Transforming Joint Air Power

The Journal of the JAPCC

Editorial

As the process of NATO Transformation moves forward, it is clear that a number of key capability areas are now being tackled, including a wide range of air power related topics. However, perhaps one area that has yet to be addressed fully is that of Unmanned Aircraft Systems (UAS). Undoubtedly, the technology in this area has made rapid advances in recent years and, whilst individual NATO nations have developed a range of UAS related programmes, we have yet to develop any detailed NATO policy and doctrine to guide the future development of UAS and fully integrate them into future combined operations. This needs early resolution if NATO is to make best use of UAS within its force structure and also reap maximum operational benefit from this exciting new technology.

To try and take this work forward, the JAPCC has made the UAS topic its top priority theme for 2006. Our intention is to engage with all UAS stakeholders, including NATO staff, industry and academia to identify what NATO needs to do to exploit the UAS potential properly. We plan to do this through a variety of different fora, including meetings and conferences. This JAPCC Journal is a further major strand in this approach. Based upon all these different discussions and feedback, our aim is to develop a NATO UAS "Flightplan", setting out what topics need to be tackled in order to transform the NATO UAS capability.

Reflecting the growing importance of UAS, this issue of the JAPCC Journal offers a range of viewpoints, beginning with an article from our new Director, General Tom Hobbins. Also included are inputs from a cross-section of NATO Chiefs of Air Staff summarizing their current UAS operations and their future national plans in this area. Beyond that, articles are also provided on the UAS experience in current operations, including that from an Israeli perspective, together with academic and industry views. Taken as a whole, I believe this provides a comprehensive insight into all aspects of UAS operation, which I hope will serve to stimulate debate across the NATO air community.

Following on from the last edition, I am grateful to the new Chief of Air Staff, RAF, for his personal interview that gives us all a good insight into future RAF plans within the NATO context. I am also pleased to have received an unsolicited article from Dr Andrea Nativi, which I hope may be the first of many from our elite readership.

I hope you enjoy this edition of the JAPCC Journal.

Hans-Joachim Schubert
Lieutenant General, DEU A
Executive Director,
Joint Air Power Competence Centre

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We encourage comments on the articles in order to promote discussion concerning Air and Space Power inside NATO's Joint Air community. All comments should be sent to journalads@japcc.de

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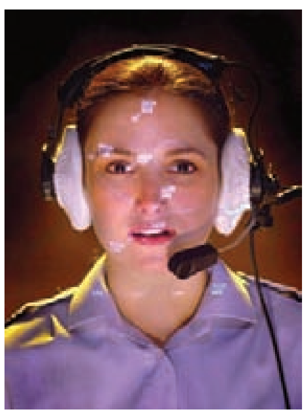
Transformation & Capabilities

6 Unmanned Aircraft Systems: Refocusing the Integration of Air & Space Power

10 The Evolving Capability of UAV Systems

14 Integrating UAVs with Other Airspace Users



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18 Exploiting a New High Ground

22 Beyond Technology: Successful Unmanned Aircraft System Employment

CONTENTS

View Points

26 An Interview with Chief of the Air Staff, Royal Air Force

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30 30 Years of Israeli UAV Experience: Interoperability and Commonality

34 Manned Unmanned Missions: Chance or Challenge?

38 Manned Vs Unmanned: Aerial Systems - False Expectations, Real Opportunities & Future Challenges

42 Lessons Learned from Predator Operations

44 Unmanned Air Vehicles: Some National Perspectives

Out of the Box

48 Airbase Defence in Expeditionary Operations

Photo NATO

Inside the JAPCC

52 News

54 JAPCC Conference 2005

Regulars

56 Bios

58 Book Review

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Unmanned Aircraft Systems: Refocusing the Integration of Air & Space Power

By General Tom Hobbins, USA A
Director of the JAPCC

Unmanned Aircraft Systems (UAS) of all types and sizes are proving their worth everyday in operations around the world. From hurricane relief in New Orleans to combat operations in Afghanistan and Iraq, they are extremely flexible. They can be designed and built for small reconnaissance ground-teams, for strategic level commanders and any level between. Besides being flexible, they are also cost effective. Compared to other assets, UAS can complete their missions at relatively lower costs. The tremendous advances in technology and the exploding numbers of UAS offer even greater opportunities for aerospace power. But, unless these systems are properly integrated into a comprehensive command and control system, UAS will not meet their full potential.

Global Hawk

UAS Boom

Joint air and space power is in the midst of a proliferation of UAS. As recently reported by the US Department of Defense, over 32 nations are developing or manufacturing more than 250 different models, and 41 countries are operating over 80 types of UAS.[1] By the latest count, the US alone is operating over 1,000 unmanned systems. Added to this explosion in the number of systems, there has been a similar expansion in the diversity of UAS' size and capabilities. At the low-end of the spectrum there are micro unmanned systems like the Wasp. This mico-UAV weighs less than 225 grams, is just over 20 centimeters long with a wingspan of approximately 30 centimeters.[2] It has a ceiling of 1,200 feet, a range of less than 5 nautical miles and an endurance that is measured in minutes.[3] At the other end of the spectrum, there are long-endurance systems like Global Hawk and Euro Hawk that weigh more than 14,500 kilograms, are over 15 meters long and have a wingspan of 40 meters.[4] The Global Hawk capabilities include a ceiling of 65,000 feet, an intercontinental range of 5,400

The US Department of Defense adopted the UAS terminology rather than unmanned aerial vehicle (UAV) to "more clearly emphasize that the aircraft is only one component of the system, and is in line with the Federal Aviation Administration's decision to treat 'UAVs' as aircraft for regulatory purposes".

nautical miles and an endurance of 32 hours.[5] By 2015, the number of UAS will increase by more than 3,000.[6] The introduction of new UAS will continue for many years to come. When unmanned balloons and near-space systems with ceilings of over 120,000 feet are added to the mix, endurance can be measured in months and the diversity of capabilities and options available to commanders are incalculable.[7]

The BUSTER

Segregation

Currently, however, this proliferation and diversity of UAS have led to developments that are segregating airspace and aircraft and hampering the application of aerospace power. Even more troubling is that this is happening counter to the transformational efforts of NATO nations to integrate their forces better and make them more interoperable for both joint and combined operations. Two "pressures" are driving the segregation. The first is the "bottom-up" tactical development of UAS without an overall strategic vision or concept of operations and second is the corresponding lack of procedures to integrate these diverse systems into a network of systems. It is not surprising that each nation and its independent services are focused on fielding unmanned systems to provide new capabilities to meet their own very specific needs. For example, the US Army has acquired a small tactical UAS known as BUSTER (Backpack Unmanned Surveillance Targeting and Enhanced Reconnaissance), to meet its requirement for a system to provide warfighters with critical, real-time battlefield information in high-risk areas such as Iraq and Afghanistan. The purpose of this system is to increase the warfighters' situational awareness and provide them with force protection. These systems weigh only 4.5 kilograms and can be carried in a backpack, launched by soldiers and reach altitudes up to 10,000 feet. The system provides soldiers with extraordinary capabilities. This example can be repeated in many other Services of the NATO nations. Each Service and the industries that support them are scrambling to field UAS to tackle the many difficult problems each face.

However, little is being done to establish the means to integrate these unmanned systems with other forces and systems, be it between manned and unmanned, interservice, or international systems. The high demand for current and planned UAS, the diversity in their capabilities and the lack of an integrating concept of operations, across all these systems, is putting pressure on command and control measures to operate these systems safely in crowded airspace. According to the USAF Joint Air-Ground Operations Center, there have been three midair collisions between small unmanned aircraft and helicopters during current combat operations making airspace control and deconfliction serious issues.[8] Lt Gen Walter Buchanan, Commander of US Central Command Air Forces, has stated "What I worry about is the day when I have a C-130 down low with a cargo-load full of soldiers and a UAV, it won't have to be a big one, comes right through the cockpit windshield".[9] These problems have led to increased procedural airspace control measures in an attempt to deconflict aircraft and increase safety. Although procedural airspace control measures provide some increased level of safety for aircraft over what is provided by uncontrolled airspace, it is far from optimal and does little to optimize support to the joint fight. Airmen from all Services and nations must address this and other issues segregating airpower and develop solutions to improve the integration of all its assets. We must also ensure our army and navy forces are involved in the solution to this issue.

Joint Integration

Although current and future unmanned systems may be quick to solve individual Service and tactical problems, more must be done to develop the means to integrate these systems beyond

The networking of systems will improve situational awareness and battlespace knowledge at all levels of command.

their stove-pipe functions into the joint and combined force team. Optimization of UAS as part of joint/combined forces requires a wider perspective. It is incumbent upon each nation and the Alliance to develop the doctrine, concept of operations, standards, and tactics, techniques and procedures (TTP) necessary to integrate UAS and other systems into our force structure. NATO should take the lead to standardize national efforts to the maximum extent possible.

Doctrine

At the doctrinal level there are a number of issues that must be addressed. A major doctrinal challenge centres on how to integrate these systems into the airspace that is typically above what is controlled by the ground component commander. Some examples of this type of procedural control include segregating airspace into restricted areas and coordination zones as well as providing altitude blocks for different types of aircraft. Currently, procedural airspace control measures are being employed to deconflict aircraft and the components. The proliferation of unmanned systems only highlights existing problems in attempting to apply existing linear battlefield doctrine to non-linear situations, like urban operations, which joint forces face today. In an attempt to employ various joint forces safely in the tight and difficult confines of urban operations, commanders are forced to increase procedural deconfliction measures. When unmanned systems are added to the dense concentration of different assets, the situation is further exacerbated, leading to more restrictive procedural measures. Although this provides increased safety to those assets in the air, it only further limits the application of aerospace power, handicapping its many strengths and ultimately decreasing the air support available to those who need it most. Joint doctrine must move away from procedures that only serve to deconflict joint forces. New joint doctrine must allow and provide the positive means necessary to allow airmen to **integrate** air assets in order to meet the Joint Force Commander's priorities.

Concepts of Operation

It is time for airmen to take the lead and aggressively develop the concepts of operation where UAS are integrated into the joint force in "value-added" roles. UAS can add value by increasing military capability, decreasing cost, or reducing risk. If systems do not add value to a particular mission, nations should not pursue them until they would add value. Generally, UAS show great promise as a tool for missions that are dull, dirty, or dangerous. Regardless of the roles they serve, and to the maximum extent possible, UAS must be interconnected with other systems and forces throughout the battlespace to exchange information and help correlate this information more quickly, precisely, and efficiently. The networking of systems will improve situational awareness and battlespace knowledge. The networking of systems and appropriate sharing of knowledge must occur at all levels from the tactical: for the company fighting the 3-block urban war; to the operational: for commanders who must allocate limited resources and monitor, adjust and communicate their operational intent; to the strategic: for our political masters who must provide political guidance and civilian control.

Force Development

High-level doctrine and concepts of operations are simply not enough to bring UAS integrated capabilities to the joint fight. A cadre of professionals must be trained to maintain and operate these systems as part of an interconnected joint/combined team. For each concept of operation, TTP must be developed. Currently, due to a lack of resources and out of necessity, development of UAS TTP has been left primarily to the warfighters engaged in operations. Although this has produced results, just as in other aerial platforms, it is preferable to have the resources necessary to develop, test and refine TTP, and train personnel prior to their employment on the battlefield. This will require nations to not only purchase relatively inexpensive unmanned systems but also to secure the necessary manpower and other resources to serve as the cadre that will nurture, develop and refine the application of airpower through UAS.

"The system provides soldiers with extraordinary capabilities".

Conclusion

The efficient and effective integration and interoperability of air and space forces into joint and combined operations is the keystone of aerospace transformation. The integration of unmanned aerial systems is a microcosm of the effort that must be made to improve joint forces interconnectedness. Airmen must critically challenge the status quo and provide comprehensive recommendations to improve air and space power's contribution to joint and combined operations. They must judiciously review standing air and joint doctrine in the context of today's strategic environment and push necessary changes forward. Concepts of Operations and the TTPs to support them must be established for the missions where UAS can add value. Finally, additional resources, beyond merely acquiring equipment, to include investments in personnel, organizational structure, training and facilities, among others, are necessary to develop UAS' contribution to joint/combined forces. As airmen develop the road forward for unmanned systems in particular, and aerospace power as a whole, they must remember to think jointly and work with the ground and maritime components to provide solutions to the problems that have driven the rapid development of unmanned aircraft systems of all shapes, sizes and capabilities. ■

[1] Office of the Secretary of Defense (OSD), -The Unmanned Aircraft Systems Roadmap: 2005-2030, 20 July 2005, p. 38, http://www.acq.osd.mil/usd/Roadmap%20Final2.pdf.
[2] Ibid., 29.
[3] Ibid.
[4] Ibid., 6.
[5] Ibid.
[6] Frost and Sullivan research study findings for the European and Asian markets, combined with JAPCC research on US UAS acquisition programs. Frost and Sullivan data was presented at the Future of Unmanned Vehicles conference held in London in November 2005.
[7] OSD Roadmap, 35.
[8] Rebecca Grant, "The Clash of UAV Tribes", Air Force Magazine Online, Vol. 88, no. 9 (September 2005): http://www.afa.org/magazine/sept2005/0905UAV.asp.
[9] Lt Gen Walter Buchanan, presentation at Defense News Media Group's Joint Warfare Conference on 26 Oct 2005, reported by Glenn W. Goodman Jr., "Congested Airspace: Hand launched UAVs Create Hazards for Manned Aircraft", C4ISR: The Journal of Net-Centric Warfare, 9 January 2006, http://www.isrjournal.com/story.php?F=1379999

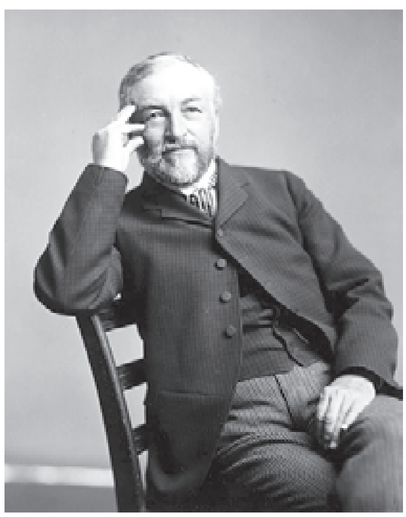
The Evolving Capability of UAV Systems

By Professor Ian Poll OBE FREng FCGI FAIAA FRAeS

The uninhabited air vehicle (UAV) is a concept whose origins can be traced back over 100 years. Professor Samuel Langley, the Secretary of the Smithsonian Institution in Washington DC, began a serious scientific study of the issues relating to heavier than air flying machines in 1886 and between 1890 and 1896, he built a number of experimental, steam powered air vehicles, which he called "aerodromes". The culmination of his work was Aerodrome Number 5. This had two wings, each with a span of 4.2 m, arranged in tandem and it had a mass of 11 kg, including the mass of the 0.75 kW steam engine. On the 6th of May 1896, following a catapult launch, Number 5 covered a distance of over 1 km, at a height of 35 m and a speed of over 20mph. The event was witnessed, and photographed, by Alexander Graham Bell and it was the first sustained flight of an un-piloted, powered, stable, heavier-than-air machine of substantial size.

Ground Breaking Flight

Even before this ground breaking flight, visionaries (and cranks) were proposing the use of radio signals to guide vehicles and some with military interests were proposing the concept of aerial torpedoes. By the beginning of WW1, Elmer Sperry had demonstrated gyro-stabilization in flight, paving the way for flight control systems that did not rely on human senses, or skill, and which could be pre-programmed to eliminate the need for human intervention. During WW1, there were a number of experimental aerial torpedo programmes. However, these were unsuccessful largely due to the primitive radio control technology and were not pursued because the rapidly developing manned aviation was carrying all before it. Between the wars, the principal driver for UAV technology was the requirement for low cost, but realistic, target practice for anti-aircraft gunners. Nevertheless, the key enabling technologies continued to be developed for reasons that had very little to do with unmanned aviation.



