PATHFINDER

COLLECTION – VOLUME 2

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Edited by:

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Air Power Development Centre
CANBERRA

ISBN 978-1-920800-23-9

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Published and distributed by:

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Cover design: 'Strip sitting 13 June Nadzab, Huon Peninsula 1944' by Vernon Jones (1944). La Trobe Picture Collection, State Library of Victoria.

Vernon Samuel Charles Jones (1908-2002) trained as an artist in Melbourne, at the National Art Gallery School 1928-37, while working variously as a display and advertising manager. He enlisted in the RAAF in May 1942 and was commissioned in the Administrative and Special Duties Branch in July that year. Promoted Flying Officer early in 1943, he served in the Northern Territory before moving into the northern islands – to New Guinea and Noemfoor (1944), and Morotai and Tarakan (1945). He was promoted Flight Lieutenant in July 1944. Throughout his postings he continued to sketch and paint, producing a large body of work which earned him the description of unofficial war artist of the RAAF. Discharged in February 1946, he became Art Editor-in-Chief and Illustrator for *Australasian Post*. His 1943 output of 36 watercolour portraits of RAAF personnel was gifted to the Australian War Memorial in 1968, and the rest of his wartime works were donated by his family to the State Library of Victoria in 2007.

Foreword

This is the second volume of collected Pathfinders produced by the Royal Australian Air Force's Air Power Development Centre (APDC). Since its conception and introduction in June 2004, two Pathfinders per month have been produced by APDC. Currently, the majority are written from within APDC to themes and interests that my staff and I judge of merit. For the future though, APDC is looking to past and current serving members of the RAAF and the other Services to provide insights into air power—past, present and future—to the 1,000 word formula that seems to work well for a growing number of readers.

All matters about and around air power are open for consideration in the Pathfinder series: strategy, historical analyses, operations, administration, logistics, education and training, people, command and control, technology and so on and so on. The generation, sustainment and development of air power are broad subjects covering many disciplines. Irrespective of subject though, Pathfinders will always be planned to deliver a focused 'so what' about air power; they are not intended to be just a narrative but deliver a measure of analysis.

I encourage our readers to think about what they would be interested in reading about in future Pathfinders and contact the APDC with their suggestions. Accompanying words, pictures and analysis are also welcome.

The Pathfinder title was chosen as a tribute to the World War II Pathfinder Force that operated within RAF Bomber Command from August 1942, forming an elite navigational group which preceded each raid and accurately illuminated the target area with incendiaries to permit visual bombing by the main force. The emblem adopted was the 'Fiery Mo' insignia that unofficially adorned the Hudson aircraft of No 6 Squadron, RAAF, in New Guinea during 1943.

I commend this volume of collected Pathfinders to you.

Group Captain Tony Forestier
Director
Air Power Development Centre
November 2007

The Air Power Development Centre

The Air Power Development Centre, formerly the Aerospace Centre, was established by the Royal Australian Air Force in August 1989, at the direction of the Chief of Air Force. Its function is to promote a greater understanding of the proper application of air and space power within the Australian Defence Force and in the wider community. This is being achieved through a variety of methods, including development and revision of indigenous doctrine, the incorporation of that doctrine into all levels of RAAF training, and increasing the level of air and space power awareness across the broadest possible spectrum. Comment on this publication or inquiry on any other air power related topic is welcome and should be forwarded to:

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Contents

AIR POWER

"Having the second-best air force is like having the second best hand in poker—it gets you nothing yet costs you money."

General George C. Kenney

Battlespace Superiority

Key Points

- Battlespace superiority—not a new concept
- ISR, C2 and Engagement form the basic elements
- Creating a networked knowledge base—primary necessity

Threats to peace and stability are constantly changing factors in the assessment of national security scenarios. Changes to these threats have been rapid in the past decade which has led to international volatility. Military forces around the world are now forced to operate in a dynamic environment that is not fully predictable and does not recognise geographic boundaries. The challenge, as ever, is for the military to gain the upper hand in the battlespace where governments have decided to employ military forces as part of security campaigns.

To respond to these challenges the Australian Defence Force must first gain an intimate understanding of the changing nature of threats and operating environment. An effective response requires the three Services to operate jointly and in a whole of government context. The current thrust is for the ADF to be able to function as a seamless force, enabled by networked knowledge, which delivers the desired effect at a time and place of our choice. Air power forms an integral and critical part of this process.

The primary aim of an air force should be to provide an effective tool for national security within the larger ambit of a National Effects Based Approach. Air power is capable of producing a very large spectrum of effects and capability development for air forces will be prioritised dependent on the effects with the greatest utility in the military response to the prevalent security situation. In the hierarchy of effects, battlespace superiority is of critical importance because it provides the necessary freedom of action required to generate effects necessary to achieve military and other national objectives at all levels of warfare.

Battlespace superiority by itself is not a new concept. Even a cursory study of the campaigns of Alexander the Great, during the period 336–323 BC, gives a very clear indication of the awareness of battlespace superiority that existed at that time. Alexander conclusively won the Battle of Granicus (334 BC)—the first major battle that he fought against the Persian Empire—by ensuring that he retained battlespace superiority at all times by having superiority of information, command and control, and offensive action.

The basic elements that create the necessary effects to ensure battlespace superiority have not changed in the years after Alexander the Great—Intelligence, Surveillance and Reconnaissance (ISR), Command and Control (C2), and Engagement. It is only the process by which superiority in these elements is achieved that has changed in the last two thousand years. Technology has now reached a sophistication that permits near real-time information flow, thereby greatly enhancing the decision-making in a force projection scenario. The core of battlespace superiority is the speed with which correct decisions can be made, disseminated, feed-back obtained and further action initiated. ISR, C2 and Engagement are also the central elements that form the basis for networked forces with this process spread across the vertical alignment of the Command and Control structure, starting from the grand strategic down to the tactical and vice versa.

The process of creating battlespace superiority is complex and involves a constant process of inputs and outputs being synthesised at different levels. To start with, three simultaneous actions take place—all oriented towards creating a knowledge base that can then be utilised to make the necessary decisions to ensure battlespace superiority.

- Surveillance sensors collect information which becomes one of the primary inputs to the creation of knowledge.
- Intelligence systems are used to distil the information to create adequate situational awareness of the level required or to request further surveillance/reconnaissance.

- Command and Control elements are employed to align the sensory inputs to the requirements of the strategic or tactical decision makers.

The knowledge that is created is used in a two-fold manner to create battlespace superiority; firstly to create information products that could either be time-sensitive or have long-term strategic implication, and secondly as the primary input for battlespace management. In the arena of battlespace management, C2 assets assume primary importance and determine the course of action to be adopted. Appropriate battlespace management produces battlespace effects that are desired to further the overall strategy.

Battlespace superiority is a critical requirement in any military operation and the elements that form its basis—ISR, C2 and Engagement—will have to be very carefully protected. Any loss or degradation of these elements would have a cascading effect on the network possibly to a level where effective response and performance may no longer be possible. Thus force protection becomes a key element in the planning and execution of a campaign for battlespace superiority.

Battlespace superiority is a requisite for the efficient functioning of a military force. In order to analyse the full impact of battlespace superiority in the outcome of any conflict, Pathfinder will examine the concept from a historical, contemporary and future view point in the next three issues. In combination, they will provide a holistic appraisal of the background, need and methodology by which battlespace superiority can be obtained and leveraged for maximum advantage to one's own interests. This is necessary because the continuous changes that take place in the theatre of operations cannot be fully anticipated and it is only exhaustive analysis of all aspects of the conduct of war that will provide the background to adapt in a dynamic environment. Only the capability of a force to adapt at a very fast rate to emergent challenges while continuing to maintain battlespace superiority will ensure victory.

Battlespace Superiority II

The previous issue of *Pathfinder* identified three aspects—Intelligence, Surveillance and Reconnaissance (ISR); Command and Control (C2); and Engagement—as the key elements of battlespace superiority. In this issue the concept is examined from an historical perspective, to provide the background essential to understanding the way in which air power contributes to the achievement of this critical effect in one's own interests.

Key Points

- Utility of aircraft in providing information recognised from earliest military usage
- Ability to network knowledge into correct command decisions a key to victory through battlespace superiority
- Effective engagement usually reliant on successful application of ISR and C2 principles
- The ends remain the same, but the means are constantly changing

Realisation of the impact that 'eyes in the sky' could make on the battlefield ensured that ISR was the very first role conceived for military aircraft. It was the necessity felt by every land commander to know what lay beyond the next hill, and every ship's captain to know what was beyond the horizon, that provided the impetus for the powers of Europe (and even military bit-players like Australia) to begin acquiring the frail and unarmed aircraft available before 1914. In Britain the link between ISR and aviation received no clearer recognition than that, during the lead up to World War I, development of the Royal Flying Corps (RFC) was placed under the direction of the British Army's foremost expert on field intelligence, Major-General David Henderson.

Not surprisingly, the first use made of an aircraft in war—by the Italians fighting the Turks in Libya on 22 October 1911—involved a one-hour reconnaissance flight. Even after several years of attrition warfare on the Western front had spawned new roles for aircraft (strike, air defence), the ISR role was so fundamental to the air effort that specialised reconnaissance units remained integral to the RFC. No 3 Squadron of the Australian Flying Corps was one such 'corps reconnaissance' unit. Later wars and developments in methodology have never altered the basic equation; collecting information on terrain, enemy locations and activities remains the foremost contribution that air power can make towards enabling commanders to reach the decisions that achieve battlespace superiority.

Information relevant to the battlespace comes from many sources and in many forms, and needs to be assembled and sorted effectively and quickly (in real-time, if possible) if it is to benefit and inform a commander seeking to impose dominance over an adversary. These days this historical truism linking ISR and C2 is currently embodied in the commitment of advanced defence forces to embracing the goal of 'network-centric (or enabled) warfare'. But this also is nothing new, particularly in the air warfare scene.

Consider the outstanding early example of networking achieved by the RAF during the 1940 Battle of Britain through the use of operations rooms. HQ Fighter Command, located at Bentley Priory in Stanmore, London, contained the Air Defence of Great Britain (ADGB) filter and operations rooms. The filter room sorted through incoming information from radar stations, observer corps posts, etc, to remove duplication, doubt and confusion before this information was sent to the plotting tables at both command and group level. The operations room at Bentley Priory allocated threats to the various groups for defensive measures to be taken, and allowed a complete overview of the battle to be maintained.

Without a doubt, it was this innovation in processing information and presenting it in a form that commanders could use to make timely and well-judged decisions that became one of the key ingredients in the RAF success in the Battle of Britain. Recent scholarship has exposed the myth that a small band of RAF fighter pilots ('The Few') staved off defeat by overwhelming German numbers. In fact, the Luftwaffe and RAF had broad parity in fighters throughout August–September. It was the British possession of radar and the C2 advantage conferred by the ability to vector in resources where they were needed, at the time they were required, which enabled the RAF to achieve battlespace superiority by mid-September. To an extent, some commentators now wonder whether the importance of these advantages meant that the outcome of the battle was actually a foregone conclusion.

Examples where Engagement has been a critical factor in achieving battlespace superiority are numerous. Perhaps none is more striking, however, than the successful integration of all arms practiced by the Germans during the opening land campaigns of World War II. 'Blitzkreig' entailed a level of coordination between armoured and infantry columns, operating with close artillery and air support, which had not been seen since the battles of Hamel and Amiens in 1918 (both of which involved the Australian Corps). An air example closer to home is the battle of the Bismarck Sea in March 1943, when a timely intelligence windfall (sigint disclosure of a Japanese intention to reinforce their New Guinea forces by sea) translated into a carefully planned air attack (which was practiced and rehearsed) and was delivered in a coordinated manner that totally overwhelmed the air defence the enemy was able to provide their ships at sea. The result was the near-total destruction of a vital troop convoy, which deterred the Japanese from again attempting major surface reinforcement in the New Guinea theatre.

As these examples illustrate, the achievement of battlespace superiority—itself a critical precursor to securing victory in a conflict—is best assured when attention is fully focused on the three elements of ISR, C2 and Engagement. The next *Pathfinder* will address battlespace superiority in the current Australian context.

Battlespace Superiority Today

Key Points

- Technological advances enables battlespace superiority
- Time-sensitive targeting critical
- Concept of battlespace changing to neutralise technological advantage
- Human dimension of warfare always a factor

The advent of air power brought a completely different perspective to the concept of battlespace superiority. The basic two-dimensional model that had prevailed for centuries was irrevocably changed by the employment of aircraft in military operations. Obtaining battlespace superiority has always been a complex matter. Although the use of the third dimension brought another element into the equation, it also helped to alleviate some of the problems that commanders faced in the quest for battlespace superiority.

