerials might easily lead us to imagine an important role for passive radars in this debate on the future effectiveness of stealth.(20) In parallel to that, the effectiveness of active stealth, in which a signal of the same frequency as the radar is sent back to it, can also be called into question by the number of transmitters which, remember, are separated from the receiver. To fool the radar, appropriate signals have to be sent back to each of those transmitters independently. With stealth, therefore, apart from the cost of programmes, the defence is likely to steal a decisive advance on the attacker: the example of passive radars, which, incidentally, cost little, illustrates the multiplicity of parameters to be dealt with if there is to be hope of escaping detection

(18) Corentin Brustlein, Étienne de Durand and Elie Tenenbaum : *La suprématie aérienne en péril – Menaces et contre-stratégies à l'horizon 2030*; CESA, La Documentation française, 2014; p. 75-76.

(19) *Ibid*., p. 77, quoting Arend Westra: *Radar versus Stealth. Passive Radar and the future of US military power*, in *Joint Forces Quarterly*, No. 55, 2009; p. 136-143.

(20) *Ibid*., p. 77-78, quoting Carlo Kopp: *Evolving technical strategy in advanced air defense systems*, in *Joint Forces Quarterly*, No. 57, 2010 ; p. 86-93.

for a sufficiently long time to fulfil a nuclear mission. So if it is becoming more and more complex to decoy the defences, one might try to take them by speed. This option is to a great extent favoured and shared by nuclear weapons states through research into hypervelocity.

It is envisaged that hypervelocity will be achieved by use of what are called ramjets, or even super ramjets (scramjets). A ramjet uses the principles of a conventional turbojet (compression of air on entry, heating the air by burning fuel in it and exhausting of the even more compressed air at very high speed thereby creating thrust), but uses fewer moving parts. A scramjet is similar but the air is at a much higher speed on entry—already supersonic. The United States has incorporated its research on hypervelocity into a programme called *Prompt Global Strike*, which aims to offer the ability to hit any target anywhere in the world from US soil, and at speeds which would foil any capability to react. In November 2011, a trial said to be conclusive was conducted with HTV-2, the Hypersonic Technology Vehicle No.2, but a further test from Alaska in August 2014 was a failure: the missile exploded a few seconds after launch.

China is also committed to acquiring this technology, and conducted three trials in 2014, on 9 January, 7 August and 2 December, in the development of its hypervelocity missile, WU-14. The last of these trials caused somewhat of a stir with the United States, ever attentive to such experimentation. *The South China Morning Post* announced after the December test that: *The system is designed to be carried by a ballistic missile to an undisclosed suborbital altitude and then released. The vehicle then dives towards its target at speeds of up to Mach 10, or more than 12,000 kph. The technology is expected to be capable of penetrating any existing defence system with nuclear warheads*.(21)

In April 2014, the Chief of the air staff (CEMAA) stated to the national defence and armed forces committee that mastery of hypervelocity is now a central issue. In the United States, Russia, China and India—all countries in which the need for modernisation of the airborne nuclear component is not even questioned—experimental programmes are being conducted on hypervelocity vehicles. Given that, France cannot remain inactive.

France, the ramjet and the carrying vehicle

During the same hearing, CEMAA added that France could not simply draw a line under 50 years of research and abandon studies in which it has a definite technological advantage. An article in a 1994 edition of *Libération* spoke of the performance of a ramjet that had reached Mach 6, as well as the objective to equip future horizontal take-off space launchers with super ramjets using

(21) Mimi Lau: *China mounts third hypersonic 'Wu-14' missile test*, in *South China Morning Post*, 6 December 2014 (www.scmp.com/news/china/article/1656748/china-mounts-third-hypersonic-wu-14-missile-test-us-report-says).

'hypersonic combustion' (hydrogen has twice the thrust of kerosene)… and by 2020 to 2030 to possess hypervelocity ground attack missiles that would move at over 8,000 kph. With stealth (transparency to radar) no longer being enough to fool the enemy, the article said that according to strategists only a very high peak speed would allow penetration of lines of defence.(22) France has for many years worked on ramjets: René Lorin before the First World War; Leduc, who designed aircraft between 1945 and 1958; and the Griffon, which could fly at Mach 2, at the end of the nineteen fifties. The ASMP-A (Mach 3), and the European long-range air-to-air missile Meteor, intended to fly at Mach 4, are the contemporary incarnations.