Professor Samuel Langley

Coming of Age

During WW2 the aerial torpedo concept was used by Germany in the form of the V1 "flying bomb" and many of the UAV enabling technologies received a terrific boost; notably propulsion, guidance, navigation, electronics and computation. Post WW2, in parallel with the rapid development of manned aviation, it was recognized that the UAV could be used to extend military operational capability. UAVs began to be considered for reconnaissance, decoying, suppression of enemy air defences (SEAD) and long range

"The aerial torpedo concept was used by Germany in the form of the V1 Flying Bomb".

delivery of weapons (stand-off bombs). However, progress was still hampered by the lack of maturity of some of the key technologies. This was especially true in the areas of guidance and navigation.

It is generally acknowledged that the UAV "came of age" during the Vietnam conflict. This was the first time that UAVs were used in action and a very large number of missions were flown. UAVs were used to gather images and electronic and communications intelligence. They were also used for SEAD. In the 1980s, as a result of repeated conflicts in the Middle East, Israel became a major user and developer of UAV systems and their associated technologies.

Enabling Technologies

The past 20 years have seen tremendous progress in the enabling technologies, largely thanks to growth in non-aerospace markets. The mobile phone boom has driven communications, display and energy storage technology. The personal computer market has driven processing power and data storage capacity to ever increasing levels, whilst power consumption, size and cost have been dramatically reduced. The video games market and the internet have driven developments in information processing, imaging, simulation, encryption, and data management, analysis and compression. Arguably, the most significant development of all has been the establishment of the global positioning system (GPS).

Aviation Development

From the beginning of aviation, the navigation task has been performed by humans. The availability of secure GPS is revolutionizing navigation and it allows the complete removal of the human from the cockpit. Over the past one hundred years, there have been

Photo US DoD

"Military options can be constrained by the potential cost in lives".

tremendous developments in military, manned aviation. However, in many ways, the potential of aviation to deliver military benefit and advantage is severely limited by the human in the cockpit. Air vehicles are subjected to very severe biological limitations. The human puts clear limits on the size, speed, altitude, manoeuvrability, endurance, configuration, complexity and methods of launch and recovery. When these limits are removed a whole new spectrum of operational capability is released. Added to this is the fact that human life has become a huge political issue. Military options can be constrained by the potential cost in lives. In a world where news travels in all directions at the speed of light, even the loss of a single life can have a major impact on public opinion. With no humans in the cockpit, a great many things change.

System Development

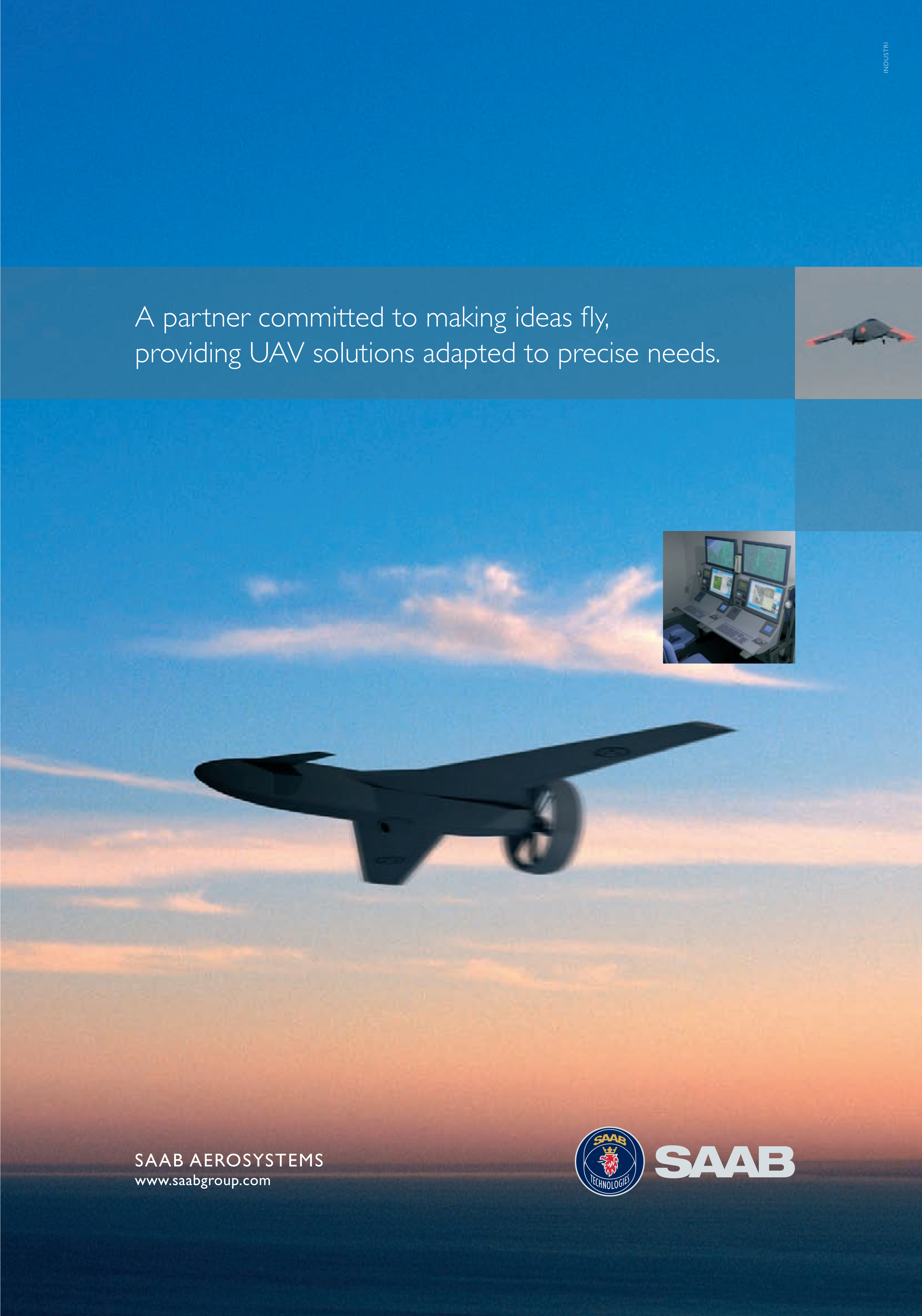
After a century of manned military aviation, we have the opportunity to open a completely new line of development for airborne systems. However, progress is being inhibited by a number of pressing issues that need to be addressed and solved quickly. Arguably, the most serious problem is that of airworthiness and certification. Military and civil regulations have been developed to cover manned systems and manned operations and the regulators have not yet provided a framework that will allow UAV operators to "file and fly" in all types of airspace. UAV systems that can only operate on ranges are of no operational value. In technology terms, there are serious gaps in propulsion and actuation technology for small vehicles. UAVs in the Tactical Class offer the greatest number of new operational opportunities, but without robust and reliable sub-systems the potential cannot be released.

(ST Aero) FanTail

Challenges

Beyond these teething problems, the principal challenge is the development of new concepts of operation. At this early evolutionary stage, the operational emphasis is on intelligence gathering, mirroring almost perfectly the initial stages in the development of manned aircraft. However, as awareness of the potential grows so will the demand for other capability. At present, unmanned systems are being used to complement and augment legacy manned systems, whose service lives are measured in decades and which are sometimes ill-suited to the tasks that they are required to perform. UAVs offer more capability, less risk, lower cost, shorter service lives and faster and more frequent upgrades. This means that UAV equipment can be matched to the existing threats and, with greater flexibility than manned systems, be able to adapt more readily to changes in the nature of the threats or to completely new threats.

Whole military strategies can be built around new UAV system capability, in much the same way as happened with manned aircraft in the last century and, although there may be some reluctance to accept the view that UAV systems will revolutionize military thinking in the 21st century, it can be argued that manned aircraft systems are now in the same position as battleships were in the early years of the 20th century and we know what happened to them! ■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Integrating UAVs With Other Airspace Users

By Wing Commander Mike Strong, RAF, EUROCONTROL Military Unit

Background

The concept of an aircraft without a pilot in the cockpit mixing with other airspace users is an anathema to many people and a challenge to regulators. Nevertheless, this is exactly what EUROCONTROL is seeking to address with regard to UAVs.

EUROCONTROL is the European organization for the safety of air navigation. Although predominantly civil-staffed, it includes a Military Unit, is based in Brussels, comprises 35 member states and is responsible *inter alia* for developing a seamless, pan-European air traffic management (ATM) system.

Photo by SAAB AD

nEUROn artistic-drawing

The Need

At present, most military UAVs in Europe are restricted to airspace that is segregated for the purpose from other aircraft or they are flown over the sea using special arrangements. Where operations are permitted outside segregated airspace, numerous restrictions to ensure the safety of other airspace users normally apply. This is extremely limiting. To exploit fully the unique operational capabilities of current and future UAV platforms and to undertake the training necessary for the safe conduct of UAV operations, European military authorities require UAVs to be able to access all classes of airspace and to be able to operate across national borders.

This need was articulated during the autumn 2003 session of the European Air Chief Conference, which suggested an investigation should be made into the possible harmonization of ATM procedures for the use of military UAVs outside segregated airspace in peacetime. EUROCONTROL was invited to undertake the work required because of its pre-eminence in ATM in Europe and the task was then assigned to the Military Unit within the Agency. The work itself, to develop EUROCONTROL specifications for the use of military UAVs as Operational Air Traffic (OAT) outside segregated airspace, was undertaken by a specially formed task force (the UAV-OAT TF) comprising military and civilian members with experience in the ATM practicalities of UAV operations. NATO also participated.

Why Specifications?

Early on, the TF opted for *Specifications* as the most appropriate category from the EUROCONTROL regulatory and advisory framework, rather than *Rules* or *Guidelines*. Specifications had voluntary status; individual states would therefore be free to decide whether or not to incorporate the EUROCONTROL specifications into their own national regulations.

The TF sought to avoid reinventing the wheel by identifying best practice and building upon existing material. That said, in reality, there were no extant national procedures just waiting to be adopted and adapted for implementation throughout Europe. Instead, the TF had to start with something very close to a clean sheet of paper. Nations recognized this and were, accordingly, extremely supportive.

Principles

The TF followed three basic principles. Firstly, UAV operations should not increase the risk to other airspace users; secondly, ATM procedures should mirror those applicable to manned aircraft; and thirdly, the provision of air traffic services to UAVs should be transparent to ATC controllers. The TF also sought to be innovative by not accepting any constraint imposed by limitations in current UAV capability. Instead, it took the view that technical issues were something for industry to address. Notwithstanding, the TF paid particular attention to collision avoidance, sense and avoid, and separation minima, since these are areas of understandable concern to other airspace users.

Specifications

The TF initially identified 26 draft EUROCONTROL specifications, covering areas such as:

- Categorization of UAV operations.
- Mode of operation.
- Flight rules.

- Separation from other airspace users.
- Sense and avoid.
- Separation minima.
- Airfield operations.
- Emergency procedures.
- Interface with ATC.
- Equipment requirements.

These were then subjected to a safety assurance process by an external contractor, intended to support the argument that, **by application of the draft specifications, military UAV OAT operations in non-segregated airspace will be acceptably safe**. The approach taken was to demonstrate that the risks to other airspace users from UAV operations would be no greater than for manned military OAT in non-segregated airspace and would be reduced as far as reasonably possible. Recommendations arising from this process were then incorporated into the specification document, resulting in an increase in the number of specifications to 33.

The specifications are high-level, generic and standalone, so they can be understood without supporting detail and thereby be more amenable to incorporation into national regulations. For example, they envisage a primary mode of operation that entails oversight by a pilot-in-command and a back-up mode that enables a UAV to revert to autonomous flight in the event of loss of data-link. A similar hierarchy is followed with regard to separation provision and collision avoidance. Thus, where ATC is not available to separate a UAV from other airspace users, the pilot-in-command will assume this responsibility using available surveillance information and technical assistance in the form of a sense-and-avoid system. The latter will also initiate last-ditch autonomous collision avoidance should circumstances warrant.

"The specifications are high-level, generic and standalone, so they can be understood without supporting detail and thereby be more amenable to incorporation into national regulations".

Other specifications are even more pragmatic. Thus, the air traffic service provided to UAVs should accord with that provided to manned aircraft, and UAVs should carry similar equipment for flight, navigation and communication as required for manned aircraft when flying VFR and IFR except for Anti-Collision Avoidance System, which is currently predicated on having a pilot in the cockpit.

In short, if UAVs require integration with other airspace users, they must fit in with those other users and with current procedures, rather than existing ATM having to adjust to accommodate UAVs.

The Way Ahead

The draft specifications are presently being progressed through the EUROCONTROL consultative and approval process, with the aim of presenting them to the Provisional Council (a EUROCONTROL governing body) by the end of 2006. The TF has maintained links with other agencies, helped by the fact that most TF members were at the heart of their own nations' policy-making on UAVs. In addition, the TF Chairman participates in the NATO UAV FINAS (Flight in Non-Segregated Airspace) Military Working Group, which is likely to adopt the EUROCONTROL specifications for the ATM aspect of its work.

There is no doubting the collective wish for a successful outcome to the work of the UAV-OAT TF. However, because this is focussed on ATM, it is just one part of the bigger jig-saw that must fit together before military UAVs will be allowed to fly routinely outside segregated airspace. Other agencies working on airworthiness, security, operator training and other such aspects must all perforce play their part. ■


SAAB Aerosystems Copyright

Exploiting a New High Ground

Using the Airspace Above Flight Level 650

By Colonel (S) Dan Lewandowski, USA A, JAPCC

In some circles, it's called 'Near Space'. Others call it 'Very High Altitude'. Whatever you call it, the airspace from 65,000 feet to 325,000 feet AMSL (20 to 100 km) is a part of the Earth's atmosphere that almost no one uses. With technological advances, particularly in the area of Unmanned Aircraft Systems (UAS), exploitation of the Stratosphere and Mesosphere is now becoming affordable and a real possibility for military operations.

Why So High?

The desire to go above flight level 650 (above 20 km) is driven by security, weather avoidance, cost, and persistence. Security at such high flight levels is increased because of the almost non-existence of threat weapons that can operate at such high altitudes. Security is further enhanced by the fact that from such a height, most adversaries won't even know the collection platform is in the area. As for weather, once the UAS passes through the Troposphere, it is above all normal weather considerations. Temperatures are, relatively speaking, rather constant. The new environmental consideration is that of exposure to the Sun's radiation. This is not difficult or costly to deal with, especially when no human is in the vehicle. Very high altitude UAS are expected to have the additional advantage of being much less expensive when compared to satellites.

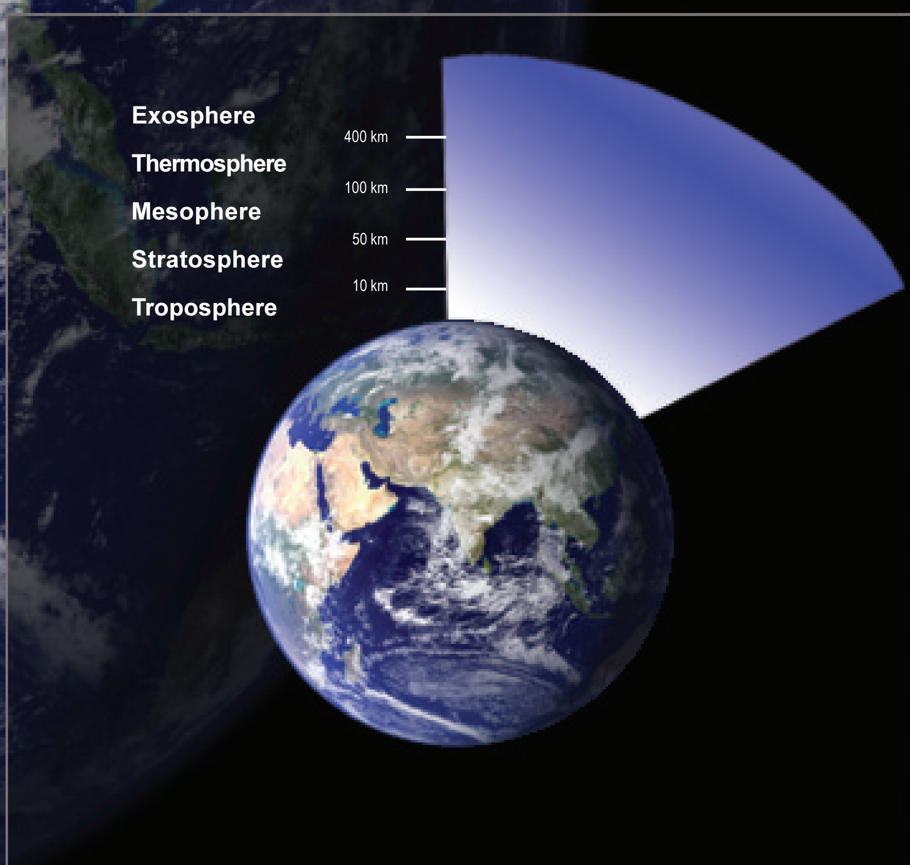


Image courtesy of NASA

"Satellites have normally provided collection capabilities over the battlespace".