Technology has been an enabler on the battlefield. Innovative uses of technology have brought about improvements in all of the three elements that combine to create battlespace superiority—ISR, C2 and engagement. Therefore it is not surprising that in contemporary terms battle space superiority is almost a direct function of technological sophistication of a force.

It is now possible to gather intelligence, carry out surveillance or reconnaissance of an area of interest continuously for 24 hours a day and seven days a week for as long as necessary. This can be achieved not only by space-borne assets, which may not be accessible or affordable for a number of nations, but also by high altitude long endurance unmanned aerial vehicles. What is more, it is also possible to make the information available to the users by disseminating it in almost real-time.

Similarly, improvements in the command and control infrastructure now enable the commander to 'see' the tactical picture as it emerges and if necessary intervene. Technology has made C2 links, the lifeline of any operation, robust and redundant. This has increased the speed of decision-making, which is of cardinal importance in the battlefield. By its characteristics of rapid entry into theatre, speed of response and precision, air power engagement capabilities are now considered the preferred option in a majority of cases. Once again technology has provided air power with precision engagement options that were unavailable just a decade ago.

The outcome of the improvements that technology has brought in ISR capabilities, C2 and engagement has been the emergence of Time-Sensitive Targeting (TST) as the optimum tool in the quest for battlespace superiority. TST is the classic combination of the three basic elements, and when applied in the appropriate manner can deny the adversary even the slightest of chances to contest battlespace superiority. TST, when used against leadership targets, creates a disproportionately high effect that can under certain circumstances even lead to a complete collapse of the adversary.

Conventional warfare could produce situations wherein the quest for battlespace superiority is a straight forward operation, based on the optimum employment of available assets. TST is the ultimate combination of military force projection capabilities and is difficult to execute effectively. In theory, it is possible to obtain battlespace superiority by the intelligent combination of adequate ISR, cohesive C2 and precision engagement capability. However, in practice, the difficulties in conducting TST as part of a larger campaign are numerous.

The first obstacle is the necessity to obtain engagement clearance from the appropriate level, which will more often than not be at the political. In a majority of cases, the time required for this would negate the advantages of TST. This situation could be ameliorated by delegating greater autonomy to senior military commanders.

The major difficulty in carrying out TST towards creating battlespace superiority is the large amount of resources required to make it effective. ISR of the calibre and quantum that would make TST a worthwhile operation is extremely expensive to obtain. The need for all ISR effort to be integrated and secure further exacerbates this problem. Highly redundant and reliable command and control networks are necessary to ensure that the operations are conducted within the ambit of the larger campaign. Engagement assets, that are available 'on call' at short notice are also resource draining. The developments taking place in Unmanned Combat Aerial Vehicles will at a future date make engagement a more cost effective option, but currently it is prohibitive in its resource intensity. Therefore, obtaining unlimited battlespace superiority even with sophisticated technology is not currently within the grasp of a majority of military forces.

Further, having acclaimed technology as the foundation to achieving the required level of battlespace superiority, it is also necessary to understand that technology alone may not always produce the effects needed to reach the sought after end state.

If current trends provide any indication, conventional wars are unlikely to be fought in the future. This is partially brought about by adversaries who understand the technological superiority of major powers and do not contest battlespace superiority. Instead they resort to concepts of operations that change the very nature of the battlespace to the extent that technology by itself may no longer be an advantage in dominating it or gaining superiority. This kind of warfare could be termed asymmetric, guerrilla, insurgent etc. In this situation the threats are diverse and unpredictable without adhering to traditional *modus operandi*. These tactics are aimed at denying a major force the advantages that it has by dominating the battlespace. Effectively the adversaries assure themselves a 'level playing field'.

This situation does not detract from the need to have adequate battlespace superiority to win battles and wars. However, the distinct delineation that existed between the end of conflict and the beginning of peace has been markedly blurred in the recent past. The conduct of an overall 'conflict' has undergone a distinctive change by encompassing 'restoring the peace' as yet another phase of the larger conflict. In such a condition, the criticality of battlespace superiority in winning the 'conflict' reduces somewhat dramatically.

The human dimension of threats and their repercussions will always have to be factored in the planning of any conflict. Today, technologically advanced forces have no assured way to ensure that omnipresent ISR, secure C2 and precision engagement capabilities translate to battlespace superiority. Battlespace superiority is necessary to win battles, campaigns and wars. But with the dynamic changes taking place not only in the conduct but also the concept of warfare, it remains an elusive goal.

Battlespace Superiority in the Future

Key Points

- Technological changes will increase ISR pervasiveness
- Air and space communications will enable TST
- New weapons will increase the flexibility of air power application
- Battlespace superiority will extend to cover all adversaries

In previous issues of *Pathfinder* the critical elements that create battlespace superiority have been identified as Intelligence, Surveillance and Reconnaissance (ISR); Command and Control (C2); and engagement. Even into the future this remains valid, but improved capabilities in both quality and quantity will be required to counter an adversary that adopts asymmetric, guerilla or insurgent warfare. In particular the ISR system will need to significantly improve its ability to monitor an adversary in complex environments. These environments have historically hidden an adversary from observation and include jungle, forested and urban terrain. The research programs that are designed to deliver the necessary capabilities have already commenced.

The American Defense Advanced Research Projects Agency (DARPA) is leading this research effort and has a number of projects underway. One project is called Combat zones That See (CTS) and aims to employ thousands of mobile phone-like cameras spread over large areas of a city to detect, identify and track all movement—human and vehicular. The CTS will be capable of reading licence plates and recognising individual humans. Further reduction in size of these sensors to the size of a grain of sand is the aim of another proposal called Smart Dust. DARPA's VisiBuilding program has already fielded handheld sensors that can 'see' through concrete into a building and locate humans, weapons and other materials. Work is in progress to develop this technology further and produce an airborne system that will monitor larger areas from greater range. Finally, the Human ID at a Distance program seeks to develop the means to identify people at distances of a few hundred metres. The comprehensive information that would be available from an ISR system fielding these types of capabilities is being referred to as 'military omniscience'.

Developments are also being made in airborne sensors that could see through other natural barriers. Millimetre wavelength radar has demonstrated an ability to penetrate jungles and forests to detect vehicles and people beneath the canopy. Other sensors have demonstrated abilities in penetrating the earth to detect underground caves and tunnel systems.

Linking these sensors to allow their data to be collected, monitored and assessed to form a cohesive picture and its further dissemination will become a key role for air and/or space platforms. Large airships that operate between the air and space environments, an area called near space (above 60,000 feet and below 100 kilometres), offer distinct advantages over traditional platforms. It is envisioned that these airships would be able to operate at very high altitudes providing the required connectivity while remaining on station for periods of a year or longer at a significantly lower cost than needed for satellite coverage. High altitude assets will make ISR data available over wide areas to users that will include the C2 system as well as other engagement nodes in near real-time.

Connected in this way, the C2 system will have the ISR information to carry out time-sensitive-targeting (TST). Engagement systems that execute TST will benefit from the development of weapon systems that will increase the range of situations where air power can be applied.

A weapon being developed is the Small Diameter Bomb (SDB). This weapon weighs about 250 pounds, allowing an average tactical strike aircraft to carry eight of them instead of four 500-pound bombs. The smaller warhead permits its use closer to friendly forces, and a single aircraft can be used to attack a number of targets. Using GPS guidance SDB has demonstrated an accuracy of about one metre when employed against targets at ranges greater than 80 kilometres.

Another weapon being developed is the Very Small Bomb (VSB). This will weigh only about 50 pounds (about the size of a single 155 millimetre artillery shell) allowing the carriage of 36 VSBs and attacks against many more targets. Precision will be the same as for SDB with a maximum engagement range of about 20 kilometres. The smaller warhead will cause less collateral damage.

Perhaps the ultimate weapon that can be envisaged at this time will be the Airborne Tactical Laser (ATL). Carried aboard an aircraft like the JSF, ATL will be powered by a generator driven by the airflow around the aircraft. With this power source there is theoretically no limit to the number of engagements that can be undertaken while the aircraft is airborne. As ATL will be a speed-of-light weapon there will hardly be any delay between weapon initiation and impact. ATL will be precise and produce no appreciable blast.

Future Uninhabited Aerial Vehicles (UAV) and Uninhabited Combat Air Vehicles (UCAV) will provide air power with increased persistence. When combined with the weapons described above, an 'omniscient' ISR system and effective network communications, they could change the concept of how the battlespace is dominated. With UAVs and UCAVs persistently positioned in the area of operations they could, in the future, be programmed to automatically suggest weapons solutions to hostile targets identified on the network as a result of ISR or human detection. The suggested weapon solution would only require clearance by the C2 system to allow execution. This will mean that air attacks could be *suggested* to commanders rather than being *initiated* by them. Timeliness of attack would be optimised and TST could be fully implemented against all adversaries.

The future will deliver significant improvements to each of the critical elements that provide battlespace superiority. The amount and quality of ISR data will steadily improve until it approaches 'military omniscience'. Air and space power will provide the connectivity across a whole force for the dissemination of ISR data and analysis. The C2 system will have near real-time access to this information and will be enabled to control TST.

Air engagement systems will be enabled to rapidly carry out TST tasking and will be armed with weapons that increase the flexibility of air power application. In the future battlespace superiority will be delivered by real-time TST with precision and with no collateral damage.

Air Control Doctrine: Myth or Reality

> **Key Points**
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> - Air control was largely a response to a particular set of circumstances in which the RAF found itself after World War I, and which do not necessarily translate to later times and places
> - Although cost effective as an additional measure available for colonial policing, air control was never as successful or economical as its advocates claimed
> - The doctrine of air control and substitution of air for ground forces provide a more compelling case for joint operations than for an air power-alone solution

One of the most contentious areas of debate about air power concerns the notion that aircraft can substitute for ground forces in enforcing government authority when combating an insurgency. Up until relatively recent times there has been attention paid, principally within the United States Air Force, to arguments that such a doctrine might be relevant to the situation America has found itself facing in a number of small wars. The basis of the case in favour of this application of air power rests on the apparently successful experience of air control, or 'air method', operations enjoyed by the Royal Air Force during the third decade of the twentieth century.

When confronted in 1919 with a renewed incursion by followers of a charismatic Muslim cleric dubbed the 'Mad Mullah', who had been causing persistent problems for the colonial administration in Somaliland (now Somalia), the British decided to reinforce the large number of ground troops required to contain him with some aircraft. By January 1920 a single RAF squadron of DH9a light bombers had arrived, and these were promptly used to bomb the mullah's adherents out of the stone forts they occupied. The heavy casualties caused by these raids within days put the insurgents to flight. For the next three weeks the army, supported by the RAF with reconnaissance as well as bombing, hounded the mullah back across the border into Ethiopia. For a cost of £77,000, air power was seen to have ended a problem which had bedevilled British authority in the area since 1899.

On the back of this astonishing success, hailed as the "cheapest war in history", the RAF found itself charged in 1921 with policing another empire hot-spot—this time one that was considerably more politically-charged and dangerous. Iraq's population was seething with unrest, particularly in the Kurdish north which was under the hostile influence of the former colonial power, Turkey. On 1 October 1922, Iraq was placed under its first Air Officer Commanding, Air Vice-Marshal Sir John Salmond, who brought with him eight RAF squadrons of DH9s, Bristol Fighters and Vickers Vernon transport aircraft. The previous army force (33 infantry battalions, 6 cavalry regiments) was reduced to a brigade of four battalions of British and Indian troops and four companies of armoured cars manned by RAF personnel.

Salmond immediately found his hands full in the province of Mosul, where a Kurdish rebellion had already broken out. He mounted the world's first air evacuation, using his bombers and transports—all 18 of them—to lift out British servicemen and civilians, as well as friendly local leaders, from Sulamaniya to Kirkuk. During the first months of 1923 the situation was still unresolved, but when he realised in May that the Turks were preparing to move against him with superior forces, Salmond decided to seize the initiative. Employing a combination of judicious bombing and rapid trooplift by air he restored order to the endangered areas. Pacification had taken just five months and cost about £8 million—far less than the £20 million that the War Office estimated would have been required for the army alone to do the job. British casualties had been one man killed and 14 wounded.

The success of these first two instances of air control operations naturally led to the same tactics being employed elsewhere around the British Empire, most notably in Transjordan (Palestine), Aden, and on the North-West Frontier of India. A border dispute with Yemen in 1923 ended with the death of just one British officer, a single aircraft lost and a bill for £8,567. Colonial Policing (or 'Col Pol' as it was called) became a central plank in the case for the RAF's existence as an independent service, a proposition under concerted challenge by the army and navy at the time. The doctrine also underwent a degree of development and refinement.