For all that, achieving hypervelocity by means of a super ramjet (scramjet) will have consequences on the dimensions and weight of the next launch vehicle, which in turn will have extremely demanding consequences on the future carrying aircraft.(23) Whatever system is chosen will have to be sufficiently reliable and adaptable to ensure penetration of enemy defences for several decades, during which regular progress will continue to be made in the field of anti-missile defence.(24) CEMAA has also underlined this point when speaking of the two options under study—a new generation combat aircraft and a heavy transport. Hyper velocity might well lead to a complete change in the shape of the airborne component of the French deterrent.

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The battle between the sword and the shield is an illustration of the theory of games, in which offensive and defensive measures try in turn to outdo the other in order to reduce the effectiveness of each. In following the general lines of this theory, deterrence is now in a position where its effectiveness today and into the future seem closely linked to mastery of hypervelocity. The Minister of defence stated that, 'the choice of the future weapons system, composed of the ASN4G missile and a carrying aircraft yet to be defined, represents a major challenge for the armed forces.'(25) The challenge is worth it for the credibility of the deterrent of course, but also to maintain the continuity of a remarkable store of French know-how that the necessary research will finance and progress, and which will certainly lead to spin-off conventional and civilian applications.

(22) Philippe Testard-Vaillant: *Le moteur qui décoiffe*, in *Libération*, 20 December 1994 (www.liberation.fr/sciences/1994/12/20/le-moteur-qui-decoiffe_116700).

(23) *Rapport d'information* (information report) *No. 668*, *op. cit*.

(24) *Rapport d'information No. 2249*, *op. cit*.

(25) *Discours de clôture du colloque pour les 50 ans de la dissuasion*, 20 November 2014, *op. cit*.

Challenges in the Use of Space for Air Operations

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The diversity of recent external operations, which include *Harmattan* in Libya, *Serval* and then *Barkhane* in Mali, *Sangaris* in CAR and *Chammal* in Iraq, has put the reactivity and preparation of French forces to the test. The forces face highly mobile enemies who are frequently unconventional in the way they operate. French air forces have been rapidly mobilised for each of these operations, in each case making use of their reach, reactivity and great mobility. More generally, an air force is often today the arm of choice within the range of assets available to the political power in order to make its initial decisions felt. Air operations are therefore establishing themselves at the same time as they are increasingly making use of space facilities.

A link between space and air operations, begun in the nineteen nineties

Since the beginning of the nineteen nineties, the increasing use of space has been the symbol of a broad effort to adapt military assets to new strategic conditions. Space-based systems were at the time expected to contribute to the acceleration of the rhythm of operations by reducing the OODA cycle (Observe, orientate, decide, act), which was then being applied to the increased use of air power.

That would lead, it was said, to a revolution in military affairs. Such visions were somewhat excessive. At the end of the nineteen nineties, General Fogleman, former Chief of Staff of the US Air Force, declared that during the first 25 years of the next century, we would in real time be able to find, identify and target anything of importance that moved or existed on the surface of the planet. He also strongly underlined the decisive advantage of aerospace forces because of the speed, range, agility and altitude of aircraft and spatial systems combined with their capabilities in information handling, surveillance and reconnaissance, which allow them to have considerable effect from afar.(1)

(1) See original quotation in Colonel Robert C. Owen: *Aerospace Power and Land Power in Peace Operations, Towards a New Synergy*, in *Airpower Journal*; Fall 1999; pp. 4-22.

The acts committed in recent years by numerous paramilitary groups in Africa and the Middle East have shown that in fact we still have some way to go to achieve such capability. From the first Gulf war in 1992 to the conflicts in Central Europe a few years later and then Afghanistan from 2000, we have seen that capability in space, which up to then had been largely directed towards strategic intelligence gathering, has progressively become a distinct and separate factor in operational superiority. On of the symbolic examples of this growing relationship lies in the use of guided munitions—within which the air arm clearly has the major place. The following table shows that use of American GPS has rapidly become a new standard in the use of guided munitions from aircraft:

Conflicts	Total munitions	% guided munitions	% munitions guided by laser (without satellite support)	% munitions guided by GPS
Iraq 1991	238,000	4 % (9,500)	4 %	0 %
Serbia 1999	23,700	32.5 % (7,700)	29.5 %	3 % (700)
Afghanistan 2002	22,000	59 % (13,000)	27 %	32 % (>7,000)
Iraq 2003	30,000	66.5 % (19,950)	39.5 %	27 % (8,100)

Increase in the use of guided munitions since 1991(2)

The practice has greatly expanded since then and the rate of use of GPS guidance for munitions by all the coalition forces in current operations against ISIS in Iraq is now approaching 100 %.(3)

The contribution of space assets to air operations

The most recent national operations (including *Barkhane*) show every day that space assets are contributing to an ever-greater range of functions which themselves often have to put up with limited means.