Persistence is the single most important benefit of operating in the Stratosphere. A commander desires persistence so that he or she can maximize situational awareness, collect information and increase knowledge. As an example, imagine the power of being able to track every moving ground vehicle in a theatre from a single very high altitude UAS utilizing a ground moving target indicator radar. Combine that radar with change detection software and computer computation capabilities that can provide speed of vehicles, groupings of vehicles and tracking of individual high visibility vehicles, then a single asset can enable information dominance on the battlefield.

Aircraft or satellites have normally provided collection capabilities over the battlespace. The persistence of aircraft over a location has been mostly limited by the pilot. Due to long mean times between mechanical failures, and the development of air-to-air refuelling, the ability of collection-type aircraft to stay on station has greatly increased over time. These aircraft are now only limited by the endurance of the human in the cockpit. Satellites have the advantage of no over-flight restrictions which enables collection over otherwise denied airspace. And from geostationary orbit, satellites can 'stare' at a location for years at a time. Satellites have their limits though. From geostationary orbit approximately 22,240 statute miles (35,786 km) above the Earth's surface, it is difficult to see small objects, because the resolution of various sensors is poor. From lower orbiting satellites, you get much better resolution, but the time over target is reduced to 15 minutes or less, depending on the exact orbit and flight path of the satellite over the location being viewed. With UAS advances, the limitation of the human is gone and the advantage of persistence remains for extended periods of time. The Euro Hawk, for example, is expected to have an endurance of 32 hours. Although not at an altitude above 65,000 feet, this demonstrates the advances already made in high altitude persistence. Going into the Stratosphere is where Very High Altitude platforms really could earn their place in the military Order of Battle. For example, Lockheed Martin is currently developing a test model High Altitude Airship (HAA) that is scheduled for launch in 2011. If successful, the HAA will remain in flight for 90 to 180 days, with a 4,000 pound (1,800 kg) payload.

> *"A commander desires persistence so that he or she can maximize situational awareness, collect information and increase knowledge".*

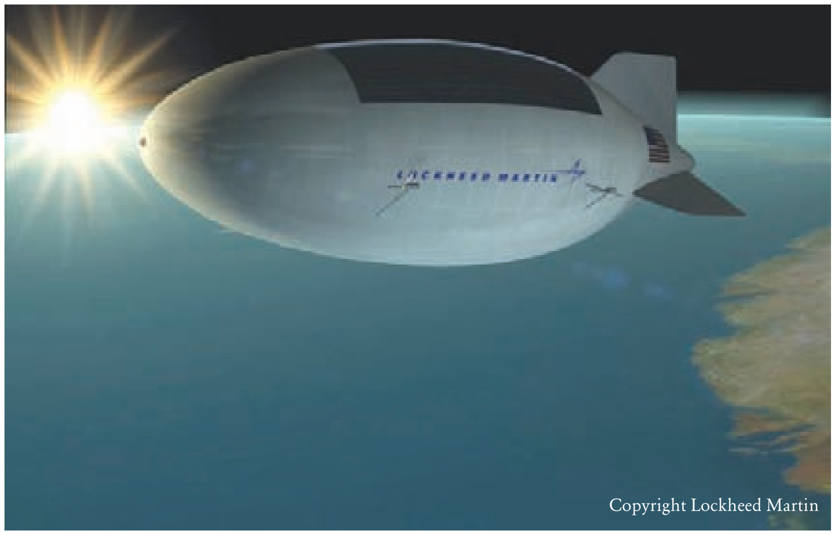
What Would We Use At Very High Altitudes?

The missions and capabilities of UAS range from the smallest micro systems, weighing less than half of one pound, to the large Global Hawk that has a wingspan 1.3 metres wider than an Airbus 320, and 6 feet wider than that of a Boeing 757. What this wide array of UAS lack though, is the ability to go to the highest levels of flight. Only airships and vehicles equipped with rocket-type engines can go to flight levels of 70,000 feet and higher. The 'explosion' of UAS capabilities is fuelling efforts to go even higher, to go regularly through the Tropopause and into the Stratosphere. The hope is that Very High Altitude UAS could one day even fly into the Mesosphere. From these altitudes, the main missions of UAS would be Intelligence, Surveillance & Reconnaissance (ISR) by an array of electro-optical, electronic emission, synthetic aperture, infra-red and weather sensors, and communication relay or broadcast.

Why Is An Easy Concept So Difficult To Achieve?

Probably the most asked question is why are we trying to use an Airship? Why not just make an aeroplane to fly that high, or a satellite to fly that low? The basic reason we can't use aeroplanes is because we can't get the lifting force needed. Given that below the Tropopause, air density decreases by half every 20,000 feet (6 km) and above the Tropopause it decreases by half every 15,000 feet (4.5 km), it is easy to see that over 90% of the Earth's air mass is below 10 km in altitude. When you reach an altitude of 75,000 feet, the surface area of the wing needs to be 16 times larger than at sea level. At an altitude of 150,000 feet, the surface area would need to be over 500 times greater, in order to achieve the same lifting force. These numbers are just not possible for an aircraft.

Spacecraft have a minimum altitude requirement or they are forced to re-enter the Earth's atmosphere. Once a satellite falls below an altitude of 100 km (325,000 feet), the drag of the atmosphere is so great that the satellite will return to Earth in a matter of a few days. Thus, putting satellites into this part of the atmosphere is just not possible. Airships are the only viable option with today's technology, but even they have their limitations. In the Stratosphere and beyond, there are generally increasing temperatures as the altitude increases and this causes problems for electronics as well as the expansion of gases. A lack of air cooling capability due to the reduced air density is another limitation. Finally, the problem of flying through weather and the jet stream, in order to get to the desired altitude, must be dealt with. There are challenges for the very high altitude 'High Ground' but they are not so great that they should prevent us from addressing them.



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"The High Altitude Airship is one glimpse into the future".

The Future of Very High Altitude

The High Altitude Airship is one glimpse into the future. With an interior volume of about 5.2 million cubic feet, it will be about 16 times larger than the Goodyear blimp and seems huge by today's standards. Mankind has built such large airships in the past though; the Hindenburg was an amazing 7.1 million cubic feet in volume. If successful, this UAS could carry traditional payloads such as sensors and communications equipment. With a bit of innovation, exploitation of this new high ground could also include the use of small directional mirrors, which would redirect lasers from ground stations onto targets at very great distances. Armed with solar panels on such an Airship, energy could be produced for years providing the operational commander a robust persistent ISR and communication relay platform that would most likely reduce his demand for satellite and aircraft assets. Flight level 650 and beyond is ready for us to exploit.

Are we ready to make it happen?


Image courtesy of NASA

"Spacecraft have a minimum altitude requirement".

BEYOND TECHNOLOGY:

Successful Unmanned Aircraft System Employment

By Colonel Stephen P. Luxion, USA A, JAPCC

Frequently, there are stories published that advocate unmanned aircraft systems (UAS) as the way of the future. These stories espouse how much cheaper and safer these unpiloted drones are for conducting military missions over their manned counterparts. Most visionary and conceptional work focuses on technology. However, based on my two-year experience as a Predator squadron commander, the success of these "unmanned" systems depends more on the men and women that provide the leadership, testing, training, operation, and maintenance of these systems, than the technology itself.

The major focus on technology and cost comes at the expense of these other factors that are at least as important. The current emphasis on issues such as computer processing speed, levels of UAS autonomy, sensor technology, and communications architectures can diminish the importance of other critical issues including the manning and organizational structure required to support and advance "unmanned" systems.

Technological innovation is only one part of the transformation process. Transformation involves improvements in the areas of doctrine, organization, training, materiel, logistics, personnel, facilities and integration (DOTMLPFI). Some level of transformation is necessary across all these areas to maximize the military advantage UAS represent. The focus of this article is on transformation supported by personnel and organizational change.

In his work, *Innovation and the Modern Military: Winning the Next War*, Stephen Rosen, backs the position that there are many important drivers and aspects to military innovation. One of his many conclusions is that it is not money that is the key to innovation but talented military personnel.[1] More importantly, he concludes that a

"failure to redirect human resources resulted in the abortion of several promising innovations".[2] History shows talented manpower is critical to innovation. Our current experience with UAS demonstrates similar results.

Predator

Clearly, the integration of various technologies is important to the development of UAS. Advances in computing power, communications bandwidth, composite material manufacturing, sensor technologies as well as numerous other technological developments all combined to provide a military application in the Predator aircraft. But, the Predator UAS was a component of the US Air Force for years, with minimal operational success, until senior leadership saw the potential and provided the vision and a way ahead.

Predator, from the beginning, had the endurance and sensor capability necessary to provide commanders persistent near real-time full-motion video of the battlespace. What was lacking was the ability to do something quickly with the information Predator provided on time sensitive and high-value targets. The vision was to have in one UAS, the means to find, fix, target, track, engage and assess targets. However, the implementation of this vision met resistance until the USAF made the decision to employ more aggressive fighter, attack, bomber and special operations' pilots with experience in weapons' employment. It was these officers trained in the employment of air-to-ground weapons and large force packages that were able to fulfill the vision of senior officers.

Most military professionals have heard the stories of how a laser was added to the reconnaissance pod to "buddy-guide" laser-guided bombs delivered from other fighter aircraft onto targets. Also well known is the fact that the Hellfire missile was modified for employment from the Predator and how radios were


Photo by USAF

MQ-1B Predator

added to provide communications between the Predator and other aircraft in its vicinity. The integration of all these new technologies into the UAS was truly remarkable and tends to be the focus of many road ahead and visionary documents pushing the virtues of unmanned systems. However, it was the efforts of experienced aircrews, maintainers, and weapons experts that were at least as important to the successful integration of technology into the Predator and the development of the concepts of operation and tactics, techniques, and procedures (TTP) that made it all work on the battlefield.

The new breed of Predator pilot, with their air-to-ground expertise, worked with engineers to develop the procedures, displays, and checklists necessary for the successful employment of weapons from the aircraft. This was no easy task. Developing reliable procedures and displays that would work, despite the distance between aircraft and pilot and the time delay caused by satellite communications, was fraught with challenge.

Concurrently, Predator pilots with forward air controller (FAC) expertise, advanced current close air support (CAS) TTP to integrate the Predator with other weapons' systems. The Predator had proven its worth at finding targets, but more was needed to effectively engage the targets. These pilots developed the procedures to safely operate UAS in the same airspace as manned aircraft, in order to effectively identify and engage targets as a Hunter-Killer team.

"The new breed of Predator pilot, with their air-to-ground expertise, worked with engineers to develop the procedures, displays, and checklists necessary for the successful employment of weapons from the aircraft".

Developing these procedures and technical solutions was simply not enough; training and the full integration with manned aircraft were also necessary. These Predator experts acquired the assets necessary to train manned aircraft pilots and Predator crews together on the procedures. They built leadership confidence through the development and enforcement of training and performance standards and convinced senior staff to allocate valuable resources such as range airspace and manned tactical assets for training and further development. Following the events of September 11, this initial cadre of innovative Predator aircrews played an important role in convincing wartime commanders to employ and to continue to improve these new capabilities in combat when lives were at stake.

Organizational Change

Although the Predator capability has been validated through operations in Afghanistan and Iraq, more must be done. Predator and Global Hawk assignments, historically, have been two to three-year assignments for pilots away from their primary weapon system. Following their UAS assignment, these experienced aircrew return to their previous aircraft. The USAF has now determined that this is not sufficient for the long-term development of unmanned systems. It is now in the process of implementing the organizational changes that Rosen documented as necessary for successful innovation. The USAF has committed to the development of a career path for young officers to learn and practise the new ways of unmanned aerial warfare.[3] Rosen states that such changes are "necessary to ensure that the new skills are not relegated to professional oblivion".[4] By providing a UAS career path, the USAF will ensure a pool of unmanned aircraft experts to work all levels and aspects of UAS development are maintained.

Predator being prepared for operations

Conclusion

The ability of pilots to conduct operations remotely from halfway around the world is truly a technological marvel. Still, these systems and the TTP to employ them are being developed, tested, and flown by skilled airmen. Discussions of drones operating autonomously throughout the world, without a man-in-the-loop, are premature. Even if this becomes technically feasible, it is unlikely that it will be politically acceptable to remove the human from the command and control of the mission. Although it is likely that technology will make pilots' stick and rudder skills less important, their skills as professional aviators, accompanied by their situation awareness, will remain critical. UAS, even those with an autonomous capability, will still require a pilot to be responsible for the aircraft or flight of multiple aircraft, the implementation of rules of engagement and overall mission management. More importantly, UAS operations and the continued innovation required needs more than technological solutions. Doctrine, organization, the training of highly proficient aircrew/operators, materiel, logistics and the integration with other joint systems will all play an important role. Some may ask what then makes UAS so different than manned systems.

"By providing a UAS career path, the USAF will ensure a pool of unmanned aircraft experts to work all levels and aspects of UAS development are maintained".

The new breed of Predator pilot

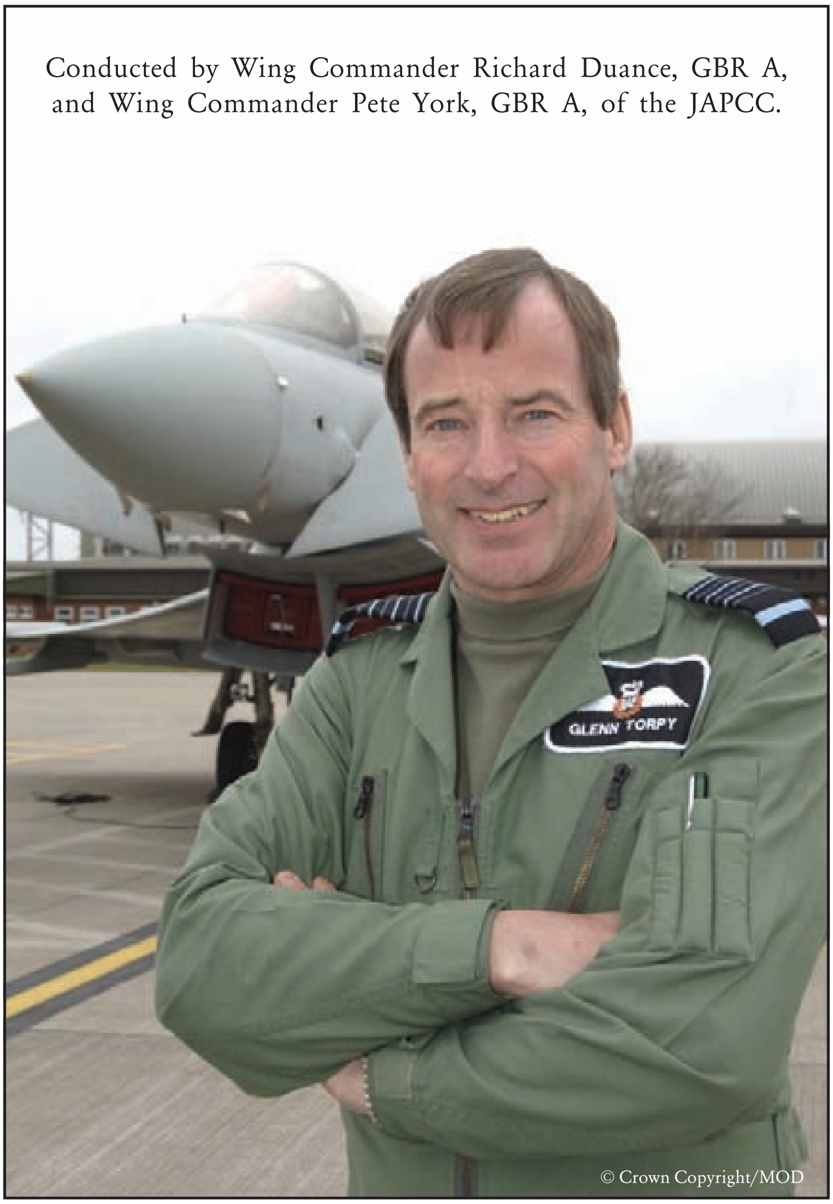
Very little and that is the point! ■

[1] Stephen Peter Rosen, Innovation and the Modern Military: Winning the Next War, (Ithaca: Cornell Press, 1991), 252.
[2] Ibid., 252-253.
[3] Ibid., 20.
[4] Ibid., 20-21.