The idea of coercive bombing of civilian populations, in particular, became highly controversial, especially in what were notionally constabulary-type operations. The practice was begun of providing the residents of targeted areas with advance warning of the consequences of non-compliance with government directives, a measure which supposedly ensured that the killing of women and children was minimised. Thus the concept of the "inverse blockade" was born, whereby normal life was disrupted while villagers stayed away from their homes and crops until told that it was safe to return. Such were the notions of humane conduct of warfare in the 1920s and 30s.

In reality, the success of the air control doctrine was exaggerated. Because of the political and economic climate which spawned the concept, during which the RAF was forced to find a rationale for its existence at a time of heavily curtailed defence spending, the claims made for air power were probably far too high. The delivery of warnings to targeted communities were not invariably given in remote localities, so the "humaneness" of operations was often suspect. The claimed accuracy of bombing against specific houses within villages was almost certainly false, hence claims of minimal violence and damage were similarly misrepresented.

Above all, air control never involved the RAF acting solely on its own; in almost every case, these operations were conducted in close conjunction with ground forces—in truth, they were invariably joint operations. If anything, the emphasis placed on air control carried a significant penalty for Britain, by distorting the distribution of the RAF to Egypt and other remote parts of the empire, and causing emphasis to be given to building a force of light bombers which left the RAF quite unfit for other roles. Even the savings achieved were something of a myth. While British Army units were usually withdrawn, their place was taken by Indian troops—a shift of financial expenditure which the Indian Government greatly resented. And finally, the coercion entailed by RAF attacks might have suppressed rebellion for a time but it rarely ended the conflict, certainly not in Iraq, Palestine or the North-West Frontier.

Air Control Doctrine: A Contemporary Analysis

Key Points

- Air control is a continuously evolving concept.
- It was used to great effect in the 1991 Gulf War in its modified form, facilitated by the improvements in offensive air power capabilities
- The move towards a seamless force makes the concept of air control in a joint manner a viable and attractive proposition in contemporary conflicts.

It is an interesting coincidence that the first places where the then-emerging doctrine of air control, or 'air method', was trialled were British Somaliland (now Somalia) and the former Ottoman provinces of Mesopotamia which after the First World War were formed into the British-controlled mandated territory of Iraq. Both the nations have remained world trouble spots to this day, requiring British, American and Australian military intervention within the past decade or so. Currently the Western coalition maintains around 140,000 ground troops supported by a large number of aircraft in Iraq. In Somalia there has not been any coalition ground presence since the early 1990s, but the United States has resorted to air strikes against anti-American ground fighters as recently as January this year.

The concept of air control was actually a tailored response to difficult circumstances that the Royal Air Force found itself in, vis-à-vis its independent identity. The fact that it worked, when employed with adequate caution and in conjunction with land forces, made it an attractive proposition for use in colonial policing. While air power definitely contributed to controlling the colonies, for various reasons the real efficacy of air control was greatly exaggerated at that time. The concept of air control was, to say the least, revolutionary, but air power capabilities had not matured to the extent required for the concept to be put into efficient practice in a way that matched the rhetoric. Available technology at that time did not permit accurate bombing and the actions conducted by the Air Force invariably led to extensive collateral damage. Therefore, it was not surprising that the concept was not pursued with any great vigour, even by die-hard air power enthusiasts.

In the very early stages of the Vietnam War, before large scale ground intervention, the United States employed air power in an attempt at air control of sorts. However, it was not until the 1991 Gulf War that the concept of air control was revived, although it was not explicitly called by that name. The main effect of the earlier air control activity was one of deterrence and it remained so even in its new iteration. In 1991, air power was used extensively to deny manoeuvre opportunities to the adversary land forces, thereby limiting their employment potential. Subsequently, the concept was further refined and used in what came to be termed the 'kill box' tactics. As was the case in the early days, this was a classic case of a joint approach to prosecuting the enemy. In the 'kill box' concept, the surface forces contained the enemy within a designated area which was then attacked by air power with no fear of any unforeseen friendly casualties. This worked extremely well during the 1991 conflict.

However, a deeper analysis of the 'kill box' concept reveals some drawbacks. Firstly this technique could only be successfully employed in battlespaces that were open and conducive to cordoning enemy forces within designated areas. Even though air power sensors now have the capability to 'see' at night and through smoke, dust and bad light, they are not sufficiently developed to penetrate environments such as thick jungle foliage and elaborately constructed shelters. Second, the terrain of the operation determines whether an enemy can be effectively cordoned off to be picked out by air power. It is effective in vast remote areas that would otherwise swallow large numbers of troops, but its impact may be somewhat diluted in urban combat zones. Finally, in cases where the control of the air is contested, even a little bit, air and ground operations to contain and attack enemy forces in a discrete area may become untenable. Although the concept was extremely successful in 1991, it must be borne in mind that it was achieved in a situation of overwhelming air superiority.

Even when applied with caveats, a concept such as air control will always intrigue concept developers. This is more so in a global situation that views even the slightest collateral damage as unacceptable and is more attuned to deterrence and creating strategic effects than responsive destruction. The classic air control role as practiced in the 1920s is obviously a thing of the past.

Despite these challenges, the concept has seen a rebirth in the so-called 'war against terrorism' albeit in an altered form. Ironically it was in Afghanistan, where the concept had been used in the 1920s, that this revival took place. Once again, it is not referred to as air control, but the core objective has remained the same – to deter an adversary and deny them the opportunity to manoeuvre. Much has been made of the symbiotic relationship that now exists between Special Forces and the offensive elements of air power. The image of a Special Forces operative calling down an air strike on adversaries is now common place. The underlying doctrine behind this goes back to the original concept of air control. Once again the synergy between high-technology, high-end air power capabilities and ground forces, in this instance the Special Forces' ability to flush out hidden adversaries, makes a war-winning combination.

This tactical success has entrenched a twenty-first century version of air control as a method of combating surface forces. The concept envisages the surface forces herding the enemy into a designated area and then facilitating air power in attacking or even eliminating them. Well-executed, such action will lead to the enemy, so cornered, being more likely to surrender than put up an unequal fight. The effect is more of deterrence rather than destruction.

There is an on-going debate within the arm-chair warrior community regarding the role of the surface forces in the implementation of this concept. It is understandable that surface forces are chagrined at the support role that they have to play in these operations, but the realities on the ground point towards this type of air control as the optimum way to prosecute a very vaguely defined conflict against elusive adversaries. For effectiveness, both air and ground forces will have to play their parts expertly, with high levels of integration.

Air control as perceived in the 1920s, without adequate air power capabilities to support even the least complicated of objectives, has evolved into a new and hitherto unforeseen concept. The acceptance of the need to be a seamless force, using the individual competencies of the constituent parts, is obviously the cornerstone on which the contemporary air control doctrine rests.

The Air Campaign

The air campaign has a prominent position in military operations and forms an integral part of military campaigns conducted in the pursuit of national security interests. An air campaign is the controlled conduct of a series of related air operations to achieve specified objectives. The planning, execution and integration of air campaigns are complex functions and require the application of professional mastery of airmen for their success, as highlighted by our Air Force's air power doctrine.

Key Points

- The planning, execution and integration of air campaigns are complex functions and require the application of professional mastery of airmen.
- Control of the air to ensure the freedom to conduct effective operations is a vital prerequisite for air and surface campaigns.
- The air campaign will continue to play a vital part as a first response to any national security crises.

ADF doctrine defines a campaign as a series of actions to achieve an operational commander's objective, normally within a given time or space. These operational objectives are selected to achieve the desired military strategic end-state. Although all ADF campaigns seek joint outcomes, they may be conducted as a single environmental campaign or as a coordinated combination of maritime, land and air campaigns. The environmental campaigns are defined by the medium in which they are primarily conducted, rather than the medium in which their effects are created. For example, air campaigns are conducted from the air and create effects both in the air and on the surface.

The ability of air power to conduct responsive operations over long distances may sometimes mean that the air campaign alone may be used to achieve the joint strategic or operational outcome sought. More often, joint campaigns will include orchestrated maritime, land and air campaigns, frequently conducted in an expeditionary manner throughout

Australia's areas of interest, in the near region and beyond. In all cases, the air campaign will be a vital part of creating the desired joint effects.

Where a joint campaign is being conducted, the planning, conduct and effects of an air campaign must be considered within the larger context, and synchronised with the maritime and land campaigns. Air operations can be conducted simultaneously or in a sequence, as needed, to best harmonise with the campaign objectives and also to optimise the use of available forces. The Air Operations Centre (AOC) plans and executes air campaigns to ensure that their effects are tailored to achieve the desired objectives either independently, or orchestrated with those of the other joint force components to create joint effects.

The inherent characteristics of air power, such as speed, reach, responsiveness and flexibility, often make the initiation of an air campaign the first action in the joint campaign, especially where speed of response is critical. The requirement for air forces to obtain and maintain control of the air, provide persistent knowledge and shaping of the area of operations and to provide air mobility to support the deployment, manoeuvre, sustainment and redeployment of forces throughout the joint campaign also means that the air campaign is often the last to finish. Throughout the joint campaign, the AOC will be responsible for the assignment of air effort in accordance with the joint commander's priorities.

In a conflict, the air campaign begins with operations to ensure friendly control of the air, an essential pre-requisite in any joint campaign. If an adversary chooses to contest control of the air, air forces will conduct a counter air campaign to win and sustain the required degree of control of the air for the duration necessary. Such a contest for control of the air may include air combat operations against airborne enemy aircraft in theatre and air attacks against enemy aircraft and facilities at their operating bases, possibly deep inside enemy territory. Control of the air is not an end state by itself. However, without the necessary level and duration of air control, in a joint campaign, even minimal threat from adversary air power can jeopardise the likelihood of success of surface campaigns and also lead to unsustainable friendly losses.

Air campaigns can achieve outcomes that contribute directly to strategic and/or operational success. History shows that a successful air campaign is an essential precursor for the success of land and maritime operations in a contested battlespace. The Battle of Britain stands as testament to an air campaign where the British Government had to rely principally on air power to ensure the survival of the nation. This air campaign achieved an operational outcome that denied Germany the pre-requisite of controlling the air over the English Channel prior to invasion. The Battle of Britain made a critical contribution to the strategic outcome of securing the British homeland and the eventual liberation of Europe. Events such as the sinking of HM Ships *Prince of Wales* and *Repulse* in World War II and the 1982 conflict for the Falkland Islands are enduring reminders that control of the air is crucial for effective surface operations.

With control of the air, air forces can leverage the flexibility of air power to conduct a wider range of operations including independent strategic attacks, shaping, reconnaissance and surveillance operations ranging through, around and beyond the theatre. It can also carry out precision attack and air mobility operations integrated with surface force campaigns. For example, after gaining control of the air, the air campaign in the 1991 Gulf War carried out air strikes that neutralised the Iraqi military's warfighting and C2 capabilities and prepared the battlespace for the land campaign while continuing to provide the massive air logistics and air mobility effort that was needed for the surface campaign.

The effective, harmonised and timely execution of all the environmental campaigns is vital to the success of joint operations. This naturally places specific demands on personnel to demonstrate the highest level of professional mastery of their environmental capabilities and operations. This mastery must also encompass the ability to integrate and harmonise the three environmental campaigns to achieve joint outcomes.

The air campaign will continue to play a vital part as a first response to any national security crises. Throughout the range of operations, from high-end conflict to humanitarian assistance, the need to counter any adversary air threat and maintain control of the air in the theatre of operations remains the foundation for successful joint, inter-agency or coalition campaigns. Control of the air will be fundamental to other phases of the air campaign, just as it will be to any surface force campaign. The key for masters of air power is to fully understand the air campaign and the impact that it has on the wider joint campaign.

The Evolving and Adapting Air Operations Centre

On a balmy evening towards the end of RAAF Hornet operations over Iraq in 2003, the commander of our F/A-18 contingent was discussing the nature of the functions being performed by the Coalition Air Operations Centre with the Commanding Officer of a USAF F-15E squadron. The Eagle driver's words were insightful: "What we have is a very good fixed targeting system, with an appended time sensitive targeting cell. What we now need is priority on developing a very good time sensitive targeting system with an appended fixed targeting cell".

Key Points

- Asymetric nature of recent air operations highlight the need to possess a targeting system that is time sensitive rather than designed to deal with fixed targets
- The key challenge for an AOC engaged in these operations is to reduce the decision cycle between recognising a fleeting target and engaging it
- In extreme situations, to reduce the time taken in establishing the legitimacy of a target, C4ISR resources will have to be combined with commanders—to centralise control and execution in real-time

Since the coming of age of massed air power in World War II and the need to plan and task massed air missions, the United States Air Force has continually refined the way in which it plans, commands and executes air operations at the theatre level. Historically, this desire has been driven by the pursuit of the optimal means to plan, execute, and assess the effects of massed air operations against a spectrum of fixed targets, but it has been characterised by a relatively ad hoc approach to dealing with more mobile and fleeting targets. Recently however, the operational environments that have been encountered in Kosovo, Afghanistan, and Iraq have been influential in an urgent re-prioritisation of the focus of the AOC's functions. The traditional massed nature of the conventional enemy has adapted in the face of 'shock and awe', and the centres of gravity of their operations are not predominately fixed but increasingly mobile, fleeting and very hard to find. Therefore, the AOC has had to adapt and evolve considerably to get air power platforms to deliver the required effects on time.