The greatest demands for the Air Force (and others) are on logistics. For example, the operation in Mali, which today has Niger as its rear base, is very demanding because of its enormous geographical area: the establishment of satellite telecommunications facilities clearly contributed to the flow of events. Such assets allow large areas to be held in a coordinated manner, and without them

(2) Sources (compiled and recalculated) from Peter Hayes: *The Future of Military Space*, in *National Security for the 21st Century – Balancing our National Requirements*, Dwight D. Eisenhower National Security Series, Washington D.C., The Eisenhower Institute, February 2004; and Lewis Jeffrey: *What if space were Weaponized? Possible Consequences for Crisis Scenarios*, Washington D.C., Center for Defense Information, July 2004, 36 pages.

(3) This is essentially what was said in April 2015 by Major Kim Vibe Michelsen, representing the US Combined Joint Task Force for Operation Inherent Resolve against ISIS (http://newscentral.exsees.com/item/b82e16eb14a88770e859c9589314bbed3c424742384344f2662771ac49160d5f).

France would find it impossible to conduct such operations at the strictly national level. The existence of a capability to deploy air assets (as is today being done from Niamey) also relies on the effectiveness of the networks that the forces can establish over long distances. It follows that these networks benefit directly or indirectly from satellite assets.

Before even committing to an operation, its rapid and efficient planning is a condition for success. Here again, space plays an increasing role and directly shapes a country's ability to intervene on its own initiative, particularly once it starts using its air power. It all starts with knowledge of the theatre of operations, updating of maps and charts, of potential targets and so on. French observation satellites have given a decisive contribution to this planning activity: Helios, and also the Pléiades satellites (partly intended for military use) contribute to knowledge of the terrain in a much-reduced timescale (read 'weeks'—as in Mali, for example). Such knowledge would be unobtainable under the same conditions by other means. The agility of new generation satellites—that is, their flexibility in field of vision—and their productivity, amounting to several hundred images per day, have changed forever the approach to operations.

To conduct air operations, thorough knowledge of enemy air defences is also needed. The importance of this will clearly not be the same for every adversary, but many countries now have modern anti-air defences, which can complicate the task. The action in Libya had to take this into account in particular, and any intervention into Syria would obviously impose even tighter constraints. France has been conducting experiments on listening from space since the mid-2000s, with the Essaim and Elisa programmes, and operational assets are planned for 2020 onwards with the Ceres project. Such capability is irreplaceable if one is to gain better knowledge of the potential adversary. Listening satellites ensure constantly updated knowledge of enemy defences and modes of use in times both of peace and of war. In other words, they offer a continuous function which is difficult to guarantee by other means. They also cover the geographical depth necessary for those lands it would by definition be difficult to cover without risk.

The growing reactivity of space assets also directly supports the conduct of operations once they have started. Whether in the targeting phase, or in rapid post-bombing assessment of damage, observation satellites become more relevant as their flexibility increases. Their capacity to gather quickly the necessary imagery, and the progress made in the distribution of images to the operational levels, are a demonstration of the advances made in just a few years. Shortening the OODA loop has become a reality, to the extent of being able to replan missions in flight. Such flexibility is essential to the success of modern operations. It is perhaps worth noting in passing that this increased speed follows the natural evolution of society, itself driven by the speed of information made available by the media, which make extensive use of satellite communications. Growing use of drones will make further calls upon satellite capabilities, be it for their remote piloting or for transmission

of the information gathered by these aircraft. More generally, the increasing complexity of the instruments and detection devices carried by all aircraft will result in increased need for telecommunications, which satellites will have to supply—at least, in part. It is not a question here of trading space and non-space capabilities against each other: modern conflict demands the collaboration of both, in order to collect and transmit the mass of information.

Tomorrow's challenges?