An Interview with Chief of the Air Staff Royal Air Force

Air Chief Marshal Sir Glenn Torpy, KCB, CBE, DSO, BSc(Eng), FRAeS, RAF

Conducted by Wing Commander Richard Duance, GBR A, and Wing Commander Pete York, GBR A, of the JAPCC.



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Sir, Congratulations on your recent appointment as Chief of the Air Staff, Royal Air Force. On taking up this post, what do you see as the key challenges facing the Service and what are your key priorities?

I see myself building on the foundations set by Sir Jock Stirrup and his predecessors. We've made excellent progress towards generating an agile and adaptable force structure, more suited to today's security environment. The shift from a Cold War orientated Main Operating Base culture has not been easy but I genuinely believe that we now have a balanced Air Force, which is structured and orientated towards expeditionary operations. Agility is at the heart of our capability. Our aim is to achieve rapid effect across the battlespace, but we also need to be able to adapt swiftly to changes in the overall security environment. We need to keep pace with that change, intellectually and doctrinally, and our equipment needs to have the embedded flexibility to be capable of adapting to new demands. As a consequence, single role platforms will, I believe, become increasingly something of the past; from both a financial and operational perspective, multi-role must be the way forward. We must also make sure that we have the right people to support the frontline and ensure that they are just as agile and adaptable as our equipment.

In terms of priorities, further development of our expeditionary capability must lie at the top of the list, especially in the areas of Command and Control (C2) and expeditionary logistics. Secondly, I want to reduce operating costs. HQs need to be smaller and more agile and fit more closely with the reduced size of our frontline; this is already underway with the collocation of HQ Strike Command and HQ Personnel and Training Command. But we also have to streamline our processes. Here I believe we can draw on the lessons from operations where we have small, relatively flat, HQ structures in which responsibility is genuinely delegated; we need to translate that experience into our peacetime HQs, rigorously shedding tasks that are no longer relevant. On the equipment front, Typhoon has to be our main equipment priority; it will be the backbone of our fast jet force for the future. We also need to develop our UAV and UCAV capability, both of which offer significant capabilities for the future. That said, we need to gain a better understanding of how these platforms can contribute most effectively, and the associated costs. I also believe greater priority should be given to integrated air-land operations. Op DESERT STORM and Op ALLIED FORCE involved distinct air campaigns followed by discrete land campaigns. On the other hand, Op ENDURING FREEDOM and Op IRAQI FREEDOM (OIF) demonstrated the need for, and value of, truly integrated operations, with the Air Component providing significant support to the Land Component. This must continue in the future. To support that, more realistic training is required, particularly through the use of synthetics and distributed mission training. This will help to reduce costs but, more importantly, as we move into an increasingly networked environment, it will be the only way to deliver effective, joined-up training.

"Greater priority should be given to integrated air-land operations".

Would you care to comment at this stage on the Lessons Learnt from Iraq and Afghanistan?

Yes, I think one of the main lessons we have learnt is the need to be able to respond quickly to unpredictable events, often over strategic distances. Balanced forces, held at high readiness, with robust strategic mobility and appropriate C2, are essential for today's security environment. As an example, during Op TELIC we established 8 Forward Operating Bases and associated C2 – in 7 different countries – in just 6 weeks; this was a significant achievement. Additionally, Iraq and Afghanistan have both emphasised the complex, ambiguous and non-linear nature of the modern battlespace, in which asymmetric threats feature heavily and engagement opportunities may be brief and unpredictable. Speed, therefore, will be of the essence. The other thing we have seen very clearly in Iraq and Afghanistan is that the military - during many phases of an operation – will be playing a supporting role. Although there may be periods of high intensity warfare, Other Government Departments and Non-Governmental Organisations will have a vital role to play from the very start, not least in delivering humanitarian relief and reconstruction. This makes life more complex and increases the need for a fully integrated campaign plan, which draws together all the levers of government. The task is made all the more challenging when the efforts of other Coalition partners have to be integrated into the plan.

In that respect, do you see a need to shift away from combat aircraft like Typhoon more towards support platforms like Support Helicopters (SH) and Strategic Air Transport (AT)?

No, I don't. I see maintaining a coherent force structure, which places appropriate emphasis on enabling capabilities – such as AT and SH - as the most important task. Both of these capabilities are being fully utilised in current operations, but C2 and ISTAR are also absolutely fundamental to the way we conduct business. It would be too easy – and convenient – to reshape our force structure to suit the environments we are dealing with today in Iraq and Afghanistan, to the detriment of being able to cope with the unpredictable. More to the point, our fast-jets – like Tornado GR4 and Harrier GR7 – are playing a vital role in delivering CAS and ISR to Coalition ground forces. It's worth noting that during OIF, 80% of the air effort went to the Land Component and I see this trend continuing in the future. The other significant lesson to come out of operations in Iraq and Afghanistan is the need for Air Dominance. The Coalition's complete control of the air provided freedom of manoeuvre and action to each of the Components; this allowed the Coalition to use relatively light ground forces – because firepower

"Typhoon has to be our main equipment priority; it will be the backbone of our fast jet force for the future".

was available from the air – and meant that key enabling capabilities, such as tankers, ISTAR and C2 platforms, could operate well forward in order to maximize their effectiveness. Another area that requires further investment is our ability to generate and maintain a shared picture of the battlespace; without that we will not be able to effectively conduct collaborative planning and deliver truly joint effects. At the moment, we still rely too much on the procedural separation of activities and forces – in time and space – in order to prevent fratricide.

Recent operations have confirmed the need for precision. But what we lack is persistence over the battlespace – both in terms of ISTAR and a striking capability. This is where UAV and UCAV are likely to play a crucial role, particularly as more sophisticated weapons - like directed energy weapons - become available. This will allow platforms to remain airborne for many hours or even days without rearming. Having a persistent ISTAR and striking capability offers significant opportunities for increasing the speed and tempo of operations and, of course, our ability to engage small, fleeting targets. But going back to your original question, I firmly believe that we must remain postured for the unexpected, which means maintaining a coherent and balanced force structure, including high-end capabilities like Typhoon.

Surely a challenge for today is how we get the right capabilities to the front-line, on time and within budget. What is the RAF doing to make sure this occurs?

You are absolutely correct. Central to achieving this objective is the development of an agile

procurement process, which is able to keep pace with changes in the operational environment and, importantly, exploit the rapid advances in technology that we see today. The recent announcement of the UK's Defence Industrial Strategy, which proposes a closer partnership between the MOD and Industry, will, I hope, be one of the mechanisms for delivering this agility. If you look back over the past 15 years, the UK's Armed Forces have been committed almost continuously on operations, and we owe it to our servicemen and women to provide them with the best possible capability from the resources of the Defence Budget. A better partnership will allow industry to focus their resources, especially in areas such as Research and Development, and create an environment where industry is much more involved in the through-life support of platforms. Incorporating the potential for growth and incremental capability enhancements need to be key features of this strategy.

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"We also need to be able to adapt swiftly to changes in the overall security environment."

On the military front, we need to be a lot more rigorous in setting requirements – we need to say what we need, rather than what we would like. Regrettably, technology is seductive, and we are all prone to asking for the moon!! We also need to make more use of experimentation and, where appropriate, the early introduction of possibly immature technology which, in the hands of the war fighter, can be incrementally developed. The introduction of Predator by the USAF is a classic example of how this can work and the enormous benefits that result, both in delivering an early operational capability and steering future development.

The NATO Response Force (NRF) is one of the drivers for NATO's military transformation. In the last edition of the JAPCC Journal, Lt Gen Gaviard, Chief of Air Defence and Air Operations, French Air Force suggested that national air components should increasingly take responsibility for providing the complete ACC, air forces and support. What is your view?

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"Further development of our expeditionary capability must lie at the top of the list".

I can understand why Gen Gaviard takes that view. From both a training and execution perspective, drawing from one nation is the simplest solution. That said, I think it's probably a bit of a tall order to expect a single nation to take on the complete task, especially with the number of other commitments we face. At the moment, the US, UK and France are probably the only nations that have the complete range of capabilities required to fulfil this role singly. I believe, therefore, that a more likely option could be, perhaps, 2 or 3 nations in conjunction with NATO, getting together to fill a particular NRF period – or back-to-back periods - with one leading as the framework nation. This worked well for NRF 5 and 6, and provides a useful framework to improve interoperability and burden share.

And finally, a very important question. If they meet in the competition, do you think England will beat Germany in the World Cup?

I'm sure it will be a highly competitive match!

Sir, thank you for your time. ■

30 Years of Israeli UAV Experience

Interoperability and Commonality

By Yair Dubester – Israel Aircraft Industries(IAI)/MALAT General Manager
Ido Pickel (IAF Capt. Res.) – IAI/MALAT UAV Operator

This article presents a brief overview of the Israeli experience in the domain of Unmanned Air Vehicles (UAV) based on numerous operational challenges from 1973 to the present day. The various UAV solutions, which were conceived over the years, are presented below detailing the operational requirements, technologies and design principles used.

Over these 33 years, we have seen an evolution from simple, proof-of-concept Remotely Piloted Vehicles (RPVs) to a multiplicity of advanced, fully operational UAV systems responding to the demands of practically all military forces and echelons. The 1973 Yom Kippur War was the impetus for raising the operational level of the UAV by incorporating real-time video assets capable of tracking mobile SAM batteries in threatened areas. The R&D matured even further resulting in the "Scout" UAV system which first saw operational use with the Israeli forces during the "Peace for Galilee" campaign in the early 1980's. Since then, the operational mission use of UAV has only intensified with a continuous and significant increase in flight hours around the world.

The Combat in the Bekaa Valley

The Scout UAV were used with unparalleled success during the 1982 “Peace for Galilee” campaign. The strikes against Syrian missile batteries in the Bekaa Valley are excellent examples of effective UAV use in combat, both in a SEAD scenario and as close support to ground forces. The UAVs were used to detect, identify, and perform target acquisition for strike aircraft followed by immediate real-time BDA.

The results were impressive. Most of the SAM batteries in the Bekaa Valley were destroyed, and a large number of fighters defending the SAMs shot down. Israel had achieved air supremacy of the region in but a single afternoon.

The Scout UAV was removed from service in 2004 after almost 25 years of successful operations. During that period this tactical UAV system saw numerous upgrades, improvements and adaptations, in order to respond to continuously sophisticated operational requirements.

SCOUT – 25 years of Operational Service

Enlarging The Envelope

A direct consequence of the successful UAV operation in the 1982 campaign supporting SEAD operations was the US Navy's interest in adapting the Israeli UAV to their requirements. The result of this effort was the highly successful and still operational (with the US Marines) Pioneer UAV, a direct derivative of the Scout. The Pioneer UAV was originally adapted for Navy operations by implementing point rocket launch and point recovery by means of a net set up on the ship's deck. Several Pioneer systems saw extensive use during the 1991 "Desert Storm" campaign in Iraq, once again proving its capabilities and reliability

Pioneer – The Sea Master

with great success. In accordance with the US UAV Roadmap, operation of the Pioneer with the US Marines is planned to extend up to 2015.

Bigger, Longer, Higher

After proving itself operationally in SEAD, Targeting and general ISR missions, the evolving requirements led to the gradual fielding of UAV systems with enlarged operational envelopes. That meant growing not only from a mission perspective, from which also evolved new payloads and concepts of operation, but also from other perspectives, such as flight performance, around-the-clock/all-weather operational availability and dedicated capabilities for specific missions on the edge of that envelope. To state just a few examples: the ability to operate

Searcher UAV with SAR Capability

around-the-clock without landing and with combined Colour Electro Optical/Infra Red payloads, in

Ranger – Features skid-landing on grass and snow

adverse weather conditions with Synthetic Aperture Radar/Ground Moving Target Indicator payloads,

Hunter - "The most reliable tactical UAV in the US"

and to perform SIGINT missions, such as ELINT and COMINT. The increase in requirements and missions led to the fielding of the even larger systems, e.g. Hunter, Searcher and Ranger UAV systems.

Smaller, Lower, Affordable

Now that the tactical UAVs had proven themselves worthy at the division level and higher, the need arose towards providing the UAV asset to all forces. Independent real-time ISR capability was now to come to the lower echelons such as the brigade, company or Special Forces. This was especially needed for missions such as urban warfare and homeland security which became ever more common.

This requirement generated the development of two new "families" of UAVs, the small Tactical UAV (TUAV) and the mini UAV. In fact, this family approach was chosen in order to provide each

I-View TUAV performing pinpoint landing with parafoil

UAV level with its own optimal solution while maintaining maximum commonality and interoperability within the various systems with a minimum logistics effort. The most important lesson learned over the years regarding TUAV was the importance of pinpoint landing in any terrain and a parafoil for controlled landing. The parafoil was tested along with the parachute and was selected due to its ability to allow the TUAV to land safely at a predefined point. The I-View Small TUAV was designed according to that lesson. The small TUAV offers tactical intelligence at the battalion and brigade levels. The focus here is to offer a low-footprint, all weather/all terrain operating capability with dedicated functions, such as pinpoint automatic recovery.

When analyzing the requirements for optimized over-the-hill observation and all terrain operation, the most important requirement is a 360° day or night under the belly payload installation, in order to have a steady, with no limits, real time ISR image at all times. The other requirement is to protect the payload in rough terrain by allowing the Mini UAV to land on its back. The Bird-Eye Mini UAV offers a modular solution for tactical intelligence gathering at the battalion, company and Special Forces levels. It enables offset observation patterns for maximum operating force flexibility.

All In One

Alternatively, the demand arose for UAV capable of longer flights capable of carrying multiple sensors at extended range. For example, Maritime Patrol missions require heavier payloads, greater electrical power capacity, higher flight altitude, longer endurance and greater system reliability. The required system should include a platform, which will be the best "Truck" to carry several sensors simultaneously, that are not sensitive to electromagnetic interference (EMI) and have full interoperability.

This concept was implemented in the Eagle/Heron UAV that was conceived as a multi-payload, multi-mission UAV. The classical twin-boom design enabled the re-positioning of multiple and separately placed antennas away from the engine for minimal or no EMI. The retractable landing gears were put inside the booms freeing up considerable space for various payloads in or under the fuselage. Accordingly, the Navy requirement for offshore maritime ISR gathering resulted in the Advanced Ship Control Station that enables direct system operation from the ship fire control centre. Once a de-icing system was integrated on the "Eagle/Heron" the operational envelope was enlarged even further to include flights in icing conditions.

Where Are We Going?

The use and application of UAV is spreading throughout the world, mainly on military missions. Based on IAI's experience this includes 27 different customers and over 270,000 flight hours. The general direction of development has been based on integrating maturing technologies with continuously evolving user requirements.