Officially designated a weapon system in its own right in 1995, the Combined (CAOC) or Joint (JAOC) AOC has developed a 72 hour cycle that centrally collects the necessary Intelligence, Surveillance and Reconnaissance (ISR) information and after combining them with the Commanders intent—along with specified rules of engagement (ROE)—plans, executes and assesses the air campaign. The execution 'product' of this cycle is an Air Tasking Order (ATO) that effectively controls each day's air operations. Two other ATOs are always in various stages of production and staggered in parallel so that each day a new ATO controls all airborne theatre assets. Unity of Command and the centralised control of all air assets allow the Air Component Commander (ACC) to allocate air assets to best effect, while exploiting the unique characteristics of air power through the facilitation of decentralised execution.

In Operation Iraqi Freedom, the CAOC performed to devastating effect against Saddam's conventional forces, efficiently locating and destroying both fixed and easily identifiable mobile military targets. Baghdad's fixed defences were effectively annihilated even before coalition land forces massed for the final assault. From that time on, the nature of the challenge for the AOC changed significantly. As the war took on the character of an insurgency, the mission of the AOC changed from the need to construct a complex 2000-plus mission ATO to that of flexibly assigning far less air assets, invariably in direct support of land forces. Most importantly, it had to address the evolving challenge of getting its sensor-to-shooter timings to the minimum possible, to effectively target enemy combatants who were ambiguous, elusive and fleeting. Both procedural and technological solutions had to be found to be effective against such time sensitive targets.

Much has already been written about the evolving nature of future warfare and the challenges it poses to all manners of war fighters. While it would be premature to sound the requiem for conventional war fighting—

and hence the need for high end, complex, organisational excellence as embodied in the modern fixed targeting AOC—the challenge of the modern battlespace in which air power has to operate needs immediate and creative attention. Operations in Kosovo, Afghanistan, Iraq and also southern Lebanon typify the extent of the challenge. While it seems obvious that reducing the decision cycle is the key, it is critical to recognise an important complication; for a war fighter conducting operations in accordance with the Laws of Armed Conflict (LOAC) as laid down in the Geneva Convention, it is only acceptable to kill legitimate targets.

Targets are considered legitimate only after what can sometimes involve a complex and time consuming process. The decision to lethally neutralise a SAM site that has just shot at a friendly aircraft from an open paddock is straight forward when compared to responding against a group of two or three well-dressed men who have just launched a SA-18 from a hospital roof. The Israeli experience in southern Lebanon is particularly instructive. The improvised civilian truck-borne rocket launcher becomes a legitimate target as soon as it fires at Israel from a position at the end of a street. However, within the time of flight of a fighter jet's armament, it can rapidly become an undesirable target, because of collateral damage constraints and the possible political fall-out, as it quickly retreats inside a garage in a civilian dense area.

To be effective in such extreme situations, the AOC will need to streamline its sensor-to-shooter processes and simultaneously speed up its target legitimisation processes. The ability to conduct centralised execution from the AOC will need to be realised in a complex battlespace by combining in real-time the C4ISR resources and the appropriate level of commanders who are authorised to make tough and discretionary decisions (with a LOAC lawyer in close proximity). This is a slight variation of one of the more important tenets of air power employment, that of 'centralised command and decentralised execution'. When necessary, control and execution will have to be intimately tied.

To meet the challenges of the future battlespace, the modern AOC must not only master the organisation and execution of massed air power, encompassing days of complex planning, but also prosecute time sensitive, legitimate targets within minutes of detection. Centralised control is essential to allow air power to shorten the sensor to shooter cycle in both of these scenarios effectively. However, the control of execution will need to be flexible enough to accommodate the evolving nature of targets throughout the future battlespace spectrum.

The On-going Evolution in Air Power Application

> **Key Points**
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> - The circumstance and environment in which military forces are employed is constantly changing.
> - Air power can contribute effectively to effects-based planning and operations.
> - Technology can become a double-edged sword if not fully understood.
> - There is no substitute for sound doctrine and professional mastery.

A common thread across the history of military air power has been the impact that forward thinking has had in its optimum application. It can be argued that the claims of early air power strategists were not matched by the capability of the systems of the day. However, technological advances have overcome past difficulties and today air power has fulfilled those early promises and become a valuable element of military and national power across the contemporary spectrum of operations. Recent conflicts have illustrated that air power, properly applied, is very effective in shaping and responding in a battlespace to create war winning conditions, at times being the dominant element. It has also been demonstrated that air power, like any other force projection capability, will struggle to make an effective difference if employed inappropriately and if not properly integrated into a joint military or national security campaign.

The 1991 Gulf War was a watershed event in the evolution of the application of air power. The dominant contribution that air power made to the allied victory was seen as a clear indication of its coming of age. The effectiveness of air power in that war, achieved through superb campaigning—carefully matching capability, planning and execution to objective through orchestrated operations—was proclaimed by enthusiasts to be the beginning of an era of air power ascendancy. It is undeniable that in the past two decades air power has played a significant and crucial role in joint military and, increasingly, national security, operations. However, the circumstance and environment in which military force is employed is constantly changing and this has also had credible impact on the forward thinking and application of air power. Four major factors must be carefully considered in order to understand the on-going evolution of air power application in today's context.

First, this requirement to alter the practical application of air power requires air power practitioners to constantly adapt its doctrines and systems to context to ensure effectiveness. Because of its inherent flexibility, the application of air power is unique and success is critically dependent on a clear understanding of current principles and the capacity to mould it to cater for emergent situations. For example, the recent conflicts in Afghanistan and Iraq are indicative of the move towards insurgency and guerrilla warfare to counter conventional forces. The adversary has chosen these styles of warfare for a number of reasons. These include: the natural asymmetry of such forces when compared to the conventional, state-based militaries of the west, which have difficulty in countering insurgents who are embedded amongst the people; and the fact that irregular insurgent forces suit the cultural and religious ethos and warfighting capabilities of those groups fielding them.

Whatever the motivation, their actions are characterised by a seeming randomness and absence of a conventional strategy. Under these circumstances, the absence of predictability in the conflict-space is a constant factor, making it imperative for our force projection capabilities to be flexible and adaptable. Air power offers some solutions. With the battlespace in a constant state of flux, the inherent characteristics of air power—speed, range, precision and persistence—make it a natural choice for projecting power that, with appropriate ISR and C2, can be rapidly and precisely bought to bear on fleeting targets.

Second, in the past decade or so, military planning has undergone a clearly visible transformation towards an effects-based approach, increasing the relevance of air power because of its capabilities to influence the physical, cyber and cognitive domains, often simultaneously, as part of an orchestrated and parallel campaign. Since the ultimate end-state sought in conflict is to alter the mindset of the adversary to align with our own, it is in the cognitive domain that the final outcome will rest. However, effective influence in the cognitive domain can only be achieved by actions that are initiated in the physical and cyber domains. These actions will be spread across the complete spectrum of effects that air power can bring to bear—from physical destruction to the manipulation of information.

The third factor is the increasing danger of technology hindering the concerted and optimum application of force at the desired time and place. Contemporary application of air power will have to adhere to the basic tenet of 'centralised control and decentralised execution' which will need to be appropriately tailored and orchestrated for effectiveness in the physical, cyber and cognitive domains within a given context. The technological developments essential for this control also provide senior commanders with the ability to 'see' the tactical battlefield from remote locations, thereby allowing them to intervene, not always appropriately, in tactical decisions, thus introducing the potential to undermine decentralised execution. Mastering the dynamic balance between control and execution to empower decision-making at the appropriate level will be the hall mark of successful twenty-first century operations. State-of-the-art technology, if not well understood, can become the proverbial double-edged sword.

The fourth factor underpins the previous three. The need for the development of sound, contemporary, doctrine and related strategy in applying air power cannot be overstated. These must be kept fresh in the minds of practitioners through sound operational analysis and ongoing education so that commanders can create and implement effective plans. This translates to the professional mastery of the theory, practice and considered development of air operations by the people of the air force. Flexible, innovative and adaptable thinking and the conversion of concept to reality by professionals are the most important factors in the success of air forces, particularly smaller ones like our own that are sophisticated and seek to remain first rate, but is also resource constrained.

The importance of air power as an integral part of a joint force is now cemented through demonstrated historical success. However, there is ongoing change, more evolutionary than revolutionary, which affects all aspects of its employment. It is imperative for air forces to be constantly aware of the changing face of conflict and to constantly adapt to optimise the employment of air power on the day.

A Fresh Look at Air Attack

From the time that the attack from the air first appeared in the writings of air power theorists, they have been a point of contention not only amongst military strategists, but also in the larger community. The realisation of the capability from the First World War onwards only heightened the debate. They have been variously hailed as the panacea to the unnecessary loss of life that accompanies any war and reviled as immoral because of the uncontrolled collateral damage that seemed to be integral to any air attack until recent times. However, there is no doubt that regardless of the debate, air attacks have become a highly preferred way for a nation to attack its adversaries in almost all situations.

Key Points

- Control of the air and precision attack are the dual functions of air force's force application
- Control of the air is a prerequisite for the success of any military operation
- Precision attack is carried out to shape the environment, deter aggressors and to deliver decisive response

The fundamental reason for creating any warfighting organisation is to provide the nation with the ability to apply force, if necessary even lethal force, in support of national interests. The Air Force contribution to such force application is through air attacks, which are the high-end response that air power can bring to bear against security threats. Even without being used, such a capability has salutary deterrent effects that may prevent an adversary from initiating hostile activity, thereby averting potential conflict.

If armed conflict occurs, Air Force will carry out force application through the dual functions of counter air and precision attack to attain the primary goals of the joint campaign. Counter air missions are carried out to obtain control of the air and precision attacks are directed against the enemy's centres of gravity. All air attacks are intended to create decisive effects through kinetic and non-kinetic, offensive and defensive means in support of the joint force.

An appropriate level of control of the air is an essential prerequisite for any military operations in which the ADF participates. It is likely that an unconventional adversary may choose not to, or may not be able to contest the control of the air. However, at other times the Air Force will be required to fight for and gain control of the air to ensure that the joint force is able to operate unhindered in the desired areas for the time required to successfully complete the mission or campaign. This will be achieved through counter air missions that are carefully crafted to optimise the employment of air power resources. Planning to maximise the effective use of available air assets is critical in the case of small-size air forces. For such forces, the versatility inherent in air power would have to be exploited to ensure that counter air and other air campaigns can be conducted concurrently.

Counter air operations can include both offensive and defensive actions. However, air power is inherently offensive, and achieves the best results when employed to destroy, disrupt, defeat and contain adversary air power as close to its source as possible. When utilised offensively, air power is capable of engaging hostile forces well beyond the range of surface weapons and before they can threaten friendly forces. The offensive application of air power against enemy facilities and air bases places challenging demands on the reach and penetration of Air Force's air power assets and the capacity to sustain deployed operations.

Defensive counter air operations aim to neutralise the effectiveness of hostile air action and deny the enemy control of the air. These operations normally take place over or close to friendly territory and aim to minimise damage to friendly forces while inflicting maximum attrition on the opponent. While such actions may complicate the adversary's counter air operations, they are essentially reactive in nature and offer the initiative to the adversary, who will be able to control the tempo of operations.

The future threats to Air Force's ability to control the air dimension of the battlespace will be multifaceted and could include high-end fighter aircraft, advanced air-to-air weapons and sophisticated surface-to-air missile systems. The future force that has to fight to obtain control of the air will, therefore, need to have the capability to deal with the emergent air threat through a combination of onboard sensors that allow transparent networking, stealth, electronic warfare capability, systemic range, weaponry and professional mastery of Air Force personnel.

Air Force carries out precision attacks to shape the environment, deter possible aggressors and, when necessary, to deliver timely and decisive responses. Maintaining an adequate precision strike capability with a numerically small force requires a careful mix of effective command and control networks, support systems and weapon system technology. A capable adversary will place such extraordinary demands on air assets in terms of survivability that only highly capable systems operating near-leading edge technology will be able to carry out credible precision strikes and create the necessary effect.