The development of space technology, and the experience acquired in using it since the Gulf war, has led to its increased use on the ground. Even if numerous doubts may be cast on their supposed infallibility, the use of satellites has proven its military worth from the continuity of intelligence to launch of precision munitions, not forgetting the capability it offers to modify airborne missions at the last moment, or even en route to the target.

Space is well established as a force multiplier: in particular it increases the means for power projection. It is no longer impossible to imagine transmitting real time information to each echelon of command about the layout of enemy systems, or even to boost the effectiveness of individual military action. We now know that bringing together intelligence (observation and listening) and satellite positioning and guidance confers a decisive advantage. Such a development for air operations will lead naturally to much greater integration of space-based communications in aircraft—for example, for real time transmission of images, of the enemy situation or even for the programming of countermeasures. Furthermore, the increasing use of drones will make greater and greater demands on the need to communicate by satellite in the bands reserved for military communications, both for their operation and for the transmission of data.

And yet each of these intervention situations is surrounded by a range of uncertainties, often felt as soon as air operations begin. There is a sort of alchemy unique to each conflict and created by those who act within it, to which forces and operations must adapt constantly. Spatial assets must be able to respond to these constraints and to the new needs which they generate. Spatial systems will doubtless improve the flexibility in use and reactivity of air forces in particular. Planning demands constant updates on every situation in timescales that are coherent with the reactivity of air action.[4]

All this will be achieved above all by constant effort to improve technical systems. In parallel, we have to learn to understand and control the vulnerabilities that use of these systems present,[5] in the face of possible countermeasures that the

(4) Today's orders of magnitude mean lands of several hundreds of square kilometres can be updated in just a few days.
(5) Already widely discussed today, protection of space assets will become a major issue in the years to come.

adversary might bring to bear, such as jamming of satellite communications or navigation systems, camouflage and decoying.(6) That in turn implies that the air forces adapt their organisation and deepen their knowledge and practice in these systems in relation to other means available to them in order to get the best from them in military contexts that are ever more specialised and ever changing. But let us not fool ourselves: we are not talking solely of military performance here. Improving the contribution of space to this type of operation in reality boils down to strengthening the effectiveness of political decisions taken at the highest level, which are swift to call upon the air arm as the very first means of action the nation possesses to insist upon its political position.

(6) Not to mention IT hacking, of course, now seen as a real threat to networked systems.

Innovation in the US Air Force

Jean-Patrice Le Saint

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The US Army, the US Navy and the US Marine Corps each possess an aviation component to meet their organic requirements, but only the USAF has the full range of offensive, defensive and support capabilities to act in the air, in space and in cyberspace. It carries out five core missions: air and space superiority; ISR;(1) rapid global mobility; global strike and command and control. It operates two of the components of the nuclear triad,(2) operates the overwhelming majority of military space capabilities and contributes significantly to the national intelligence effort. Like its sister services, it fills positions required in the regional combatant commands (COCOM) and concentrates on the organisation, training and equipment of its forces. Directed by the Secretary of the Air Force (SECAF) and commanded by the Chief of Staff of the US Air Force (CSAF) it has its own budget, the programming and execution of which are controlled by Congress.

As the premier military aviation organisation in the world, the USAF projects an all-powerful image, by virtue of the range and size of its capabilities and, even before its creation in 1947, its uncontested role in conceptual, doctrinal, technological and organisational leadership. This reputation results partly from its considerable resources, but also from a permanent quest for optimisation, which sets it apart at the very heart of the Defense Department. As recognised by General Martin Dempsey, Chairman of the Joint Chiefs of Staff: "The Air Force has been certainly among the most adaptable parts of our national military instrument of power. Every Service has made some adaptations, but I would suggest that the Air Force's seems to me, in my experience, to be the most prominent, most visible, most important."

Innovation is at the heart of the ethos of the USAF. The sources of innovation are many, as are the initiatives aimed at stimulating it. Paradoxically, no agreed definition exists within the USAF of innovation, and there is no organization

(1) Intelligence, surveillance and reconnaissance.

(2) The airborne and surface-to-surface ballistic components.

charged with its overall direction and management. Innovation in the USAF is not a function, or even a job, but an objective to guide the actions of each airman. The spirit of initiative which inspires it sits uneasily with entrenched bureaucracy. Defence literature, which contains much on land innovation, has little to say on the subject in the field of aerospace. It is therefore difficult to arrive at an exhaustive description of innovation, but an overview is possible, as is a description of how the USAF intends to face its present and future challenges.