- The basics of effective ISR collection are similar for large, as well as small, UAV platforms.
- The Safety level of UAV should meet and even exceed General Aviation safety levels.
- Automatic Taxi, Take-Off and Landing, mission planning and execution capabilities are critical to enhance safety.
- Human Machine Interface and system operations tailored to the level of the enlisted soldier are essential. Simple training and a qualification process is achieved (not requiring certified aircraft pilots) with significant gains in cost and with an optimized operational outcome for each UAV operator. Nevertheless, an Air Traffic qualification is required.
- A "UAV Family" approach should be adopted in order to offer each level of operation with its optimal solution, at the same time maintaining maximum commonality and interoperability.
- For short-term operational requirements or when a fast response is needed, UAV services like System Lease or Power by the Hour should be offered for all UAV platform sizes and payloads.

Bird-Eye Mini UAV

- Integration of the UAV capability into the C^{4}I system is essential in order to link the "Sensor to the shooter" (or user) in real time.
- All systems regardless of their size must meet all airworthiness criteria in order to operate not only in military airspace but also in civil airspace.

There should be two principles for Airspace management. Flying to and from the mission area should be monitored on general aviation flight paths after all means of ensuring safety, such as IFF, have been taken. Flying in the mission area should be in a defined flight segment in a closed military airspace. ■

Manned-Unmanned Missions: Chance or Challenge?

By Prof. Dr. Axel Schulte
Flight Mechanics, Guidance & Control
Institute of System Dynamics and Flight Mechanics, Munich University of the German Armed Forces.

Aeronautics Defense Systems

When thinking of the co-existence of humans and unmanned combat robots furnished with technologies such as artificial intelligence, machine learning and emergent behaviours, our Hollywood-movie-conditioned minds are likely to dwell on visions of uncontrollable, super-intelligent killing machines, turning against their human creators. With this mental picture in mind, the following questions might be worth considering: What are current technologies truly capable of? Can *human/machine co-agency* be achieved? Would it be a concept to benefit NATO war fighters? While trying to answer these questions, I wish to focus on the airborne application, one of the most developing domains in this field as the battlefield deployment of so called Uninhabited Aerial Vehicles (UAVs) is commonplace today.

Today's UAV Guidance Approach

The required automation technology for UAV flight management, guidance, navigation and control has been rapidly developed in the last decade. The general principle of integrating man and such machinery is known as *supervisory control*. While the on-board automation typically performs fast inner control loops (e.g. stabilization and trajectory guidance), the ground-based human operator is responsible for mode selection and demand value setting as the observable outcome of planning, decision-making, human deliberation and anticipation of the level of mission management. Thereby, a *hierarchically organised work system* is established, which may fail due to human or machine error, but it can be assumed that the automation will never intentionally act against the human operator's goals. No one would seriously speak of such an automated UAV being smart or intelligent. The "intelligence" as a result of mental, i.e. cognitive performance, is solely that provided by the human operator.

> *"What are current technologies truly capable of? Can human/machine co-agency be achieved?"*

The inadequacy of this approach becomes obvious when the supervision of multiple vehicles by a single operator is required. Such ideas are currently being discussed in various NATO fora under the

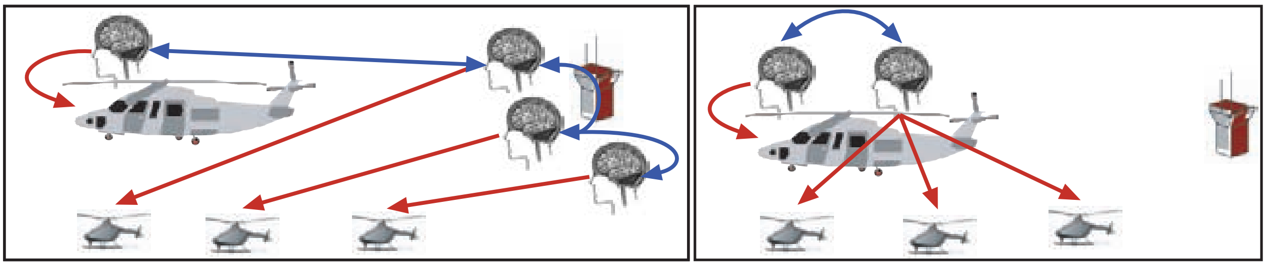

Figure 1: NCW approach with centrally controlled UAVs (left) and MUM-T approach with decentralized UAV operator (right)

term *Manned-unmanned Teaming (MUM-T)*. This is an approach to control multiple UAVs and their payloads simultaneously from a manned aircraft, in order to increase the effectiveness of the manned system in performing its mission. However, while this concept appears clever, there is a likelihood of the human operator reaching *cognitive overload* whilst controlling multiple platforms. Inevitably, this would lead to errors and performance decline.

How to bring in more cognition

How then do we bring in sufficient cognitive capacity to cope with the task of supervising and steering more than one unmanned remote platform in a co-ordinated manner while maintaining control of the parent (manned) aircraft? The obvious answer is to increase manpower by providing at least 1 operator per UAV and placing him somewhere central, e.g. in an AWACS. Task each operator centrally and make the output results attainable via "Internet" for download. This aspect of *Network Centric Warfare (NCW)* is currently being investigated in conjunction with multiple decentralized options, MUM-T being one of them, (Figure 1). The advanced technology involved in the NCW solution is mainly in the field of information technology whereas MUM-T highlights human factors research and autonomous flight guidance issues, the latter being the focus of this article.

Autonomy, Co-agency or Both?

The question remains how to build enough cognition into a MUM-T setup. From a purely technology-driven stance, the simple answer could probably be to make the UAVs autonomous! So, what are the requirements of an appropriate *autonomous system* and what are its differences to the aforementioned automated system? Commonly, an autonomous system would be expected to pursue the overall goals of the considered mission, be reactive to perceived external situational dynamics, generate solutions by means of anticipation, deliberation and planning and execute them without human intervention; in short to be an *artificial cognitive system*. But, what use might such a system be, performing completely detached from human input? Imagine a member of a purely human team who is unapproachable to his teammates and you have the answer! Obviously, making the UAVs autonomous in this limited sense is not the solution!

"Obviously, making the UAVs autonomous in this limited sense is not the solution!"

In order to embed the UAVs into the highly interactive work environment of a MUM scenario, incorporating teamwork is compulsory, the basis of which is the appreciation of the behaviour of teammates, humans and machines alike. Establishing the capability of teaming between humans and machines will be referred to as *co-operative control*, as opposed to the classical paradigm of supervisory control. Interaction shall no longer occur at the level of mode selection and demand value settings but through the negotiation of requests and commitments at the task level. This will be based upon a common current situational understanding by both humans and machines. Although the final decision authority (e.g. for weapon deployment) stays with the human operating element, there will be established a peer team of the human and several *artificial cognitive units* on-board each UAV and an *intelligent operator assistant system* on-board the manned aircraft (see Figure 2 for the architecture). Therefore, various machine capabilities have to be implemented, for instance:

- *Mission accomplishment* to autonomously comply with the mission objective.
- *Operator assistance* to direct the human's attention, by technical means, to the most urgent task and to balance his workload whenever demanded by the situation.
- Human-machine and machine-machine *co-operation* in order to

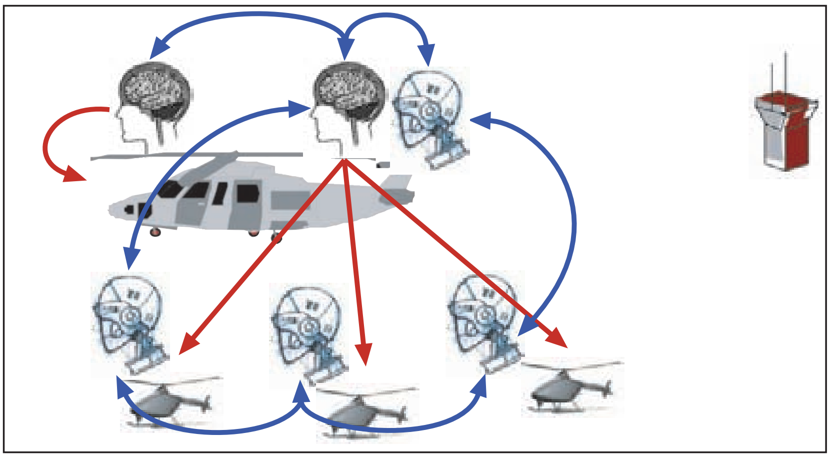

Figure 2: MUM-T architecture with intelligent operator assistant system and artificial cognition on-board the UAVs

achieve common top-level goals, such as team building and the co-ordinated pursuit of a common mission objective.

Approaching Artificial Cognition

In order to implement such functionalities there are several approaches available. Artificial intelligence, expert systems, soft computing, machine learning and genetic algorithms are just a few up-to-date keywords, predominantly denoting methodological approaches to process knowledge. Most are poor from an architectural viewpoint. The theory of agents offers such a conceptual perspective, though mostly leaving out the method aspect. One promising approach combining both has been developed at the Bundeswehr University located in Munich, the so-called *Cognitive Process (CP)*. The CP comprises a layered architecture of capabilities, all of which are structured according to the CP blueprint of the sub-processes, namely, situation gathering and interpretation, goal determination and planning and plan execution (see Figure 3). It is strictly structured along the line of a *knowledge-based architecture*, separating an application-independent inference (i.e. processing) engine from the explicit, central representation of static *a-priori* knowledge and dynamic situational knowledge. The *a-priori* knowledge will be implemented by a knowledge engineer on the abstract level of so called *mental notions*, whereby the modelling of e.g. goals to be pursued or action alternatives and their related behaviour will be possible.

On the basis of the CP, an engineering framework for implementing artificial cognitive units in an efficient manner has been developed, the so-called *Cognitive System Architecture (COSA)*. On the basis of the rule-based architecture *Soar (State Operator and Result)*, an object-oriented layer has been designed with *Cognitive Programming Language (CPL)*. Currently, further work is planned to advance the system for future operation on embedded real-time computing platforms.

Applied Research

Researchers at the Bundeswehr University have been working on co-operative automation technology in the field of aircraft guidance for almost 20 years. Early approaches were on knowledge-based systems assisting airline pilots in IFR flight. The *Cockpit Assistant System (CASSY)* was successfully flight tested in 1994; it was the first prototype of its kind. The *Crew Assistant Military Aircraft (CAMA)* followed in the late 1990s, incorporating technology capable of autonomously performing mission tasks (e.g. tactical situation analysis, tactical re-planning) on the basis of goal-oriented behaviours, while keeping up a situation adapted dialogue with the pilot, in order to balance his workload. More recent work focuses on the co-agency of autonomously co-operating Unmanned Combat Aerial Vehicles (UCAVs) in a Suppression of

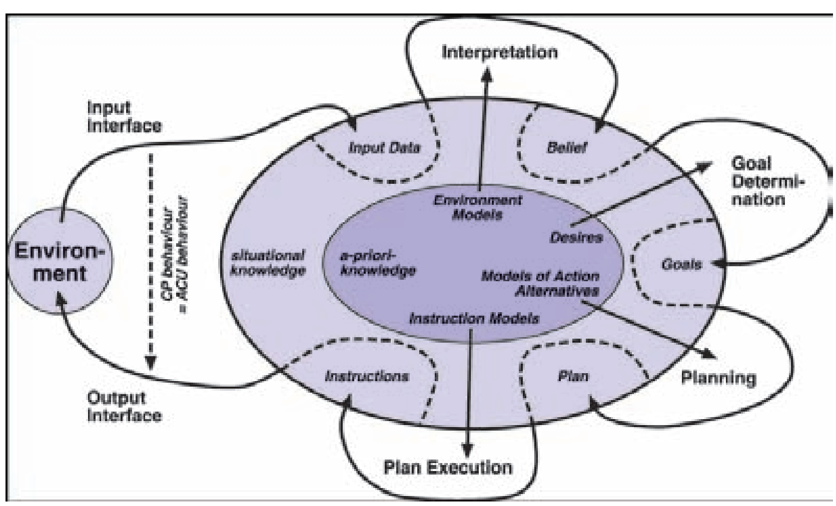

Figure 3: The Cognitive Process

Rotorcraft UAV Demonstrator

Enemy Air Defence (SEAD) scenario. The scope of this research is on the co-ordination of machine agents, i.e. the UCAVs, on the basis of goal-driven dialogues negotiating for task allocation. Upcoming activities will cover *adaptive automation,* to provide intelligent crew assistance in military helicopter guidance and *manned-unmanned teaming* for airborne army missions, both of which involve technologies of cognitive automation and human-machine as well as machine-machine co-operation and co-agency. The technologies will be field tested on the Bundeswehr University UAV demonstrator platforms, currently under construction. ■

"Researchers at the Bundeswehr University have been working on co-operative automation technology in the field of aircraft guidance for almost 20 years".

Fixed-Wing UAV Demonstrator

Photo USAF

MANNED Vs UNMANNED

Aerial Systems - False Expectations, Real Opportunities & Future Challenges.

By Dr Andrea Nativi

The United States currently has around 250 Unmanned Aerial Vehicles (UAVs)/ Unmanned Combat Aerial Vehicles (UCAVs) in service. By 2015, that number will rise to 1,400 excluding the smaller types. Before 2011, the US also plans to spend US$13 Billion[1] developing unmanned aerial system technology. From these figures alone, we could conclude that the days of the manned aircraft, both fixed and rotary wing, are numbered. However, we should not forget the number and variety of manned aircraft currently in use, which yet have extensive flying lives remaining. Neither should we ignore the fact that much more money than that stated above is being invested in a variety of major manned aircraft programmes, some of which will be in service for the next 25-35 years. The demise of the pilot, therefore, may not be such an imminent issue. In this article I will investigate this discussion by examining some of the pros and cons of unmanned aerial systems in the military context with a view to predicting the likely future development of this technology.

> *"While a pilot may need to fly his aircraft for a minimum of 150 hours per year to remain current, a UAS can remain stored in its hangar for most of that time, with the vast majority of UAS controller training conducted on flight simulators".*

There are, of course, numerous advantages in operating without the pilot. Flight endurance is no longer limited by the capabilities of the human being and weight and volume savings accrue from the omission of crew related support systems. While a pilot may need to fly his aircraft for a minimum of 150 hours per year to remain current, an unmanned aerial system (UAS) can remain stored in its hangar for most of that time, with the vast majority of UAS controller training conducted on flight simulators. Furthermore, UAS can be designed to operate in extreme conditions; flight envelopes can be stretched without risk to human life and UAS can be sent to places where it would be too dangerous to send a live crew. This is particularly advantageous in combat zones and for intelligence gathering. Yet, although UAS have been widely used since the Vietnam War, they have all too often been quickly put aside. Why is this?

Firstly, many UAS currently in service are little more than conventional aircraft without a pilot. Although some UAS are making possible missions that were never considered before[1] e.g. very long and dangerous Intelligence,

"The demise of the pilot, therefore, may not be such an imminent issue".

Surveillance and Reconnaissance (ISR) flights over unfriendly terrain, or attack missions against heavily defended enemy assets into which it would be too dangerous to risk a manned aircraft, no UCAV currently in development or design is offering capabilities that a conventional aircraft or anti-aircraft SAM or air-to-air missile cannot match. In short, UAS have yet to bring any new capabilities to the Air Commander.

Secondly, UAS were touted as a much cheaper alternative to piloted aircraft. Instead, R&D costs, IT development limitations and technical advances have brought with them costs, which are as high, if not higher, than the costs of operating conventional aircraft.

Thirdly, experience with UAS has shown an unwelcome tendency of increased levels of operational failure, much of it associated to technical and controller error mishaps[2]. Such sortie loss, failure and UAS attrition rates may be acceptable for small and inexpensive tactical systems but this is not so for the bigger, more complex and costly models. Training controllers to operate UAS, including mission control systems, is more complex and expensive than envisioned. In addition, parallel advances in flight simulator technology and their resultant economies in pilot training plus a very real need regularly to integrate UAS sorties with manned aircraft missions in busy airspace, have soaked up much of the expected financial savings from omitting pilots from the cockpit. Finally, there are political difficulties. Less wealthy countries cannot afford the R & D costs associated with developing UAS, nor can they afford to buy the tested technology. However, a wealthy nation may be able to absorb the cost of an UAV crash but other countries could perhaps more readily face the political cost of the loss of a pilot than the perceived waste of money in crashing a valuable unmanned vehicle.