There are two levels of precision attacks that an air force carries out—strategic attack and integrated air. Strategic attack will remain a defining function for air forces. Conducted independently of surface manoeuvre it aims to create strategic effects that degrade or destroy the enemy's will and warfighting capabilities. Despite its independence of action, strategic attack is an integral part of a joint military campaign and the whole-of-government approach to national security. The assessment that shapes strategic attack is complex, and will be guided by political intent and constraints.

Integrated air is the conduct of carefully planned and executed air campaigns as part of joint and coalition operations. These include counter land and counter sea strike operations, conducted primarily to deprive the adversary of the military power needed to exploit, manoeuvre in or occupy land or sea area. Integrated air creates operational and tactical effects, but in certain circumstances can achieve strategic outcomes.

Counter land operations fall into two broad categories—air interdiction and close air support. Interdiction can contribute to campaign objectives directly or support land forces and is targeted at enemy military potential before it can be brought to bear against friendly forces. Close air support missions are air strikes conducted against hostile targets in close proximity to or in actual contact with own forces. Likewise, counter sea operations involve the integrated application of air power against enemy maritime capabilities.

Air attacks have come a long way from the indiscriminate area bombing campaigns of the Second World War. Today these operations have no resemblance to the application of air power even twenty years ago. However, the underlying strategic goals of air attacks have not fundamentally changed—control of the air and decisive effects on the surface.

Suppression of Enemy Air Defences: A Primary Mission

The modern battlefield bristles with extremely sophisticated and varied air defence systems. Today there is a proliferation of technologically advanced yet inexpensive air defence weapons. These have added to the threat to airborne assets, and contribute to making the battlefield an extremely dangerous place. The tactical situation is such that the Suppression of Enemy Air Defences (SEAD) is ever more critical to the achievement of air superiority, delineated in time and space. The basic aim of SEAD operations is to disrupt, disable and/or destroy enemy air defence networks to an extent wherein they are made incapable of effective interference in one's own air activity.

Key Points

- Achievement of air superiority on the modern battlefield now critically depends on the core ability to suppress a variety of air defence systems
- Given the impossibility of simply destroying complex enemy systems, effort must focus on disabling key nodes to disrupt or seize control of a network
- Detection and suppressive systems will in future be distributed over many platforms, increasingly involving UCAVs

Complicating things further, some air defence systems are man-portable and have passive seekers, such as the shoulder-launched surface-to-air missiles (SAMs). Countering these is problematic, and they are worthy of a separate study. They are not the focus of this *Pathfinder*, which is the larger, more sophisticated and more capable air defence systems.

The initial concept of SEAD as an independent and critical role for air power was developed as purely a 'hard' kill option, ie. destruction options of enemy air defences by the use of anti-radiation missiles. However, over the years the role has assumed much greater sophistication. SEAD missions are now a combination of 'hard' and 'soft' kill operations optimally combined to achieve the required effect.

In the modern battlefield of networked forces, the soft kill option seeks primarily to disrupt or even control the sensors and communication links that provide a network with command facilities and decision-making capabilities. In the hard kill arena the aim is to destroy critical nodes within a network to disable the entire system. This is normally the air defence radar that is still central to area defence against air attacks.

Anti-radiation missiles therefore are still the preferred weapons for strike options. Since these missiles rely on detecting radars that are emitting and then homing on to them, they are almost completely ineffective against targets that have shut down. There is considerable work in progress to ameliorate this situation by the use of active and passive radar homing devises in combination with inertial navigation and GPS. The effective use of GPS will require accurate intelligence regarding the geo-location of the target system. These modifications are not likely to be operationally available before 2008–09 and even then available only to a few air forces. An additional drawback is that even though the traditional missiles' inability to attack silent radars will be surmounted, it still needs external cueing to maximise its effectiveness.

The SEAD concept is dynamic and the demonstrated capabilities of Unmanned Aerial Vehicles (UAV) have provided new impetus for its further development. The UAV adds a hitherto unavailable characteristic to the entire concept—that of persistence. The longer endurance of UAVs, armed with missiles, makes the operation of air defence radars, even for short periods, extremely hazardous. A radar that cannot emit is obviously of very little use as an air defence weapon system.

Another facet of the concept is the use of airborne surveillance systems to tap into the available strike forces as soon as a radar or any other emitter has been tracked and identified. This obviously is dependent on free strike assets being available 'on call' with the appropriate weapon load and may not be an option that is always readily available.

The danger of the attacking aircraft being shot down makes SEAD a necessary but unsavoury (politically and tactically) mission. For this reason, there can be little doubt that future SEAD missions will almost completely be underpinned by Unmanned Combat Aerial Vehicles (UCAV) both in the hard and soft kill options. The inherent stealth of these vehicles will allow it to approach closer to the target system and thereby the power required to jam its associated radars will be minimised. This development also points towards a UCAV being able to close-in to an air defence system sufficiently, before being threatened, to disrupt the system with a hard kill option with minimal collateral damage.

Undoubtedly, for a number of reasons, the future of SEAD resides in UCAVs. However, both the F-22 and the F-35 will field Active Electronically Scanned Array (AESA) airborne radar with electronic attack capability that in combination with the aircraft's stealthy profile will permit them to blind hostile radar in support of their own missions. It is envisaged that these aircraft will be able to create an electronically blind battlespace at will. At least for the conceivable future, the SEAD load will be distributed between a wide variety of platforms.

There is also significant research being undertaken to establish the capability of microwave energy weapons to 'burn out' computers and other electronics associated with air defence networks. There are claims that technology demonstrations have proved the viability of 'invading' computer networks and taking control of assets from their operators. At the moment this may seem a far fetched idea, but in combination with other proven methods this may well be the elusive, fool-proof SEAD capability that can debilitate even the most sophisticated air defence network.

The concerted effort being put into developing these capabilities is a clear indication that SEAD will remain a core mission in the pursuit of air superiority, which in turn remains an absolute prerequisite for the success of all other missions. This certainty remains and is an imponderable, but the means of succeeding in the all-important SEAD mission are rapidly covering a very wide spectrum of assets. It may be that in the future there will be no specialised SEAD assets, but the force package within itself will be able to provide its own SEAD capabilities. The key elements in such a situation will include geo-location of the target system, real-time data flow between the elements of the package as well as within the designated battlespace and the availability of the expanded set of hard and soft kill options—all within the force package.

The maturation of the technologies that will provide non-lethal solutions to the conundrum of SEAD will take many more years, and therefore the primacy of the hard kill option is unlikely to be threatened in the foreseeable future. In whatever form, SEAD will remain the lifeline for all other missions.

Turning Efficiency into Effectiveness: Swing-role Air Combat Capability

Key Points

- Agility must be a key attribute of a small force for it to be successful against both conventional and unconventional threats.
- Small air forces must seek effectiveness through efficiency to be successful and relevant against a range of threats.
- Swing-roling is the ability of an airborne system to change responsively from one air power role to another during a single sortie.
- Advances in command, control and communications and flexible munitions have enhanced the swing-role capability of modern and next-generation air combat aircraft.

With the widespread growth of terrorism and insurgency as methods-of-choice in modern conflicts, one could be drawn into thinking that the future of conflict resides in the asymmetric and the unconventional. Certainly the War on Terror is likely to be with us for a significant period yet, and achieving success will require adoption of unique methods to counter such an unconventional adversary. However, while 'informal violence' is on the rise, the threat posed by conventional nation-states fielding similar forces to our own is not necessarily diminishing.

For the RAAF this dichotomy provides some unique challenges. It would be wrong to think that low-end conflicts require low-end capability. If anything the reverse is true. In complex terrain such as an urban environment the requirement for high-end airborne ISR capabilities pushes the very edge of the technological envelope—after all, detecting and discriminating terrorists or insurgents who deliberately conceal themselves among the civilian population is a much more demanding task than identifying a tank in an open battlefield. Likewise, the ability to engage these elements using tailorable weapons while minimising harm to innocent bystanders is by no means a low-end capability. Simultaneously, the requirement still exists to defeat advanced adversary air combat aircraft and engage surface targets in complex air defence environments.

For the RAAF there is a clear imperative to maintain a range of capabilities able to contribute across the spectrum. To do this requires an agile force—incorporating versatility and responsiveness—that allows for successful force application at whatever level it is required, whenever and wherever it is needed. At the same time the size of our force requires us to seek efficiencies while still maintaining, even increasing, effectiveness. One of the ways of achieving this agility and of turning efficiency into increased effectiveness is through swing-roling.

Platforms that are capable of performing more than one air power role are considered to be multi-role. The AP-3C Orion is an advanced ISR platform, a search and survivor assistance aircraft, and an anti-submarine and anti-ship weapon system. The F/A-18 Hornet is capable of counter air, counter land and counter sea missions. While there are different crew training requirements for each of the different roles, generally only reconfiguration of a multi-role platform before a sortie is required to suit it to a particular type of mission.

Swing-roling takes this to the next level by allowing for responsive and flexible role change after takeoff and therefore during a sortie. This is not a new concept. Since their introduction, RAAF F/A-18s have been capable of conducting 'self-escorted strike' requiring them to be able to both defeat an air threat and deliver air-to-ground munitions. Similarly, the AP-3C is capable of conducting reconnaissance and surveillance, and counter sea roles within the same sortie. However, recent developments in networked communications and flexible munitions have produced significant enhancements to the swing-role capability of single-seat air combat aircraft such as the F/A-18 and the F-35 Lighting II—the Joint Strike Fighter—that will replace it.

In the past the principal issue with swing-roling was the lack of a suitable command, control and communications system to enable the timely direction and redirection of aircraft following take-off.

In the 1991 Gulf War, aircraft were tasked on a 24-hour air tasking order cycle. Targets were selected days in advance and there was very little, if any, flexibility for a swing-role capability. When operations in Afghanistan began in 2001 the focus had shifted towards time-sensitive targeting, which allowed a degree of flexibility during a mission to attack a target of opportunity. Although this was not generally conducted as a swing-role task but rather through use of 'loitering' single-role aircraft, this shift in thinking was facilitated by a significant increase in the ability to get quality information to the aircrew in a usable and timely fashion.

During the early stages of the 2003 conflict in Iraq, RAAF F/A-18s were able to show just how effective true swing-roling could be. Launching on a defensive counter air sortie carrying three external fuel tanks, five medium- and short-range air-to-air missiles, a targeting pod and a single laser-guided bomb, RAAF Hornets were able to switch during the mission to undertake air interdiction or close air support, and then return to the air defence role. This both maximised the use of available air hours and allowed the deployment of only a handful of aircraft to achieve results well in excess of their mass. To this end, it is clearly not only the flexibility of the platform, but also the adaptability and professional mastery of the people involved, that enables a true swing-role capability.

The introduction to service of the F-35 in the period from 2012 will allow for even greater flexibility to switch roles during a mission. The F-35 has been designed from the ground up as a swing-role aircraft able to carry a diverse suite of weapons simultaneously and be adept in both the counter air and precision attack roles. The key to enabling the unique swing-role capabilities of the F-35 will be an enhanced network capability that will allow for high-fidelity command and control information to be relayed to an airborne aircraft faster, enabling quicker and more astute action, whether that is the engagement of an airborne threat or a surface target.

In addition to its 18,000 pounds of internal fuel, the F-35 will be able to carry two AMRAAM air-to-air missiles and either two 2,000-pound laser-guided bombs or eight GPS-guided Small Diameter Bombs (SDB), as well as its inbuilt Electro-Optical Targeting System. All of these will be carried inside the body of the aircraft, ensuring that its inherent low-observability characteristics are not compromised, and the endurance and range efficiencies of the aircraft are maximised. A further 16 SDBs could be carried on external pylons if required. With the SDB having an approximate range of 60 nautical miles, the F-35 will be in a position to launch a precision attack without leaving, or departing only briefly from, the counter air role. The SDB will itself be an inherently flexible weapon that can be programmed after take-off to deliver differing kinetic effects matched to the type and nature of the target and operational requirements.

This fusing of air power roles within a single mission will provide a unique capability to the Joint Force commander. Where targets are identified by surface forces, the F-35's networked-capability, responsiveness and flexible munitions will enable swift and decisive engagement. At the same time the measured control of the air essential for any manoeuvre of the Joint Force will benefit from a highly capable, stealthy and well-armed platform. Both of these functions will be realised by a single platform type on a single mission. This inherent swing-role capability of the F-35 will give the RAAF, and through it the Joint Force, a degree of agility significantly greater than it has previously and currently enjoyed, and will ensure that platform efficiency delivers operational effectiveness.

Responsive Global Airlift: An Australian Perspective

> **Key Points**
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> - Australia's geo-strategy requires the ADF to be expeditionary in nature and that entails airlift support for sustenance
> - Responsive Global Airlift provides timely movement, positioning and sustainment of military forces and capabilities across the spectrum of military operations
> - The delivery of two new platforms over the next five years will provide a quantum increase in the responsiveness and effectiveness of the RAAF's airlift capability.