Innovation: what are we talking about?

Specialised studies in general distinguish between innovation and adaptation. Each of these may have common objectives (better effectiveness, more efficiency, risk management, cost reduction) but they occupy different time frames and do not necessarily involve the same actors.

Innovation looks far ahead, imagining the future and the ways in which it can be shaped. It is associated with long-term strategic, technical and operational prospects and depends rather on the central administration (Air Force Headquarters, the Pentagon), on partners (universities, think tanks, industry) and the headquarters of the USAF major commands (MAJCOM). Adaptation consists of improving an existing tool or the way of using it. It is rather the product of specialised tactical organisms, units or individual initiatives, and can be initiated by the chain of command.

While easy at first sight, this distinction is not totally satisfying. Futurists and planners cannot envisage the future without basing it on the present, and small changes can have major and lasting impacts. The concepts of the first laser-guided bombs or the invention of the Predator drone are examples of home-made inventions which turned out to be real game changers. For the purpose of this article, innovation and adaptation are merged, accepting that both are marked by the same search for progress, whatever the long-term aim, the subject or the level of application.

An air force resolutely facing the future

The American propensity is to seek technical solutions to operational challenges, but technological innovation is particularly essential for air and space capabilities. In the USAF this is the domain where innovation is best structured, and it is what most distinguishes it from the other Services. It is in fact, the only Service which has a Chief Scientist, a special adviser to SECAF and CSAF for scientific and technical questions. The Air Force Materiel Command, responsible for the concept, development, experimentation, acquisition and support of the Service's whole range of equipment, also oversees a specialised laboratory, the Air Force Research Laboratory (AFRL), which devotes an annual budget of $ 2.4 billion to fundamental and applied research activities. To do this, the AFRL calls on its

researchers and a number of partnership programmes. The National Defense Science & Engineering Graduate (NDSEG) programme subsidises about 220 researchers every year for an annual cost of $ 38 million, while the Science Mathematics And Research for Transformation (SMART) programme has supported 640 researchers over the last nine years, of which 89% have subsequently worked for the USAF. The Minority Leaders Program is another example of a partnership that connects the USAF with 25 universities in the context of targeted research into nanotechnologies, electro-optics and composite fabrication.

The identification and development of breakthrough technologies are either spontaneous (technology push) or originate from a proliferation of conceptual and doctrinal work (technology pull). It is one of the responsibilities of the Sub-Office of A-5/8 Strategic Plans and Requirements of the Air Staff to catalyse them. One A-5/8 Division conceives the development of the framework for the achievement of the five core missions of the Air Force, without prejudging the capabilities needed to achieve them. Another Division lists them in techno-financial terms for each of the 12 key functions which contribute to them: nuclear deterrence operations, air superiority, space superiority, cyberspace superiority, command and control, global integrated ISR, precision attack, special operations, rapid global mobility, personnel recovery operations, agile combat support, education and training. Prior to this, a third division conceives and experiments with future scenarios (Skunks, Checkmate) and the strategy to confront them (Strategy). Finally, within this division, a group of strategists, the Strategic Studies Group, independently explores important strategic trends of direct benefit to the USAF.

The Air Staff works in coordination with the major USAF Commands, each of which conducts future studies in its area, but also with a certain number of internal and external partners. Within the USAF, this is one of the vocations of the Air University, which brings together several centres for research and academic education. The Air Force Blue Horizons Project calls every year on about 15 students from the Air War College to study a forward-looking subject involving emergent technologies, the future of aerospatial and cybernetic combat, and how the USAF should prepare itself for them. Its conclusions inform future staff studies, strategic planning, Quadrennial Defense Review scenarios and the statement of requirements. The prestigious School of Advanced Air and Space Studies, the cradle of strategists for the USAF, also produces this kind of work. Outside the USAF, universities and strategic research industries also stimulate study. Among the best-known are the Mitchell Institute of Aerospace Studies, attached to the influential Air Force Association and the only think tank exclusively devoted to military aerospace questions, and the Rand Corporation, whose Project Air Force benefits each year from a research budget of around $ 45 million. Recently, the US Air Force has experimented with an innovative method of consultancy with the WIKISTRAT company which, using a virtual network of global experts, hand-selected to address

the theme in question (crowd sourcing), offers to deal with complex questions at very short notice and low cost.(3)

An air force mobilised by the current tactical needs of the war-fighter

Innovation must therefore look far ahead and seek to improve what exists. In this context, the USAF depends on its centres of technical and tactical expertise but also on each of its airmen, whether civil or military, whatever their level of responsibility.