"UAS are still in their infancy".

The Future

We must not forget that UAS are still in their infancy and their growth rate is much faster than is the case for manned aircraft, so a far brighter future is probably within reach. However, users should not sit and wait for truly reliable UAS that can simply duplicate what manned aircraft can do now. Already, accumulated experience with UAS has shown that there is no magical economic advantage in retiring current aircraft just because an UAS can perform the same mission with the same results. UAS need to become much better in every single respect.

Engineers have long complained that the human body is limiting the performance of aircraft. UAV development presents an opportunity to explore new materials and much stronger structures that can withstand higher loads or extreme temperatures. New engines can be developed that are conceived to operate for days in the most demanding ambient conditions, as can more advanced aircraft systems and new sets of control laws that allow UAVs to operate in a much different way to conventional aircraft[3]. It is conceivable that future UAVs will be able to outperform every "traditional" aircraft or missile in combat, facing perhaps a threat only from directed energy weapons.

In summary, promoting the UAS revolution to achieve economies simply by eliminating human cockpits does not seem a sound approach. In order to achieve or at least to explore the limits and the viability of a realistic future UAS concept, there is a need for vision, a willingness to take risk and to invest. ■

[1] US Dept. of Defence, Office of the Secretary of Defense, Unmanned Aircraft Systems Roadmap 2005 – 2030, July 2005, Washington DC.

[2] US DAB Study, Unmanned Aerial Vehicles and Uninhabited Combat Aerial Vehicles, February 2004, Washington DC.

[3] As demonstrated by many research programs, such as HIMAT, X-29, X-31.


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Lessons Learned from Predator Operations

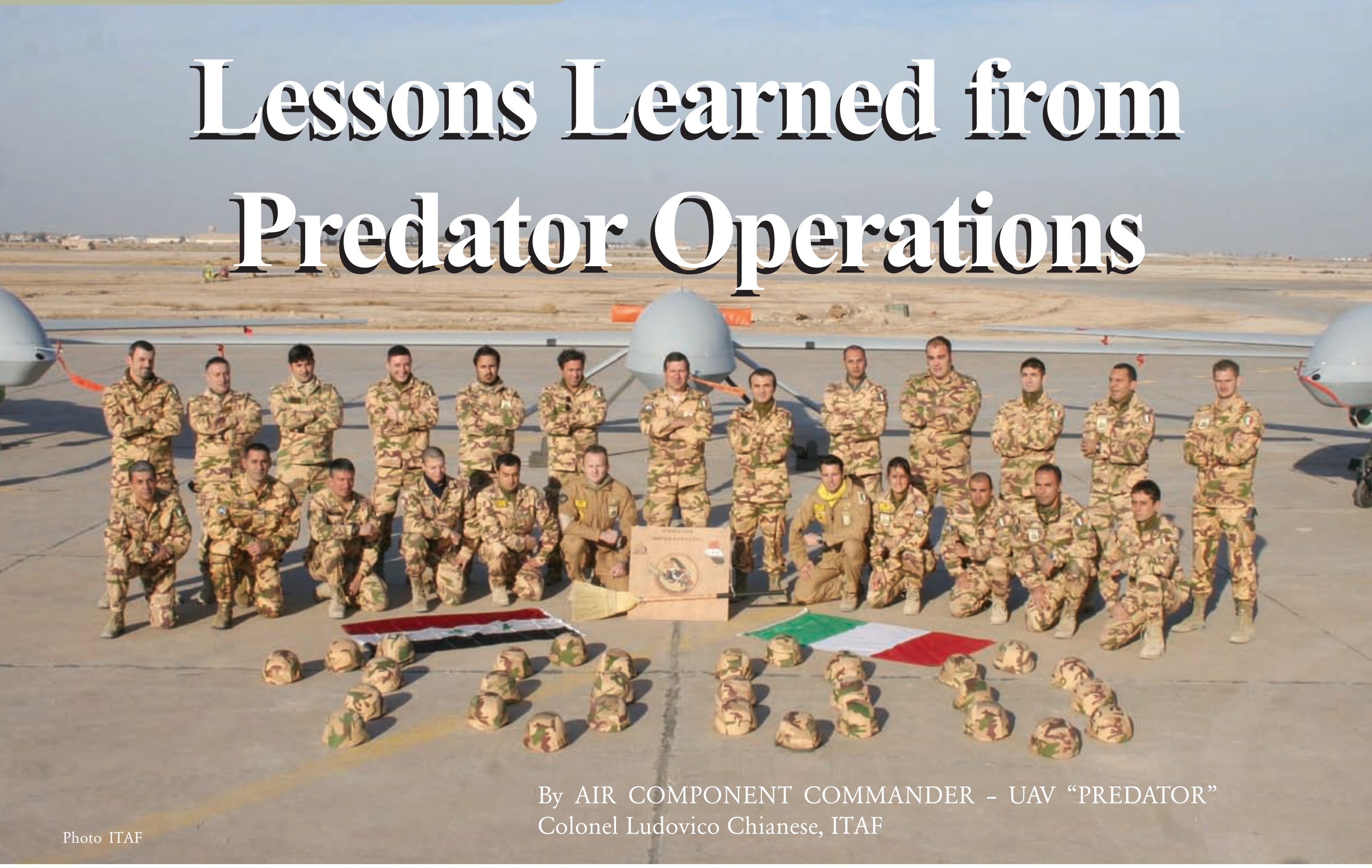


Photo ITAF

By AIR COMPONENT COMMANDER – UAV "PREDATOR"
Colonel Ludovico Chianese, ITAF

The Italian Air Force (IAF) currently has 4 RQ-1A Predator UAVs in service. They were bought from General Atomics Aeronautical Systems (GA-ASI) and assembled by METEOR (Italy). The system was deployed in Tallil (Iraq) in January 2005, in support of the Italian Joint Task Force in the Dhi Qar province. A few days after deployment, the system was ready to fly its first mission. Just 1 year later, the aircraft have accumulated over 1000 flying hours, achieving Initial Operational Capability in a very short time. The aim of this article is to highlight some of the lessons the IAF has learned from its early experience with the Predator.

"System"

The word "system" has been intentionally used to underline that, unlike "manned" aircraft, UAVs need an integrated combination of a Ground Control Station (GCS), a datalink system, Line Of Sight (LOS) or Beyond LOS (BLOS) antennas, an exploitation cell and the aircraft themselves. If any one of these components fails, the entire asset would be useless. This simple statement can be considered one of the most important "lessons learned" that implied a change of mentality. There was a need to switch from a traditional system, where the aircraft is the *core business*, to a different system, which focuses on the flow of information, how you use that flow of information and how quickly you are able to make decisions based upon it. The achievement of this different system could well be considered the first step towards a *net centric system*, consisting of a decision maker, sensors and shooters net, including the various sub-systems. This is one of the goals being pursued by the Italian Defence Strategic Concept. This is not an easy process and it is still undergoing strategic analysis by our Headquarters.

> *"The staff's job is made the more difficult by the UAVs' relatively new concept of operations and because few countries have UAV experience on which we can rely".*

The staff's job is made the more difficult by the UAVs' relatively new concept of operations and because few countries have UAV experience on which we can rely. Similarly, the jointness of the programme is a challenge in itself since all users, Air Force, Navy, Army and police forces, have different needs and expectations. State of the Art technological requirements, such as

Ku Band Satellites, sophisticated Optic, IR and radar sensors, all require highly trained and specialized operating and servicing personnel. Last but not least, universal reductions in national defence budgets will really challenge Military HQs to find the best way to allow these programmes to survive.

Programme Development

Programme development must also integrate civilian companies working within the Defence environment and take into consideration their capabilities, interests, know-how and so on. L3 COM, GA-ASI subcontractor for satellite aspects, is working to provide fine-tuning to the chosen satellite for BLOS capability, which will be needed to reach Full Operational Capability (FOC). TELESPAZIO, the Italian contractor with the Armed Forces for satellite services, is providing the appropriate channels and bandwidth on the satellite constellation. SELEX, another Italian company, is the actual provider for the aircraft spare parts.

If we now look to the future, the situation is even more complicated. The Predator will receive a system upgrade to improve its performance. All these upgrades are intended to support the interests of the Italian Armed Forces to exploit the full potential of UAVs. That is to improve our ability to use UAVs to replace high value assets in routine or even dangerous jobs and to save human lives.

From an operational point of view, LOS only enables less than optimum utilization of the UAV system. When BLOS is implemented, there will be virtually no range limitations due to high endurance (about 30 flying hours) and wide satellite area coverage. However, limitations are arising from manning, due to high training costs and the small numbers of qualified personnel. Moreover, very intense operational workloads during on-shift periods limit duty times for those personnel who are qualified. The spare part logistic cycle also needs to be improved to reduce Estimate Time Replaceable Operatives.

Weather limitations are also a significant factor. Moderate to severe precipitation, crosswinds over 14 kts, surface winds over 29 kts, ceilings below 800 ft, visibility below 3200 m, moderate to severe icing or turbulence, lightning closer than 18 km or ground temperatures over 40°C are all limitations, some of which will be overcome by the system upgrade.

Moreover, the pre-take-off procedures for each flight take up to 90 minutes. In tactical situations, where UAVs may be needed for short notice tasking, it is necessary to fly the UAVs either on Combat Air Patrol or hold them on the ground on Quick Readiness Alert, either of which is expensive in terms of flying hours and/or personnel effort.

The Unit that operates Italian Predators is the 28th UAV Sqn, based in Amendola. A former recce Sqn operating the F-104, then the AMX, the Sqn has been converted to UAVs through pilot and payloader training in the US. Mission Monitors are recruited from officers with an Intel background after a system software course. Exploitation cell personnel are recruited from photo interpreter and intelligence courses. Personnel are drawn from Army, Navy and Air Force Branches. Pilots keep their flying currency on the aircraft they used to fly before joining UAVs in order to retain their currency and motivation.

Complex New World

In conclusion, UAVs are a complex new world and their operation has brought considerable success but also some unexpected challenges. Technological developments and the need to work closely with industry have been unfamiliar areas. Trained manpower requirements and the intense workload on operators have also been higher than expected. Surprisingly restrictive weather limitations have also hampered operations, as have the respective times taken for planning and preparing the UAVs for flight. The Italian Air Force has made considerable progress with the RQ-1A Predator during their early operation and we continue to move forward towards FOC. ■

RQ-1A Predator on final approach.

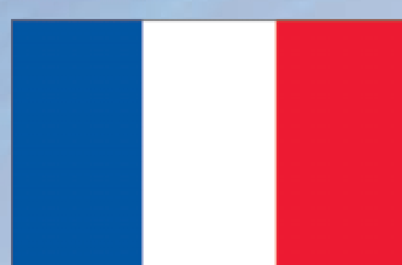
Unmanned Air Vehicles:

Some National Perspectives

The JAPCC is promoting 2006 as the year of the Unmanned Aerial Vehicle (UAV). The UAV is recognized as a major contributor to transformation in our nations' Services and NATO as a whole. In March 2006, the JAPCC hosted a UAV Forum at CC-Air Ramstein; the theme of this edition of the JAPCC Journal is but another example of the importance of this fast developing area of joint air power. NATO has much work to do to properly exploit this capability. Therefore, Lt Gen Schubert, Executive Director of the JAPCC, invited the Air Chiefs of the JAPCC sponsoring nations to provide an insight into their nation's experience with UAVs, both now and for the future.

The extracts here illustrate the broad nature of UAV experience.

Canada has found UAVs to be highly significant in reorienting our ideas and the architecture of a truly joint C4ISR system. Instead of considering these machines as individual aviation assets with unique functions, they are more critically viewed as specialized components of a larger information grid. This simple observation suggests that our lessons learned in this new capability area will rapidly accumulate; our emerging UAV doctrine will undergo significant modification as a result.



For its future UAV development programme, the French Air Force favours a step-by-step approach based on the lessons learned operating the HUNTER and the commissioning of the Medium Altitude Long Endurance (MALE) system. Today, the EUROMALE programme is underway through a European cooperation programme, which should permit France to reach its fundamental capability by 2015. For offensive missions, the NEURON European Demonstrator Programme will allow the French Air Force to evaluate the UCAV concept within the scope of the renewal of its combat fleet by 2025.

By 2009, Germany plans to introduce MALE UAV to provide all-weather reconnaissance; by 2010, we will add EUROHAWK to provide SIGINT and, by 2013, we intend to procure the GLOBAL HAWK IMINT UAV within NATO's AGS concept. We are also monitoring closely R&D into UCAVs.

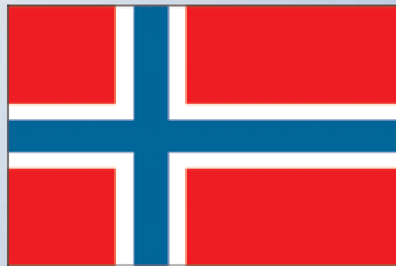
The Hellenic Air Force (HAF) is currently in the development-production phase of a MALE UAV "PEGASUS", destined for tactical and operational needs. Even though the programme started for Tactical Reconnaissance, other possible applications are being examined including area and installation surveillance, communications relay, IMINT-SIGINT intelligence collection and support of special operations. In parallel, the Hellenic Air Industry has declared participation in the French "NEURON" UCAV initiative. The main problem concerning the use of the above systems lies in the absence of air traffic regulations, both nationally and internationally, making flight trials and missions, such as sea surveillance and border control, difficult. In the medium term, the HAF is planning the acquisition of more MALE UAVs, MINI UAVs and UCAV, while, at the same time, monitoring international trends.

The Hungarian Air Force NATO/EU contribution is modular and there is no UAV planned in their Table of Establishment, although in some cases small platforms could be useful for force protection. If the ongoing development projects of the MoD Technology Agency and the National Defence University produce available assets, we will consider their operational use.

The Italian experience gathered in Iraq confirmed that UAV have great potential. Predator's surveillance capabilities have been used to enhance Force Protection and to increase precision engagement, both on the ground and from the air, while improving overall awareness. The full implementation of Beyond Line of Sight Operations is expanding the field of view. Glancing into future operations, multi-role UAV will provide the best combination of effectiveness and flexibility to unravel the uncertainty of modern scenarios.

The Royal Netherlands Armed Forces aim for a nationally owned air-ground surveillance capability with the procurement of MALE UAV systems. Initial operational capability is expected in 2011. With this AGS capability, the Netherlands Armed Forces can offer a meaningful contribution both within NATO or coalition alliances. The MALE UAV missions can vary from homeland defence, disaster relief to ISR data-gathering in warfighting mission types.

Norway is acquiring a tactical UAV capability. The Royal Norwegian Air Force (RNoAF) will declare their UAV squadron operational in 2009. The UAV capability is designated for the support of ground operations, primarily as an ISTAR-asset. UAVs establish a capacity enabling a true situational awareness for ground forces manoeuvring in future areas of operations. The upcoming Defence Study will consider increased utilization of UAV in the full spectrum of future tasks for the Norwegian Defence Organisation.

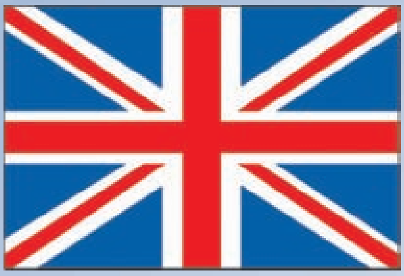


By 2012, Poland plans to equip her Air Force with at least two MALE UAV. In the intervening years, we will work on the safe exploitation of non-segregated airspace, a national communication system to distribute data collected and compatibility with the NATO Alliance Ground Surveillance programme.

The Portugese Air Force aims to operate, in the future, one UAV MALE System, composed of three to four air platforms, associated set of sensors, one Ground Control Station and support personnel. The main objective is to obtain the capability to provide long-range strategic Reconnaissance, Surveillance and Target Acquisition for the full range of NATO missions, using UAV's.