Australia's unique geo-strategy makes long-range airlift an essential element of most Australian Defence Force (ADF) undertakings for both indigenous and offshore operations. The distances within the Australian territory makes even exercises and training take on an expeditionary nature. Furthermore, recent experiences in sustaining a number of coincident expeditionary forces have highlighted the need to possess adequate airlift capabilities to secure Australia's national interests.

The concept of Responsive Global Airlift (RGA) addresses this requirement. RGA seeks to deliver a balanced airlift capability across the spectrum of operations by matching the specific capabilities of individual airlift platforms with the explicit needs of stakeholders for the achievement of Joint outcomes. This is particularly applicable to small air forces operating a limited number of airlift platforms, since those platforms are required to provide significant flexibility and responsiveness.

Australia has a long history of supporting expeditionary operations through intra-theatre airlift—from operations in the Pacific theatre during World War II, through the conflicts in Korea and Vietnam in the 1950s, 1960s and 1970s. Although there was a lull in such operations in the 1980s and early 1990s, the deployment of the ADF-led multi-national forces into East Timor in 1999 needed large-scale expeditionary airlift effort from the RAAF. This has been closely followed by the ongoing support to expeditionary operations in Afghanistan and the Middle East.

Inter-theatre logistics for Australia's recent operations have relied on three independent lift capabilities: RAAF airlift, contracted or coalition airlift, and Royal Australian Navy sealift. The existing assets of the Air Force have been adequate for the inter-theatre role, except for the lack of capability to rapidly move outsized cargo. Contracted and coalition airlift have filled this gap as required and also augmented commercial troop lift capability. Despite the small size of its contingent, Australia has regularly contributed significant airlift capability to coalition expeditionary operations.

The delivery of two new platforms over the next five years will provide a quantum increase in the responsiveness and effectiveness of the RAAF's airlift capability. Between now and 2010 the RAAF will take delivery of four C-17 Globemaster III heavy airlift aircraft, and five A330 Multi-Role Tanker Transport (MRTT) aircraft. Integrating this new fleet into the existing capability in a balanced and efficient manner will be effected through the Responsive Global Airlift concept.

RGA is a key component of Joint effects-based operations and relies heavily on an understanding of the desired Joint outcome to determine enabling payloads, and to match payloads to optimum delivery methods. RGA endeavours to match the unique characteristics of different airlift platforms—range, payload, speed, self-protection, short field performance, reliability etc—to the payload requirements in terms of size, weight, distance, priority, time constraints, airfield limitations and threat environment. While RGA incorporates the traditional 'hub and spoke' logistics delivery model, it is not constrained by it. RGA creates greater responsiveness in the airlift force by not restricting movement only between hubs and spokes but allowing direct access to and from all points within the system. This produces more effective outcomes, making RGA a vital concept for small air forces reliant on efficiency to achieve effectiveness.

The RGA model envisages that inter-theatre airlift will generally still deliver its load from a fixed hub to deployed nodes, from where medium and light transport will distribute payloads to in-theatre points. This operation can be run in parallel with different platforms delivering complementary capabilities. At smaller deployed nodes, both fixed and rotary wing aircraft can transfer stores and personnel to the points where they are required. The C-17 also has the capability to move bulk and oversized cargo over intercontinental distances directly to small nodes, bypassing the intra-theatre lift requirements.

RGA also mitigates to a certain degree the problems of battlespace control in a highly dynamic and complex airspace management environment, by both reducing the number of aircraft in the air or on the ground, and by dispersing delivery nodes to the most appropriate level.

An effective RGA framework offers Australia significantly more than just the capability to move large quantities of personnel and cargo over large distances. The ability to react responsively to produce outcomes at short notice provides significant strategic shaping effects, proven by recent expeditionary operations to provide support in the wake of the 2004 Boxing Day Tsunami and the Bali terrorist attacks. These missions have shown that a responsive airlift system can create effects that contribute to perceptions of security. RGA operations can demonstrate a nation's strategic posture, shape perceptions and can signal status, competence and intent both regionally and internationally. The inherent responsiveness of RGA allows rapid intervention with greater impact in regional crises creating enhanced strategic effects. The ability of a single C-17 to deliver, for example, a troop of light-armoured vehicles and their crews into austere airstrips in the region within hours, offers different force application nuances than are currently available with existing, lighter, airlift assets.

Within the broader framework, inter-theatre platforms like C-17 and A330 can deliver payloads to expeditionary operations around the globe without intermediate stops when supported by air-to-air refuelling. This increases the flexibility to operate in complex political environments where landing rights etc may be difficult to obtain. Given Australia's geographic isolation this is a significant factor in the expeditionary deployment of air power.

RGA will become an integrated component of the RAAF's operating concept and aspects of it will be networked to ensure responsiveness to adaptive command and control. As a node in the network, airlift assets also offer the potential to act as a network relay to other units operating at the geographical extremity of the network, while adding the information gained by their sensors to enhance battlespace awareness. In this way both inter-theatre and intra-theatre airlift assets will provide expanded support to force application beyond that provided by lift alone.

Both by nature and intent the ADF is an expeditionary organisation that requires high tempo airlift support across the spectrum of operations. Responsive Global Airlift will deliver Australia's expeditionary requirements by creating a balanced system of airlift that matches optimum platform capability to the requirements of the Joint stakeholder from home to frontline as part of a coordinated effects-based approach.

ADF's New Multi-role Tanker Transport Capability

The ability of strategic airlift and air-to-air refuelling (AAR) to increase operational combat options make them extremely valuable capabilities. This contribution to operations has shaped development toward the multi-role capable aircraft being acquired by the RAAF and considered by virtually all other modern air forces, including the USAF.

Key Points

- AAR is a key component of the Air Force's capability to create persistent effects in expeditionary operations
- The reach and capacity of the new MRTT provides enhanced mobility and force application options for joint forces

The first real demonstration of AAR occurred in the US in 1923, when a DH-4B biplane was kept airborne for over 37 hours. Despite AAR remaining a dangerous activity, by 1935 the record for the longest refuelled flight was in excess of 27 days. The effectiveness of AAR as an operational capability was initially demonstrated in the Vietnam War. Several significant examples have followed, including the *Black Buck* series of very long-range strikes launched from Ascension Island during the Falklands War, and ultimately during *Desert Storm* when USAF B-52s flew 35-hour bombing missions over the Persian Gulf from the Continental US.

The Boeing 707-338 tankers which currently provide the ADF's AAR capability were purchased as a 'training capability' but have since seen operational service on several occasions. They were part of Operation *Desert Watch* in 1998, and Operation *Slipper* in Kyrgystan in 2002. During the latter deployment the RAAF tankers completed in excess of 800 refuellings, transferring more than six million pounds of fuel. These operations were complemented by the fleet carrying out ongoing strategic airlift.

The evolution of AAR capability has seen the development of two key systems: probe and drogue developed by the USN, and boom developed by the USAF. Both systems have their advantages and limitations. The boom system was developed to enable the higher fuel transfer rates required by large receiver aircraft such as the B52. This, however, limits each tanker to a single boom, whereas the USN probe and drogue system is readily adapted to smaller aircraft and allows for multiple concurrent receivers, albeit at around one-third of the boom transfer rate.

Until the development of the KC-10, each tanker was essentially limited to one type of refuelling, virtually doubling the number of tankers required for operational receiver flexibility. As a result of the lessons learnt from the limitations of previous tankers, the KC-10 is fitted with both boom and probe and drogue systems, and—more importantly—with the capability to use both the systems in a single sortie. This, coupled with a significant cargo capacity, made the KC-10 arguably the first 'multi-role tanker transport'. These capabilities are being continually refined and the ADF's new KC-30B is one resultant product.

Designated A39, the KC-30B is a derivation of the Airbus A330-200 airliner. Significant modifications to the aircraft have seen it fitted with both probe and drogue, and boom refuelling systems. An Aerial Refuelling Operator will use a remote three-dimensional camera system to operate the refuelling systems from the cockpit. The aircraft is also able to receive fuel via boom, greatly enhancing its operations flexibility. The KC-30B is a very large aircraft with a maximum takeoff weight of 233 tonnes, enabling 270 passengers to be seated, plus the carriage of 35 tonnes of under-floor cargo and a fuel load of around 111 tonnes. These figures represent a significant increase over the current B707; most telling being the capability to offload over 65 tonnes of fuel at 1000 nm from base, representing a 147% increase in the operational envelope. The modern systems utilised within the aircraft also offer a significant increase in reliability and efficiency—airlines have achieved a 98% dispatch rate for the A330. However, because of the increased size of the aircraft there is a limitation on airfields from which it can effectively operate, particularly at high gross weights.

The KC-30B represents a significant capability for the ADF. It will provide the ability to deploy a fighter squadron across the Australian continent in one step, including the carriage of all the unit personnel and most of the required support equipment. Alternatively, the capability represents the ability to move 2000 personnel over 2000 miles in 24 hours.

A tanker in isolation is not a weapon system. One view of the tanker role is that they are more akin to the shaft of a spear that carries the tip to the target and not the tip itself. The ability to project weapons further has always been a part of the hunter/warrior mindset—consider the aboriginal 'Woomera'; a tool to enable spears to be thrown further. Fighter aircraft designs have always been compromised by the need to find the right mix of size, agility, range and overall capability. Invariably, a fighter aircraft has relatively limited range, hampered further by the carriage of weapons. The limitations of range are felt strongly when dealing with a continent the size of Australia. As stated in the Air Power Manual, 'Australia's geography means that even domestic deployments can be considered expeditionary by almost any standard.' Limitations in range can be overcome by AAR increasing the geographical area where precision effects can be created and strategic attacks undertaken.

Impermanence has been argued as a weakness of airpower in the past. The acquisition and introduction of the KC-30B's significant AAR capability enhances both real and virtual persistence. More importantly, AAR and the strategic lift offered by the KC-30B will enable air power to support land and maritime forces by an increasing ability to degrade or destroy adversary forces through counter land and counter sea operations before they are able to close with friendly forces across the spread of Australia's region. With adequate AAR, the ability to provide offensive air power over sovereign Australian territories, such as Christmas Island, will become a reality. Much like the B707 operations in Operation *Desert Watch,* the KC-30B will increasingly offer the Australian Government force options to be part of international coalitions, particularly where a presence is required and yet the risk 'on the ground' is too high.

The combined AAR and strategic lift capability of the KC-30B, in concert with the C-17 and C-130 will enhance the operational effectiveness of other elements of the ADF, especially land forces, by leveraging some of the key characteristics of air power like reach, penetration, responsiveness, versatility, flexibility, concentration of force and concurrent operations. When combined with the delivery of offensive air power through supporting the air combat force, the new KC-30B will help the ADF realise the full flexibility that air power can offer.

AP-3C Operations in the MEAO: New Missions for New Wars

AP-3C Orion deployments in the Middle East Area of Operations (MEAO) on Operations *Catalyst* and *Slipper* have comprised missions that have been both evolutionary and revolutionary. In adapting flexibly to new demands while on operations, the AP-3C crews have demonstrated professional mastery which underpins our Air Force doctrine.

Key Points

- AP-3C Orion aircraft have adapted their traditional capabilities in both an evolutionary and revolutionary manner to optimise their contribution to operations in the Middle East.
- By ensuring that a robust command and control system is in place the Task Group has optimised its contribution to ISR, both maritime and overland.
- The flexibility and adaptability that manned platforms provide in the conduct of ISR complements Uninhabited Aerial Vehicles in the same role.
- Professional mastery is the foundation of flexible air power.

The mission changes are evolutionary in the sense that the conduct of maritime surveillance operations is a continuance of what has effectively been the traditional roles of Numbers 10 and 11 Squadrons for the past 68 years; and revolutionary in that the Overland Intelligence, Surveillance and Reconnaissance (OISR) role was developed, introduced and perfected while undertaking warlike operations in theatre.

OISR tasks that can be undertaken by the Orion crews include target development, route clearance, convoy clearance, indirect fire detection, Improvised Explosive Device detection, curfew overwatch and the provision of situational awareness for ground forces on patrol or in contact.

Flying out of a forward operating base the Orion crews conduct maritime and OISR missions in the MEAO in support of coalition forces. For Operation *Catalyst*, these patrols contribute directly to the reconstruction and rehabilitation of Iraq with the maritime patrols providing support to the coalition warships protecting the economic infrastructure at the 'wet end' of Iraq. While the coalition Naval forces provide persistence and presence, the Orions provide reach, flexibility, speed and responsiveness to create enduring effects.

Operation *Slipper* missions are conducted in a different vein to Operation *Catalyst,* as they predominantly provide support for the interdiction of trans-national crime, namely the smuggling of arms, drugs, alcohol and people. Interdiction of vessels conducting this traffic removes a significant source of revenue for terrorist organisations.