Exercise Red Flag is one of the best examples of this innovation from the field. Instituted in 1975 to deal with the lack of training in air combat with adversaries using different equipment and procedures, a deficiency identified during the Vietnam war, Red Flag has progressively grown and adapted to the latest operational demands: at first the attack of defended ground targets, then combat in complex environments and finally widening to include allied air forces. Today, the exercise offers training to traditional and emergent partners of the USAF (Arab countries and India recently) on the whole range of air missions, in scenarios which include the increasing importance of the space and cyberspace dimensions. The lessons learned from the missions of very advanced realism are taken into account adapting tactics, techniques and procedures for USAF personnel, in flight and on the ground.

There exists in parallel within the USAF a number of fora where professionals can get together to discuss their difficulties and their good practices in order to innovate together. The Weapons and Tactics Conference (WEPTAC) regularly brings together fighter and bomber pilots, navigators and weapons systems officers who exchange their tactics, techniques and procedures, debate innovative concepts and propose solutions immediately applicable to their problems. Similarly, the Revolutionary Acquisition Techniques Procedures and Collaboration (RATPAC) network, twice per year, assembles junior acquirers from the Air Force and the Special Operations Command (SOCOM) to optimise and accelerate acquisition procedures for certain equipments. A noteworthy fact is that this spontaneous initiative has the support of the Assistant Secretary of the Air Force for Acquisition.

Finally, the incentive to innovate, including in daily life, is applied on a USAF wide scale. The Air Force Smart Operations for the 21st Century (AFSO 21) programme formalises an incremental programme allowing innovation by reducing the waste of time and resources at unit level. In 2013, the Every Dollar Counts campaign invited every airman to suggest cost-saving measures applicable locally. 302 ideas were accepted by the USAF, resulting in savings of $ 71 million and 24,000 hours of work per year. These two initiatives have been extended and

(3) A few weeks compared with several months; a few tens of thousands of dollars compared with some hundreds of thousands.

are now included in the Airmen Powered by Innovation (API) programme which seeks to catalyse suggestions from the grass roots.

A crucial need for more innovation

The USAF is currently confronted by considerable capacity problems. The whole range of missions is assured on the world scale it merits, and modernisation is ongoing with the impending arrival of the F-35A, new generation KC-46 tanker aircraft and the new generation LRS-B bomber. But 25 years of uninterrupted operational engagement in the Middle East and elsewhere, and the application of heavy budget constraints since 2011 (reduction followed by sequestration of the budget), have appreciably weakened the Air Force.

With 315,000 active personnel, it now has the most condensed structure in its history. While 188 combat squadrons were available in 1991, there are only 55 in 2015. The in-service fleets are ageing: the average age of the USAF's approximately 5,000 aircraft is 25 years. If the venerable B-17s had been involved in the Gulf War, they would have been five years younger than the B-52s are now. The focus over the last 15 years on air/land combat in a permissive environment has resulted in the erosion of some high-end skills not used in those operations. The stated ambition is to resurrect by 2023 80% of the skills that were present in 2001 before the launch of *Enduring Freedom*.

The signs are not good for an easing of budgetary constraints or operational tempo. Engagement in Iraq and Syria will not have given the USAF the respite counted on to rebuild its forces following the withdrawal from Iraq and Afghanistan. From now on, the rise of regional powers, especially in their aerospace capabilities, will add to the challenge of anti-access/area denial. Contemporary developments in warfare, unpredictable changes in geopolitical balances and development of non-state threats are all fraught with consequences for the USAF's capabilities, its force structure, its international partnerships and its projected detachments.

Finally, and perhaps above all for this eminently technological force, the acceleration of technical progress and the increasingly rapid diffusion of breakthrough technologies reinforce the need to anticipate and to be able to adapt quickly, certainly more quickly than the adversary. Tomorrow's USAF will have to be even more innovative and responsive.

An Air Force in marching order

The history of innovation in the USAF shows the adoption of a strategy is an indispensable pre-condition for success. To innovate is in effect to try to resolve an identified problem by affording it the priority it merits. This is how the problem

of suppression of enemy air defences (SEAD) was resolved in Vietnam, or that of precision strikes at the beginning of the 1970s. Conversely, close air support (CAS) missions in Korea were not very effective because they had not attracted sufficient interest since the Second World War.