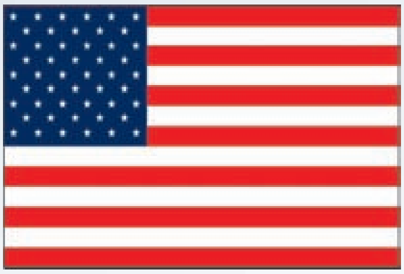
Romania started to operate UAVs 8 years ago. Presently, there are 2 Shadow 600 systems in use by the Romanian Armed Forces. One of them is used for domestic purposes and training, the other is deployed with Coalition Forces in Operation IRAQI FREEDOM. During these years of operation, the UAV systems have proved their capabilities in the service of the Romanian Army, so that we plan to enlarge the Romanian military UAV family, in order to have a good response to the new kind of threats against democratic values.

The Spanish Air Force is involved in several programmes related to the development of Unmanned Aerial Systems (UAS) with the objective of improving some already existing ISTAR capabilities. The procurement of MALE type UAS is the fourth phase of a programme that will cater for all national requirements. In addition to the value support to the traditional warfare areas, UAS are considered to improve the ability to adequately face new challenges in many other fields, like deployments and peacekeeping, control of illegal immigration and drug traffic, anti-terrorism, environmental activities, SAR/CSAR and ISTAR.



The RAF's operation of Predator A has offered a unique insight into the complexities of operating a persistent, armed UAV, thereby elevating the RAF to the forefront of high-tech UAV operations. This is exemplified further by our UAV experimentation programme - integrating the wide-area surveillance capability of the RAPTOR sensor with the impressive performance of the Predator B. We now aim to set the conditions for UAV operations outside of UK segregated airspace. From simple beginnings, the UAV is fast carving a core role in the future force and sensor mix, which will ensure Air Power's continued relevance across the whole spectrum of future offensive and support operations.

Attributes such as persistence and versatility contribute to highly capable systems improving the way we currently operate and allow us to do things previously impossible or impractical. The Air Force will integrate unmanned aviation with existing and future air and space systems to provide a more capable force, implement Human Systems Integration, and continue to lead and innovate Remotely Piloted Aircraft (RPA) and UAV development and employment. As RPAs and UAVs prove their worth, lessons learned will be applied to enhancing the next generation of unmanned systems.



Airbase Defence In Expeditionary Operations

Photo Defensiekrant

By Wing Commander Andy Ingham
GBR A, JAPCC

"WHO IS GUARDING THE BACK DOOR"?

The vulnerability of air power when on the ground has been recognized as long as combat air operations have been conducted and is encapsulated by General Douhet's observation in 1921 that 'it is easier and more effective to destroy the enemy's aerial power by destroying his nests and eggs on the ground than to hunt his flying birds in the air'[1]. In current NATO operations, the reality of facing the asymmetric threat in a non-linear battlespace is that there is no front line. Airbases supporting NATO stability and security operations, such as ISAF in Afghanistan, may be in the midst of the land

Photo NATO

NRF Demonstration - 2003

component's AO. Their size and relative concentration of personnel, aircraft and other materiel, make them attractive targets for our adversaries, particularly through stand-off indirect fire or the use of MANPADs against aircraft taking off or landing.

In principle, the key to providing effective air base defence against the asymmetric threat, both current and emerging, is to include elements of defence in depth and a layered defence, together with the close defence of our vital assets. Additionally, we need to mount a number of patrols (both foot and vehicle), provide a Quick Response Force (QRF) and ideally have a mobile reserve on-call. Moreover, when the need arises, we need to possess the ability to fight back, projecting our force into our Ground Defence Area (GDA) using a variety of support weapons.

Whilst many European nations and the US possess dedicated and well trained personnel to carry out air base defence, recent experience has shown that when deployed, we are particularly vulnerable to the stand-off weapon attack and, more recently, the use of MANPADS. We tend to be very good at providing the close defence of our assets, control of entry and maintaining a highly visible patrolling profile within the base, or within the base perimeter defences. However, where we tend to let ourselves down is in the domination of the immediate area of tactical importance just outside the base, where stand-off weapons (and MANPADS) are most likely to be launched or fired from. To effectively dominate this area we would need to be able to project our FP forces up to 10 km out from the base perimeter. To successfully achieve this, we require a dedicated, well-trained, lightly equipped and highly mobile force. Additionally, national caveats often restrict the deployment of FP forces off-base, relying on other coalition forces or, in some cases, the host nation (HN) forces to carry out this essential task. Inevitably, co-ordination and command and control can then become very difficult, lines of communication tenuous and a breakdown in language often contributes to a delay in an effective response to incidents.

"We require a dedicated, well-trained, lightly equipped and highly mobile force".

Of course, as part of his risk assessment, the commander may decide that this sort of attack is unlikely and therefore allocate his FP resources to other, higher priority tasks. Historically however, the statistics show us that the risk of a stand-off weapon attack against an air base has never been higher. In the mid 1980s, on behalf of the USAF, the Rand Corporation undertook a study to examine the vulnerabilities of air bases. When published the study concluded that since WWII, over 75% of all ground attacks against air bases were in the form of a stand-off attack. Most recently, in late 2005, the Royal Air Force suffered damage to two GR7 Harriers at Kandahar in Afghanistan. Open news sources reported that these losses were directly attributed to ground fire; clearly some form of mortar or artillery shell was used against the Harriers.

"The vulnerability of air power when on the ground has been recognized as long as combat air operations have been conducted".

"We need to mount a number of patrols".

So, stand-off weapons pose a major threat to deployed air bases. Why then do they? Because they are simple to use and are widely available at relatively low cost on the international armaments black market. Furthermore, they are ideal weapons of choice for insurgents and terrorists who, apart from the suicide bombers, prefer not to be caught. They can blend in with the local population and probably have very good knowledge of the local area. Furthermore, they can pick the time and place of the attack, most likely using the "shoot and scoot" technique. Stand-off weapons characteristics include:

- Ease of use. Personnel can be quickly trained on these systems – most are low tech, some are fire and forget. Systems can come pre-loaded or can be easily assembled.

- Small size. These weapons can be easily stored and moved covertly into position. If required they can be cached close to the firing point for ease of use at a later date. In most cases, a two-man team is all that is required to operate them.

- Readiness. During a window of opportunity, only a few minutes are required to make these weapons combat ready.

- Ease of Employment. Often, unlimited firing points are available, such as the roof of a building, a clearing in a wood or even from a pre-positioned static vehicle; the IRA achieved a huge propaganda success when they targeted Downing Street in London in 1991 with this type of device.

- Availability. Unclassified sources estimate that there are thousands of stand-off weapons and MANPADS around the world with a considerable number available on the black market, if the price is right.

So what can the defender do to combat this threat? Firstly, the commander must conduct his risk assessment based on the most accurate and up-to-date intelligence, and if the threat from stand-off weapons exists, allocate sufficient priority to provide forces to counter the threat. The FP Commander must be in tactical command of all

> *The provision of sufficient Force Protection assets needs to be assessed at the outset and the threat from stand-off weapons should not be overlooked.*

forces allocated to Active Defence, and in cases where this is not possible, due to HN or National constraints, establish effective Liaison Officers with the other supporting forces. Moreover, the Active Defence forces need to project their presence out into the stand-off weapon footprint by adopting a proactive patrolling posture throughout the GDA. Furthermore, modern technical resources such as infantry ground radars and sensors, need to be procured to provide the FP Commander with timely warnings, so that a counter-attack with support weapons (if local ROE permit their use) or the deployment of the QRF, as appropriate, to follow up the attack. Local intelligence sources should not be overlooked.

In conclusion, during expeditionary operations, air assets and in particular aircraft, provide a target rich environment for any opposing force. The provision of sufficient Force Protection assets needs to be assessed at the outset and the threat from stand-off weapons should not be overlooked. This threat needs to be countered by the provision of robust forces, familiar with air operations and capable of dominating the GDA.■


AP Photo/Dimitri Messinis

"We are particularly vulnerable to the stand-off weapon attack".

[1] Guilio Douhet, *The Command of the Air*, Washington DC, Office of Air Force History 1983 (orginally published in 1921, pp 53-54).


Photo USAF

"Stand-off weapons pose a major threat to deployed air bases".

NEWS

By Air Commodore Dai Williams, GBR A, JAPCC

Overview

In 2006, the priority for the JAPCC is to deliver a range of important projects that will aid the transformation of NATO air and space power. These projects, in support of HQ SACT, have been formalized into an agreed Programme of Work (POW), which sets out the JAPCC deliverables and timescales. In addition, JAPCC is developing projects for a number of other NATO customers that includes NATO HQ, SHAPE, CC-Air HQ Izmir and CC-Air HQ Ramstein. We believe the overall 2006 POW will make a major contribution to NATO's transformation agenda.

Unmanned Air System (UAS) Development

The JAPCC has made the UAV/UAS its top priority theme for 2006. The subject of UAS will feature prominently in our JAPCC sponsored workshops and fora throughout the year, including the 2006 JAPCC Conference. Our intention is to bring together all UAS stakeholders such as NATO staff, nations, industry and academia to identify what NATO needs to do to fully exploit the airpower capabilities offered by UAS technologies. Issues relating to airspace management, command and control, integration and interoperability are challenges faced by all NATO nations.

To meet these challenges, the JAPCC aims to develop a "flightplan" that identifies what NATO needs to do, as an Alliance, to exploit the UAS potential.

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"The JAPCC is enhancing interoperability through the development of AAR doctrine".

NATO Air Defence

The JAPCC has been asked by NATO HQ to lead a study group to examine future NATO Air Defence (AD) requirements and capabilities. This project, looking to the year 2020, will analyze the future capability requirements for NATO AD in a holistic manner to identify any capability gaps and to develop a roadmap to address them. This project should be completed by Autumn 2006.

C4ISTAR

The JAPCC is supporting HQ SACT to develop a Joint ISR (JISR) concept, a transformational project that will ensure NATO is able to meet its aspirations across the full range of effects based operations. The JAPCC is also playing a significant role on behalf of ACO in the NATO Alliance Ground Surveillance project. Working closely with the NAEW community, including Force Command and NAPMA, JAPCC has helped to develop a CONOP and to provide specialist assessment for the Main Operating Base decision process. The JAPCC is also contributing to the development of the 'Concept for Future E-3A NATO Mid-Term Employment' that incorporates an assessment of the likely expanded roles and missions such as Time Sensitive Targeting, Airborne Command Element, UAS operations and overall Air Battle Management.

Air to Air Refuelling

The JAPCC supports the transformation of the AAR capability, by developing interoperability and promoting a more coherent management, by the Alliance, of AAR assets. The JAPCC is also leading to develop a long term NATO vision for this critical capability.

The JAPCC is enhancing interoperability through the development of AAR doctrine, procedures, STANAGs and planning methodologies. This project has resulted in 2 significant improvements:

- The production of a new Alliance Joint AAR manual that harmonizes and standardizes procedures currently found in more than 20 different manuals.

- The drafting of an updated NATO AAR concept that provides a coherent structure for planning and directing Alliance AAR.

Looking longer term, the JAPCC is developing a **future** NATO AAR concept. This work, with a 15-year time horizon, seeks to identify future AAR requirements, resources and technologies and to establish future operating and employment concepts for AAR. This project incorporates the integration of AAR into network centric operations and new concepts, such as unmanned air refuellers. This work should be complete by the end of 2006.

Simulated Mission And Rehearsal Training (SMART)

NATO SMART is a distributed simulation project involving JAPCC in collaboration with HQ SACT. The JAPCC chairs both the SMART Steering Group and the Operations and Training Group.

With the initial scoping effort complete, the JAPCC is now working with HQ SACT to provide a Phase 1 report to the HQ SACT Management Board. The next steps involve gaining formal commitment of national and NCS assets for a SMART exercise event, which has been scheduled for 2008.

Future Air Exercises

The JAPCC is currently developing a project to identify a future NRF Air training and exercise concept. The aim of the project will be to examine the value and relevance of current air training programmes to support the broad range of missions and threats that the NRF faces.

The detailed objectives and milestones of this study are currently being identified. The JAPCC aims to complete the project by the end of 2006, working closely with the main stakeholders in the JFC's and ACC's.

www.japcc.de

Air Logistics

The JAPCC continues to provide strong support to the SACT Integrated Capability Teams on logistics transformation issues. This work includes the further development of the Deployable Airfield Activation Wing (DAAW) concept described in JAPCC Journal Edition 1. The JAPCC has been asked to develop a NATO force proposal to cover the DAAW capability and to lead on the assessment of the DAAW concept as part of the Defence Requirements Review 07 process. HQ SACT has also been requested to support an exercise in 2007 to test the DAAW concept.

Force Protection

Recent SHAPE TACEVALS have highlighted nations are increasingly adopting different approaches to deployed operations in a chemical, biological, radiological and nuclear (CBRN) environment. With the advent of the NRF, and the focus on multinational operations within the same deployed airbase, current NATO policy and doctrine in this area needs to be reviewed.

The JAPCC is leading with this work in consultation with SHAPE, the ACC's and the NATO AEW&C Force Command. The aim is to develop a new Concept of Operations for NRF air operations in a CBRN environment to be complete by June 2006.

JAPCC Website

If you want to know more about any of the JAPCC's projects, please visit our new website at www.japcc.de The website gives you the opportunity to add your own comments and suggestions, including any ideas on new projects that could be undertaken by the JAPCC. ■

JAPCC CONFERENCE 2005

By Air Commodore Dai Williams, GBR A, JAPCC

The JAPCC held its first air power conference in Kleve, Germany in November 2005. The theme of the Conference was to question, "How do we ensure that NATO joint air and space power remains relevant?". Over 180 delegates including high-ranking NATO military officers, academics and Defence Industrialists attended. The Conference was opened by General Henault, Chairman of the Military Committee, who addressed the issue of air power within the context of NATO's transformation process and the part played by Centres of Excellence like the JAPCC.


"General Henault emphasized the vital role of airpower".

Key Note Address

Gen Henault emphasized the vital role of airpower in today's military operations, particularly the determining contribution it can play in the early part of a campaign. He highlighted the great changes in the way air power is now applied with the focus on Joint and Combined operations and the differing scale and types of interventions. The General stressed the importance of the NATO Transformation initiative and the value of the NRF concept as the catalyst for delivering the necessary changes. Although NATO faces many challenges in making the best possible use of air power, Gen Henault believes the Alliance will continue to require a substantial and diverse set of air and space power capabilities. He argued that efforts needed to be focused, emphasizing that the challenge to the air community was to go on improving air power capabilities with continued development of new ideas and concepts.

Gen Henault concluded by paying tribute to the work done by SACT in leading the Transformation process, but he also emphasised the major role to be played by the new Centres of Excellence, which he saw as vital for the development of new ideas and concepts. He said that the work done by the JAPCC was vital to the Alliance's overall capabilities, not least because air power would remain a key element for the future success of NATO.

Panel Discussions

The remainder of the Conference consisted of a series of presentations and panel discussions with full involvement of the delegates. These discussions concluded that air and space power has much to offer in tackling terrorist and insurgent threats, where there are no front lines and where ground units cannot control the ground with any degree of permanence. Air platforms have the perspectives of height and endurance and, due to their speed, they also have the necessary flexibility for dynamic re-tasking. New technology now also offers the potential for air power to operate with an increased degree of "sensitivity" when interacting with the ground environment. Developing new technologies will further enable air power by assuming an increasingly prominent role in missions that require non-kinetic and non-lethal effects.

The panels, looking at the future, identified a range of areas where NATO air power needs to continue to evolve and to transform. These include:

- Avoiding a dual class military Alliance in which specific nations can only operate with the ones that have similar capabilities.

- Introducing new platforms and command and control systems not based on system centric or a Service centric approach, but with a holistic capability based approach.

- Recognizing a harmonized evolution versus a revolutionary approach as a pragmatic way forward – focusing on role specialization and national niche capabilities.

- Improving interoperability through broader NATO common funding, which should be viewed as an important tool for Transformation.

- NATO working to develop greater capability within space or near-space and to be less reliant on purely national sensors.

- Exploiting the potential of UAVs. There is a pressing need for policy and doctrine relating to airspace control, the integration of UAVs and the associated command and control issues.