OISR has come as a revolution for maritime crews. The conduct of OISR missions is a departure from the traditional environment and way of thinking, as Orion crews have gone from conducting operations over water to working over land. Despite the change of environment, the principles have remained the same, albeit with a number of new considerations such as understanding the language and tactics used by ground forces and the different threat environment.

The use of a manned platform to conduct OISR provides a useful adjunct to the unmanned platforms undertaking a similar role. Although lacking the endurance of a High Altitude Long Endurance Unmanned Aerial Vehicle, such as a Global Hawk or Predator, the AP-3C has a broader view that provides greater situational awareness of the battlespace by virtue of its multiple observer stations and sensors that encompass the entire electro-magnetic spectrum. All observers (i.e. anyone looking out a window—from pilots to AEAs) can observe tactical events and call the Electro Optic turret onto target—providing far greater utility than the 'looking down the soda straw' field of view that is a restriction for most unmanned systems. Furthermore, the multi-crew capacity enables onboard analysis, reducing time taken and bandwith required to transfer data to ground stations.

Given the fluidity of the tactical situation in the MEAO, AP-3C missions have to remain totally flexible and adaptable as they can be retasked at short notice. On occasions an AP-3C on a maritime patrol mission has been retasked while airborne to conduct OISR and then a few hours later returned to its original over-water surveillance task. Similarly, aircraft on OISR missions provide situational awareness to maritime forces during over-water transits. This consistently demonstrates the versatility of the multi-role aircraft conducting swing roles in a single mission. By operating as part of the Command and Control network, the AP-3C provides operational commanders with the necessary flexibility to achieve their objectives.

In order to remain flexible and responsive, the AP-3C detachment operates under a robust command and control structure supported by a responsive and effective secure communications network. Prior to being accepted, any proposed retasking is cleared through the C2 chain to ensure it is within the scope of the Task Group's mission and Australian Government direction.

The MEAO effort is optimised by a support structure that provides the intellectual rigour to develop and test Tactics, Techniques and Procedures (TTPs) that are used by the deployed crews. Although a revolution, the OISR role has been undertaken only after careful consideration of the risk, mission profiles and desired outcomes. These are constantly revised and updated to keep pace with the continually changing operational environment. Considerable effort has also been devoted to train and prepare crews for deployment and, once in theatre, to update them on the latest TTPs, developments and the emerging tactical situation.

The skill sets developed during training for direct support of anti-submarine warfare have been key to preparing crews to conduct OISR. Joint operations with the Navy have enabled tactical crew members to function in a multi-threat, multi-dimensional battlespace where they interpret the data from different sensors and then fuse the information into exploitable forms. This data is then provided to the 'customers' in a timely fashion via multiple radio nets in specific formats that meet the individual customer's requirements. The crew coordination required to conduct anti-submarine warfare is akin to that required when conducting OISR in a challenging environment.

Over its four and a half year commitment to operations in the MEAO, the AP-3C Orion Task Group has earned an excellent reputation for its professionalism, capability, and responsiveness in its highly-rated contribution to coalition operations. The crews from 10 and 11 Squadrons are regarded as setting the benchmark for theatre maritime patrols and OISR.

The evolution and revolution in mission content that has taken place in the MEAO conclusively proves that the training and education provided to RAAF personnel in air power doctrine and theory is sound, and when practically applied can produce results well in excess of the investment.

The Ascendancy of Electronic Warfare

The modern battlespace has become technologically complex and the electromagnetic spectrum is being increasingly exploited to improve warfighting capabilities. As a corollary, passive and active protection from Electronic Warfare (EW) have also assumed priority in research and development, especially in the context of air warfare. In fact EW protection has become a key issue in all activities associated with force projection and the operational performance and survivability of combat platforms are largely defined by their Electronic Warfare Self Protection (EWSP) capabilities.

Key Points

- EW protection has become a key issue in all activities associated with force projection, especially in the context of modern air warfare
- Electronic attack is now equal in importance to traditional support measures in ensuring the survivability and performance of military aircraft
- Deployable force-level EW capabilities will be essential to successfully planning and conducting even the simplest operation in future

Adequate EWSP capabilities are now considered a mandatory requirement for all ships and aircraft deployed to combat zones. In addition, the land forces also acknowledge the need for robust and effective EW as an essential part of a networked force. EW is becoming an essential requirement, not only to enable the deployment of combat forces, but also in the development of new operational capability. While EW self protection remains a critical platform centric role, EW is emerging as a force-level capability that can achieve mission goals in its own right.

This shift in emphasis is clearly demonstrated by the Joint Strike Fighter (JSF) project that has inextricably factored in organic EW capability as a benchmark for the aircraft's combat survivability and evaluation of its performance spectrum. The EW system for the JSF is being developed by

BAE Systems and includes advanced affordable low observable apertures and advanced countermeasure systems. The system was recently flight tested and is reported to be ahead of schedule, once again an indication of the importance being laid in having the EW suite integrated and operational within the overall development program of the aircraft.

Another development in the concept of operations of air forces has been the gradual but firm acceptance of the critical and equal importance of Electronic Attack (EA) to be used in conjunction with more traditional Electronic Support (ES) measures that form the basis of the self-protection suites of military aircraft. Electronic Attack is the active part of EW that involves jamming radio frequencies, electro-optical sensors and seeker heads with dedicated jammers and Directed Infra-Red Counter Measures (DIRCM). However, successful EA measures require a very high level of technological competence as well as highly developed techniques and tactics in operations. This makes EA an expensive capability and prone to being calculated on a cost versus capability equation. EA is also not a common capability because such technology may not be available or affordable to all defence forces and even when available, the complexity of operations and maintenance can reduce performance to unsafe and inadequate levels.

The increased necessity to possess good EW capabilities to ensure the survival of costly assets has initiated the convergence of different technology developments. The greatly enhanced lethality of the modern battlespace has led to a quantum jump in the vulnerability of unprotected platforms, leading to the emergence of Uninhabited Aerial Vehicles (UAV) as the preferred airborne surveillance platforms. Currently UAVs are also being evaluated for use as EW platforms to provide greater flexibility in their utilisation than manned platforms. Low complexity UAVs are cheaper to operate but cannot provide good EW support, and the more complex systems that can provide adequate EW capability are likely to be as resource intensive to operate as manned platforms.

Consequently, use of expendable tactical UAVs in ES operations is a concept that is being actively pursued. The concept proposes the use of multiple UAVs in swarms to accurately locate hostile emissions for neutralisation in a time-sensitive manner. While this might seem far-fetched at the moment, the future battlefield will not only witness such concepts in action, but it is more than likely that the strike mission will also be carried out by Uninhabited Combat Aerial Vehicles (UCAV) with kinetic or EA weapon systems. The use of multiple UAVs ameliorates the current anomaly prevalent in single-platform systems that do not provide sufficient accuracy in the location of emitters. The use of multiple networked UAVs will be capable of providing better accuracies of emitter location.

The first step in integrating UAVs into EW missions is to network a manned aircraft with multiple tactical UAVs that can collectively provide accurate location indicators and have the capability to switch roles on command. Essentially this would work as a more advanced version of the hunter-killer operations that were practiced a decade ago. There is much work still to be done in this field and inherent problems still to be addressed. For example, the command and control of mini-UAV formations in a fast changing battlespace by itself will be complicated in the extreme. Additionally, the collation of data from so many different sources to provide one comprehensive picture will also be a challenge. However, the outcome will be enhanced situational awareness leading to the capability to locate and engage targets accurately and rapidly.

A broad EW capability, that includes both EA and ES, provides deployed forces the intelligence edge that is crucial to successful planning and conduct of even the simplest operation. The need, therefore, is to have 'force level' deployable EW capabilities that bring together the disparate single-service capabilities that in combination will provide the necessary quantum of EW assets and capabilities. This process will have to be ongoing and will involve considerable effort, especially in streamlining joint training and development of operational doctrine.

Irrespective of its expense and the need for a very high indigenous technology base to ensure its effectiveness, the emerging security environment makes it imperative for the ADF to possess adequate strategic and tactical EW capability to ensure success in the battlefield. It is not difficult to imagine that future operations will be won or lost by the control of the electromagnetic spectrum.

Directed Energy Lasers: A New Breed of Weaponry

If the reports coming form the scientific community are any indication, it can be said with a great deal of certainty that a new breed of weaponry—directed-energy weapons—is about to burst out into the warfighting arena, heralding perhaps the most important revolution in military hardware since the advent of the atomic bomb.

Key Points

- DE weapons can disrupt, degrade, disable, damage or destroy
- Laser weapons can have up to 600km range and will be able to neutralise very small targets with no collateral damage
- Legal and moral issues on their use is yet to be resolved

Currently, directed-energy weapons are confined to three areas, ie. lasers, high-powered microwaves (HPM) and particle beams. All of them use the electromagnetic spectrum, with lasers operating in the light or nearlight frequencies and the microwave devices utilising the radio-frequency realm. The particle beam weapon generates its destructive power by accelerating sufficient quantities of subatomic particles or atoms to velocities near the speed of light and focusing these particles into a very high-energy beam. This paper does not explore particle beam weapons further.

The basic functional concept behind all three is the same: delivering a concentrated high energy beam to a target instead of kinetic impact or explosive blast. The principle difference between lasers and HPM is that lasers are capable of producing a more focused point of impact, making it more effective as well as affording better discrimination, while HPM affect the internal electronics of the target system. Consequently HPM are completely ineffective against targets devoid of electronics. However, both have the potential to generate regulated effects and create on a target what is increasingly being referred to as 'D5' effects—disrupt, degrade, disable, damage or destroy—as deemed nexessary

Lasers are 'speed-of-light' weapons that eliminate the time currently needed to engage a target after it has been identified. From a purely theoretical point of view this translates to real-time strike capability, overcoming all the constraints that airborne weapon systems currently face. The other advantage is the almost foolproof elimination of collateral damage that is becoming increasingly unacceptable even during all-out war.

One major development program is the Airborne Laser (ABL), which uses a chemical laser mounted in a Boeing 747-400 cargo aircraft. This uses chemical fuels to create a gaseous lasing medium and an optical turret in the nose of the aircraft focuses the beam, aiming more than a megawatt of power against the target. The ABL is expected to be able to destroy a tactical ballistic missile in its boost phase at a distance of up to 600km. The program has, however, been delayed and is now envisaged to reach final demonstration stage only towards the end of 2008.

From a warfighting point of view the implications are very clear to discern. Operational fielding of the ABL would provide commanders with the ability to neutralise a target in real-time and thereby ensure battlefield dominance. In attaining such dominance the ABL will function both in the offensive and defensive deterrent role. It will be able to degrade or destroy, as the case may be, any incoming threat and thereby create an almost inviolable bubble around a large surface battlefield within which friendly forces will be able to operate with absolute freedom from outside interference.

Another program that is nearing operational trials is the Tactical High Energy Laser (THEL) and its mobile derivative MTHEL. The THEL uses already proven laser beam generation and pointing technologies in combination with existing sensor networks to provide active defence capability against counter-air missions. By providing close-in engagement capability against short- and medium-range threats, THEL enhances the protection of theatre-level assets. The MTHEL is purposely designed for battlefield protection of combat forces from rockets, artillery and mortar shells. The system has already been successfully demonstrated and its mobility is currently based on transportation by one C-130 aircraft. It is reported that the final fielded version will be small enough to be mounted on a Humvee. While the development costs of the MTHEL have been fairly high, when operationally fielded in 2009, it will be an extremely cost effective way to protect troops in the field.

Although Directed Energy Lasers seem to be the answer to a number of issues that have plagued the application of force, they are not without their own developmental and birth pangs. There are still some key technological challenges to be addressed. These include the demonstration of sufficient power and beam focus to destroy a missile at a distance that will be tactically viable, development of a system to control the effect of atmospheric interference, the assurance of laser performance at extreme high altitude and the assurance of beam quality.

There is also an unresolved legal and moral issue of the use of lasers in warfare. Currently the only way to destroy ground targets is by using kinetic or blast effects associated with conventional rockets or bombs. These are less precise than lasers that could hit a very small target without any collateral damage. The problem arises after hitting the target, as the laser energy could be deflected at random in any direction, potentially hitting the operating personnel. The intense heat produced by the laser beam is enough to burn through the human skin. A further complication is that the human eye is far more vulnerable to laser damage than almost all military targets, because the cornea of the eye focuses laser light onto a tiny spot on the retina, rapidly burning it and causing instant blindness.