Since 2013, the USAF has conceived and adopted an overall strategy which determines its priorities, with the flexibility to cope with the unexpected. A vision, *The World's Greatest Air Force, Powered by Airmen, Fuelled by Innovation*,[4] defines what the Air Force is ('what we are') and what its contribution is to the national defence policy. A second document, *Global Vigilance, Global Reach, Global Power*,[5] presents its five core missions ('what we do'). A third, *America's Air Force: A Call to the Future*,[6] revised every four years, lays down the major objectives for the next 30 years ('what we must achieve'). A fourth and final document, *The Strategic Master Plan* (SMP),[7] updated every two years, extracts priorities and goals in order to guide planning out to 20 years, ('how we will accomplish this'). It is the SMP which, in the light of fiscal projections, guides the work of the annual planning process (Planning Choices Event) for the ten years ahead.

These documents all confirm the same credo: the necessity for the Air Force to improve its strategic agility. The ability to respond better and more quickly means innovating at all levels, first of all in the development of breakthrough capabilities and the planning processes. Hypersonic flight, nanotechnologies, directed energy, unmanned systems and autonomous systems are some of the priority areas for research. The exploration of concepts which cross boundaries in the air, space and cybernetic domains, and in the field of missions and capabilities, will be given priority. The existing stovepipes processes of research, definition of the requirement, technological development and acquisition are no longer up to date, neither is their inertia. Under resource constraints and time constraints the most viable solutions are the most flexible ones, those which combine capabilities in systems of systems. The definition of the requirement and the acquisition process will be punctuated by more numerous decision points in order to be able to modify or abandon a programme more easily during its life cycle. The creation of prototypes will occur earlier to reduce the resources necessary for turning an idea into reality.

The development of each airman's potential for innovation will also be pursued by developing his technical skills, his critical faculties and his ability to adapt. The diversity of his experience, his career path and culture will remain the measure of this. Particular emphasis will continue to be placed on further education, to enable every airman, civil or military, to develop his leadership skills. The officers,

(4) *The World's Greatest Air Force, powered by Airmen, fueled by Innovation: A Vision for the United States Air Force* (www.osi.af.mil/shared/media/document/AFD-130111-016.pdf).

(5) August 2013 (www.af.mil/Portals/1/images/airpower/GV_GR_GP_300DPI.pdf).

(6) July 2014 (http://airman.dodlive.mil/files/2014/07/AF_30_Year_Strategy_2.pdf).

(7) 2014 (www.defenseinnovationmarketplace.mil/resources/AFGS-2014StrategicPlan.pdf).

60% of whom now possess a Master's degree or its equivalent and 1,600 of them a Doctorate, will develop their ability to think strategically. Careers will be planned with more flexibility, to enable those who wish to take a sabbatical or adapt their work patterns, for example moving from full-time to part-time working. Those who choose to have a specialist career will also benefit from financial and promotion opportunities. This tailored approach is more complex; it implies rethinking personnel management policy.

Finally, the role of leadership remains essential. Behind all innovation there exists a creative individual and a sponsor, a confident and persevering chief who agrees to support the project in spite of the doubts and obstacles of a bureaucracy whose conformity and weight are no longer suited to the realities of the twenty-first century. The organisations and their command structure must create a climate of confidence, promote initiative, give freedom to subordinates and take on the (controlled) risk of failure. Today, the majority of American airmen have the feeling that they cannot influence change. The establishment of a more favourable general climate is one of the main preoccupations of the USAF high command.

The USAF at a crossroads?

The USAF is going through a delicate period. Under continuous operational pressure and resource constraints which seem likely to last, it is having trouble achieving the essential balance between recapitalizing the forces engaged in current operations and preparing for the future, while the demand for airpower increases constantly and the commitments to come could well be more demanding. It is nevertheless determined to make the effort necessary to remain first in the world and to keep the central position it occupies in US defence policy.

The transformation necessary requires a complete review of its concepts and its way of functioning. The cultural shock is accepted. It is in the process of putting the new approach into practice. The ability of the USAF to innovate and its will to do even more are the foundations. To quote its Chief, General Mark Welsh, "The history of the USAF is a history of innovation." This will remain true for its foreseeable future.