- Introducing a new concept for future exercises, by moving away from the old legacy style of counting missions and airframes towards evaluating the operational and tactical requirements for the NRF. This must include a stronger joint approach, less focused at the Component level, and with more priority to enabling activities such as airlift, logistics and CIS.

- Releasing the potential of modelling and simulation to allow NATO to conduct realistic and cost effective training.

- Promoting an effects-based mindset with the formulation of NATO policy on EBAO.

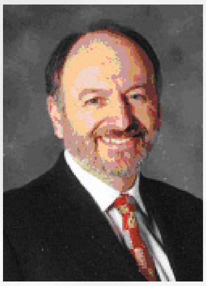
- Development of air land integration procedures to meet the operational challenges.

Conclusion

The first JAPCC Conference identified the continued need to persuade others, especially national decision-makers, about the importance and utility of air and space power. Despite prominence of late, air power is not generally well understood outside the air community; therefore we must be ready and able to demonstrate its value if air power is to remain relevant and properly resourced.

In closing the 2005 Conference, Lt Gen Schubert, the JAPCC Executive Director, expressed his gratitude for the open exchange of information and knowledge that had stimulated all the discussions. The Conference had been invaluable in helping determine the JAPCC 2006 programme of work, where the JAPCC could address the most pressing issues identified by the NATO air community, together with tasks that would contribute most to the transformation of joint air and space power. ■

General Tom Hobbins, USA A, is Director JAPCC Kalkar Germany, Commander, U.S. Air Forces in Europe; Commander, Allied Component Command - Air Ramstein; and Air Component Commander, U.S. European Command, Ramstein Air Base, Germany. Gen Hobbins entered the Air Force in Dec 1969 as a graduate of Officer Training School. He has commanded two tactical fighter wings and a composite air group. He has served as the Director of Plans and Operations for U.S. Forces Japan, Director of Plans and Policy for U.S. Atlantic Command, and Director of Operations for U.S. Air Forces in Europe. As the USAFE Director of Operations, Gen Hobbins was responsible for the planning, beddown and execution of combat forces in Europe for Operation ALLIED FORCE. As 12th Air Force Commander, Gen Hobbins deployed the 12th Air Force's AOC to Southwest Asia as Operations ENDURING FREEDOM and IRAQI FREEDOM's alternate AOC. A command pilot, Gen Hobbins has flown more than 4,275 flying hrs, primarily in fighter aircraft.



Professor Ian Poll, OBE FREng, FCGI FAIAA , FRAeS, is Professor of Aerospace Engineering and Business Development and Technical Director of Cranfield Aerospace Limited. A graduate of Imperial College, London, he has 30 yrs experience in aerospace and aviation gained in both the academic and commercial domains. A Fellow of the Royal Academy of Engineering, The City and Guilds Institute, the American Institute of Aeronautics and Astronautics and the Royal Aeronautical Society, he was awarded the OBE in 2002 in recognition of his contribution to the Cranfield College of Aeronautics.

Colonel(S) Dan Lewandowski, USA A, is the JAPCC Combat Air Branch Head. He was one of the first career space operations officers in the USAF. He was the Branch Chief for space and C4ISR programs for the Deputy Under Secretary of the Air Force for International Affairs. In 2002, he took command of the 50th Operations Support Squadron, responsible for 130 personnel and the combat readiness training of over 530 crew personnel, operating over 140 satellites. He has four masters degrees in Strategic Studies, Military Operational Art and Science, Space Systems and Business Administration.

Wing Commander Mike Strong, RAF, joined the RAF in 1966 as a military air traffic controller. He has served at RAF and RN airfields worldwide and at joint civil/military ATC centres. He has broad experience in a variety of air traffic management posts in military and civilian HQs. Since 2003, he has been on secondment to EUROCONTROL as a military expert, specializing in airspace and air traffic management matters.

Colonel Stephen P. Luxion, USA A, is the Director of Staff at the JAPCC. A 1984 USAF Academy graduate, Col Luxion spent 10 yrs flying the F-111 and 2 yrs flying the F-14A and EA-6B . He flew the MQ-1B Predator for 3 yrs and commanded the 17th Reconnaissance Sqn. He has 2,500 hrs flying time with 700 hrs combat time. Col Luxion is a distinguished graduate of the USAF Fighter Weapons School and Air Command and Staff College. He is also a graduate of the School of Advanced Airpower Studies and the National War College.

Air Chief Marshal Sir Glenn Torpy, KCB, CBE, DSO, BSc(Eng), FRAeS, RAF, has flown the Jaguar and Tornado GR1A aircraft in the reconnaissance role. He commanded No 13 Sqn during the 1991 Gulf War where he was awarded the Distinguished Service Order. He has served as the Station Commander RAF Bruggen, Germany, and has attended both Royal College of Defence Studies and the Higher Command and Staff Course. He has held a number of senior national staff positions including Director Air Operations in the MOD and Assistant Chief of the Defence Staff (Operations). In 2001 he became Air Officer Commanding No 1 Gp and during this period, he was the UK Air Contingent Commander for Operation IRAQI FREEDOM, for which he was awarded the US Legion of Merit. Following a tour as Deputy Commander in Chief Strike Command, he was posted as Chief of Joint Operations in the Permanent Joint Headquarters. In Jan 2005, he was made a Knight Commander and on 13 Apr 2006 took up his current appointment as Chief of the Air Staff.

Wing Commander Richard Duance, GBR A, joined the RAF in 1982 as a Fighter Controller. Within 3 yrs, he transferred to the Navigator Branch and qualified on the Tornado F3 in 1987. He has flown over 2000 flying hrs, primarily in the Tornado F3, and is a graduate of the Advanced Command and Staff Course at JSCSC Shrivenham. In 2005, he joined JAPCC from a tour as Commanding Officer Falkland Islands Air Wing. He works in the Policy, Concepts & Co-ordination branch responsible for Interoperability, Doctrine and Integration.

Wing Commander Pete York, OBE, GBR A, is a VIP Transport navigator who arrived at JAPCC in 2005 from CC-Air Izmir, Turkey where he was the Director of Staff. Prior to that, he was CC-Air Izmir's CJFACC Planning Chief and responsible for the implementation of NATO's CJFACC and NRF Concepts. He has experience in planning and execution of the flying schedules for RAF AT, AAR and VIP Transport fleets during peacetime routine and crisis operations. Pete has also been a tutor in the Muharraq Al-Abdullah Command and Staff College in Kuwait.

Mr. Yair Dubester, is the General Manager of MALAT, the UAV division of Israel Aircraft Industries (IAI). He completed his BSc. in Electrical Engineering at the Technion, Israel Institute of Technology, Israel in 1975. In that year he joined IAI as a design engineer on Israel's first UAV, the "Scout".

Mr. Ido Pickel, is the marketing manager in the MALAT division of Israel Aircraft Industries Ltd for Southern Europe. He is a senior qualified UAV operator and mission commander with service in the Israel Air Force UAV Sqn. He holds a Bachelor Degree in Business Administration (B.A.) specializing in Information Technology from the Interdisciplinary Center Herzliya, Israel.

Professor Dr.-Ing. Axel Schulte, is Professor of Flight Mechanics and Flight Guidance at the Institute of System Dynamics and Flight Mechanics, Munich University of the German Armed Forces, Aerospace Engineering Department. His research focus is on automation in vehicle guidance, human-automation interaction in aviation and intelligent systems based on cognitive models of human operators. In teaching, he covers the aeronautical disciplines of flight mechanics, guidance and control.

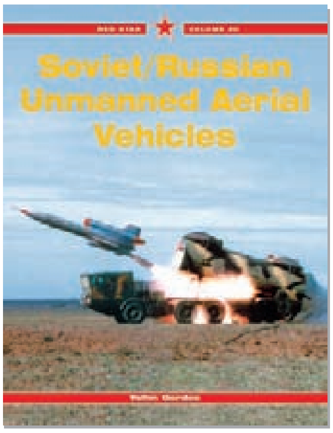
Dr Andrea Nativi, acquired a degree in Financial Law, Summa cum lauda, in Genoa University in 1984 and served as a Reserve Lieutenant in the Guardia Di Finanza from 1985-86. He became a professional journalist in 1985 and joined the Rivista Italiana Difesa in 1987; he became their Editor in Chief in 2000. He is a member of the Italian MoD sponsored Strategic Studies Centre and Military Research Centre and a respected Air Power Lecturer at the Italian MoD Joint and Air Force War Colleges.

Wing Commander Andy Ingham, GBR A, transferred to the Combat Service Support Branch at JAPCC from the Reaction Force Air Staff. He is an RAF Regiment officer with a background in Survive-to-Operate and Force Protection. He has commanded a UK SHORAD sqn in Germany, served as a GBAD/SHORAD staff officer and as the air force member of a joint service communications project team. He has also served as an Exchange Officer with the USAF at the USAF Security Forces Academy as an airbase defence instructor.

Colonel Ludovico Chianese, ITAF, is the Air Component Commander of the "Predator" UAV in Tallil, Iraq. He is responsible for the Air Task Order of the Italian UAV Squadron as Tactical Commander. The Squadron conducts ISR missions in support of the Italian Joint Task Force in the Dhi-Qar area. Col Chianese entered the Air Force in 1984, graduating from the Academy in 1988. He has served as a helicopter pilot in the SAR and CSAR role and is a flight instructor and examiner.

Air Commodore Dai Williams, GBR A, joined the RAF as a Supply Officer in 1980. He has an MA in Defence Studies and was awarded an OBE in 1996. He has been a Military Assistant to Air Officer Maintenance and COS in the Tri-service HQ Defence Supply Chain. In 2002 he commanded the UK's largest supply depot where he merged the former air depot at Stafford with the Army depot at Donnington to create a unified tri-Service depot. He was posted to the JAPCC in Jan 2005 as Branch Head, Combat Service Support. Promoted to Air Commodore in January 2006, he assumed the role of Assistant Director Transformation. He left JAPCC in Apr 2006 to be Director (Supply Chain) within the UK Defence Logistics Organisation.

Lt Col Jens C Fehler, DEU L, joined the German Army Artillery branch in 1978. He is a qualified UAV operations officer and graduated from Hamburg Military University and German Forces Staff Academy. In the beginning of 2006, he joined JAPCC from a post as the UAV flight safety advisor at the German Artillery School. Working in the C4ISTAR Branch, he is responsible for UAS.



Courtesy of Midland Counties Publications

Soviet/Russian Unmanned Aerial Vehicles
by Yefim Gordon, original translation by Dmitriy Kommissarov
Midland Publishing, Hinckley, England, 2005, 127 pages
Available as ISBN 1-85780-193-8

In the past, Soviet Unmanned Aerial Vehicles (UAV) were barely recognized by the West. However, a great number of flying target decoys and reconnaissance drone systems have been produced, and today Russian industry develops many Unmanned Aerial Systems (UAS) including Unmanned Combat Aerial Vehicles (UCAV).

The author provides an extensive overview of research and development as well as operations from the beginning to the present. Starting with an assessment of the Soviet Airspace Industry after World War II, individual chapters deal with the UAS of the four development bureaus. The chapters contain detailed descriptions and construction plans augmented by technical data sheets and photographs of the systems. The concluding chapter presents the current status of Russian UAS Technology and gives a detailed forecast of planned projects.

Reviewer: Jens Fehler, Lt Col, DEU L

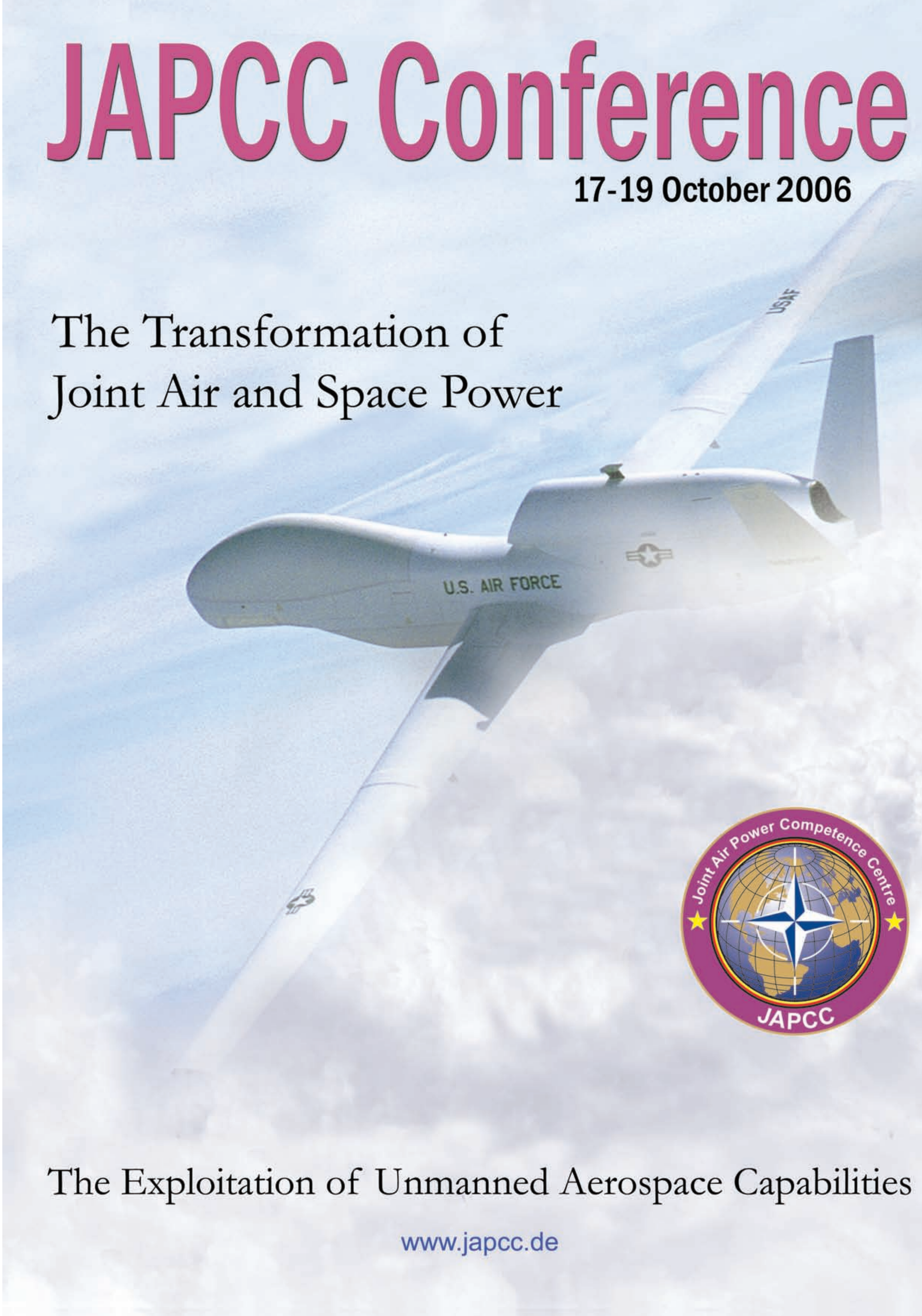
Photo Unavailable

Attack of the Drones – A History of Unmanned Aerial Combat
by Bill Yenne
Zenith Press, MBI Publishing Company, St. Paul MN USA, 2004, 127 pages
Available as ISBN 0-7603-1825-5

Research and development of UAV in the USA started at the beginning of the 20th century. The first tangible steps towards the new technology were “aircraft models”, unmanned target aircraft and reconnaissance drones. The progress in technology fields like wireless communication, miniaturization and materiel, facilitated control systems for precise navigation and secure recovery. Meanwhile, many applications for UAS operations could be identified and the significance of air based sensor platforms increased. The use of satellites to enable beyond line of sight communication between a ground control station and the UAV facilitated the development of the new concept of an UCAV. Air to surface attack has been revolutionized, and this technology has led to USA superiority in the field.

The author gives a description of development, performance and specialities of the different techniques as well as future development programmes accompanied by many impressive photographs.

Reviewer: Jens Fehler, Lt Col, DEU L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