Article 1 of the Geneva Convention's protocol on Blinding Laser Weapons states, 'It is prohibited to employ laser weapons specifi cally designed, as their sole combat function or as one of their combat functions, to cause permanent blindness to unenhanced vision.' However, Article 3 states, 'Blinding as an incidental or collateral effect of the legitimate military employment of laser systems, including laser systems used against optical equipment, is not covered by the prohibition of this protocol', effectively nullifying Article 1. In effect, from a purely warfighting point of view, ABL and MTHEL provide the commanders with weapon systems that can provide enhanced and almost complete protection at both the tactical and theatre level. There is no doubt that laser weapons will be operationally fielded in the near future as a counter-measure to the proliferation of ballistic missiles. However, the legal and moral aspects of the almost certain side-effects may be prohibitive enough to warrant a second look at their employment in the tactical battle area.

The Need for Speed: Future Hypersonic Military Systems

Key Points

- Hypersonic military systems will begin to appear from around 2015.
- Hypersonic platforms and weapons will enhance speed, penetration, reach, survivability and responsiveness.
- Defences against hypersonic systems will be problematic.

Speed, as an inherent characteristic of air power, has arguably fired the imagination of more people—both in the military and public domains—than any other single aspect of military flight. However, since the early 1980s speed has experienced a hiatus as one of the core drivers of air power projection, overtaken instead by other enhancements such as stealth, agility, improved weapons, greater endurance and network-centricity. But speed may be on the verge of a significant resurgence. Imagine being able to launch a military strike anywhere on the surface of the earth in less than two hours. Unrealistic? If the ongoing development of hypersonic platforms, capable of operating at speeds of up to Mach 10—over 12,000 kilometres per hour—continues at its current pace then this might not be an unrealistic expectation for very long.

The hypersonic flight regime begins at Mach 5, and until recently remained the practical realm of solid- and liquid-fuelled rocket engines, such as the ones that propel modern day astronauts, satellites and other materiel into space. However, as the development of supersonic air-breathing jet engines (SCRAMJETs)—which create thrust by igniting fuel in a supersonic airflow—has matured in the US, Europe and Australia, there has been a renewed interest in creating practical and economical hypersonic military systems. Research into other hypersonic challenges related to high-temperature material design, fuel selection and aerodynamics is also beginning to yield results, all of which suggests that we might expect hypersonic platforms and weapons systems in the very near future—some of them as early as next decade.

Hypersonic systems are likely to be divided into two distinct divisions: weapons and vehicles. Hypersonic weapons will be the first deliverable military systems to operate in excess of Mach 5. Developmental work in the US into hypersonic cruise missiles launched from traditional airborne and surface-based platforms is well advanced. India, in conjunction with Russia, has recently delivered to service the BrahMos cruise missile capable of speeds over Mach 3, and continue to work on next-step hypersonic technology. Russia is now renowned for its SCRAMJET development work and delivery to service of operational hypersonic cruise missiles seems to be very close—potentially by 2012–2015.

Hypersonic vehicles, which will be reusable and used for traditional air power roles, such as strike and perhaps transport, are likely to take more time to mature. The challenges to be overcome are greater than for a weapon system. One of the hurdles faced is the fact that a SCRAMJET propulsion system will not operate at low-supersonic or subsonic speeds, requiring a different form of propulsion to bring the vehicle to a high enough speed for the SCRAMJET to be engaged. Another challenge, one not faced by a fire-and-forget cruise missile, is that the aerodynamics best suited to hypersonic flight are not ideal for take-off and landing, both of which are vital to a reusable vehicle. These challenges are not insurmountable, and programs like the US Force Application and Launch from the Continental United States (FALCON) are planned to deliver both manned and unmanned operationalised platforms around 2030–2035.

Furthermore, an integral consideration in the ongoing development of hypersonic systems is the requirement for a capability to deliver a payload to space using a combination of rocket and SCRAMJET propulsion. This will not only significantly reduce the cost of lifting communication nodes and other payloads to space, but will allow for the responsive placement in orbit of military systems in significantly shorter timeframes than is currently possible.

Once in service, both hypersonic weapon systems and reusable vehicles will make a significant impact on all power projection capabilities of a nation. The speed that this technology will afford will fundamentally reshape our understanding of air power's reach, responsiveness, penetration and survivability. Perhaps the most immediate effect will be seen in the area of strike, where long-range hypersonic systems will be able to reach anywhere on the globe in less than two hours. Once within reach of a target, a hypersonic weapon system is unlikely to be stopped by traditional ground-based air defence (GBAD), which will not be able to detect the weapon in time or engage it. As an example, a sea-skimming hypersonic missile travelling at Mach 5 will break a ship's radar horizon in a little over three seconds before impact.

Other hypersonic capabilities may follow, but perhaps in a more extended timeframe. Hypersonic airlift, for example, given the high cost involved may not become a viable proposition at all unless a pressing need is identified to move troops or equipment significantly faster than is currently possible.

From an Australian perspective, there are two imperatives related to the introduction of hypersonic aerospace technologies. Firstly, we need to determine what level of offensive capability the nation requires. Almost certainly, large-scale hypersonic vehicles are going to be prohibitively expensive and would be unlikely to fit within Australia's resource constraints without a significant strategic imperative. Hypersonic cruise missiles, which would perhaps be suitable for use with the Joint Strike Fighter (JSF) or future Uninhabited Combat Air Vehicles (UCAV), might be a much more viable option. Such a capability would offer considerable penetration, reach and lethality advantages over current stand-off weapons, and may be one that Australia could easily integrate into legacy and next-generation systems for enhanced effect.

Secondly, it must be determined how to build a capability to defend against hypersonic systems. There will be a need to protect the joint force either on land or at sea from the threat posed by hypersonic weapons. Neither JSF in its current planned configuration nor the new

Air Warfare Destroyer (AWD) will be able to destroy a hypersonic cruise missile in flight. Only a zero-time-of-flight system such as a Directed Energy (DE) weapon will offer any substantial guarantee of success, and even then only if backed up by a comprehensive suite of sensor and other targeting support.

Hypersonic aerospace technology will not necessarily become an integral part of the day to day fabric of military operations in the same way that we envision network-enabled warfare systems. However, one can say with a degree of certainty that hypersonic military systems will almost certainly begin to appear in the middle of the next decade, and will have a significant impact on how we use air power. These systems can be expected to mature over the period to 2035 into a radically new capability—one that will add a completely new dimension to the reach, speed, penetration and survivability of airpower. Speed, it appears, is making a very big comeback.

Small Air Forces, UAVs and Operational Flexibility

Key Points

- The current UAVs are generally optimised for single roles and therefore lack the inherent flexibility of manned platforms.
- Small air forces are reliant on flexibility for operational effectiveness
- UAVs can fill chosen niche capabilities to meet operational needs

Over the past few years, Air Force experimentation has shown that a small air force such as the RAAF has to be ultra efficient in the use of its assets in order to be operationally effective. The operational commitments of the RAAF vis-à-vis resource availability is such that it can not afford to be profligate with any of the capabilities or assets at its disposal. An intuitive understanding of this relationship between efficiency and effectiveness has shaped both the Air Force's choice of equipment and employment concepts at the strategic, operational and tactical levels. Following this line of thought, advocates of Uninhabited Aerial Vehicles (UAVs) cite the operational efficiencies to be gained from their use, in conjunction with and as substitutes for manned platforms in many air power roles. The main advantages are listed as the potential savings in operator numbers, and the relative ease with which UAVs can achieve persistence—a characteristic which is in ever increasing demand for ISTAR and engagement tasks alike.

On the face of it, these arguments are sound. Employment of UAVs will ameliorate the problem of wasting precious crew duty time in unproductive transits to and from the operating area, and also negate the need to launch successive waves of manned platforms to maintain a presence, when a single long endurance UAV can remain on-station for 24 hours or more. However, when viewed from a broader systems perspective, these perceived advantages may be more illusory than real—at least for the current generation of UAVs. Furthermore, they may be outweighed by other, more intractable inefficiencies that UAVs bring with them.

It may be a cliché, but in many respects, flexibility is truly the key to air power effectiveness—particularly for a small force such as the RAAF. This is one of the primary reasons why the RAAF force structure has been built around small numbers of highly versatile platform types operated by equally versatile people. It is also why the Air Force has consciously avoided acquiring overly specialised systems that have utility in only limited roles or in a narrow part of the spectrum of conflict. This is the best way to ensure that maximum utility is derived from limited resources.

In the recent past, there has been acceptance of the need for individual platforms to have *multi-role* capabilities. However, the demands of modern warfare now call for assets to possess *swing-role* capabilities in which a platform may be required to perform several different roles within the span of a single sortie. The RAAF F/A-18s were employed in this manner during the recent operations in the Middle-East. It is also the way future forces are being employed in experimental war games.

In contrast, the current generation of UAVs are generally optimised for a particular role. Even the most flexible of them can perform only a small sub-set of the tasks that could be undertaken by an equivalent manned platform. Under these circumstances the operational efficiencies offered by UAVs are diminished because a greater number of platform types will need to be generated and maintained in the battlespace to cover the range of possible tasking. Further inefficiencies might be incurred because of changing and uneven demands for some air power roles at different phases or in different types of conflict. In such a scenario some elements of the UAV force structure might find itself under utilised whilst others are over stretched.

Many of these problems are being addressed in the ongoing development of more complex UAV designs and the evolving versatility of payloads. However, the versatility of the hardware is only one part of the solution:

the operators need to be equally versatile in order to perform swing-role missions. Of course, there is no reason why UAV operators could not be as multi-skilled as the crews that operate manned platforms—provided they have the necessary situational awareness they need to do their job. And there lies the rub—because the way in which the operators are currently provided with the information necessary to have adequate situational awareness consumes vast quantities of another precious and limited resource—bandwidth!

Given the way raw sensor data is currently dumped indiscriminately onto the UAV down link, the bandwidth available to the ADF will not be able to support significant numbers of UAVs operating simultaneously—let alone a whole fleet of them. Additionally the quantum of data is such that it requires a large number of operators to sift through and analyse.

In the future there is likely to be technical solutions to alleviate the bandwidth problem in the form of novel communication links such as laser communications and data compression techniques. However, the real solution lies in on-board processing of the data so that only relevant, easily interpreted information is passed back to the human operators. This is the only way to minimise the requirement for both bandwidth and people.

Unfortunately, effective on-board processing is not as easy to accomplish as it might first appear. It will require machine intelligence to make decisions about what the data means and what is relevant within the context of the battlespace. Indirectly, these decisions will affect life or death judgements concerning targeting and engagement and the final outcome of the conflict. Not only will this require that artificial intelligence be developed to a stage where it can be trusted with such decisions, but there will also be the need to overcome cultural and social issues about handing so much power over to a machine. It will therefore take time— perhaps lots of it—for software to match the versatility and decision making capabilities of the human crew's 'wetware'.

In the meantime, small air forces such as the RAAF will have to bide their time, and limit their exploitation of UAV technology to niche roles where their use can still be justified despite their inefficiencies. This is not to say that the RAAF will not consider acquiring UAVs or even armed versions to meet particular operational needs, noting the combat success of the armed Predator for example. However, this would be done with the clear understanding that they would not yet have the inherent flexibility of a manned platform, but would fill a chosen niche capability. An example of a UAV meeting the Air Force's operational needs in a niche is the Multi-mission Unmanned Aerial System (MUAS) being considered under Air 7000.

To paraphrase Mark Twain, the news of the manned aircraft's death has been greatly exaggerated. Small air forces will continue to need them for some more years yet.

Exploiting the Near Space

Key Points

- Near-space is not currently utilised to enhance military operational capabilities.
- Airships operating above 100,000 feet could provide a cost-effective alternative to persistent long-term surveillance, strategic airlift, missile early warning and act as communications relay nodes.
- The technology is still in its infancy but needs to be developed further.

The edge of space is difficult to define both legally and scientifically, but the Karman Line, at an altitude of 100 kilometres above Earth's mean sea level, is internationally recognised as the nominal boundary separating outer space from the Earth's atmosphere. It is also accepted as the boundary that separates aeronautics and astronautics. The term 'outer space' is not legally defined in international law. But it is widely accepted that a nation's sovereign airspace ends, and outer space begins, at some point between the lowest orbit altitude of artificial satellites or alternatively the highest altitude of conventional aerodynamic flight and the Karman Line. However, currently the International Civil Aviation Organisation (ICAO) controlled airspace is limited at 60,000 feet thereby leaving a big swath of airspace untended.

The altitudes between about 65,000 feet and 300,000 feet, where sovereignty of airspace itself is vague, has been termed the near-space realm and is characterised by the fact that the air is too thin for conventional aircraft to operate and gravitational pull and atmospheric drag are too high for satellite orbit. This part of the atmosphere has until recently been ignored.

About two years ago, military planners evinced interest in utilising this space for military applications, especially for deploying communications and surveillance assets. This has led to concerted research being carried out in reinvigorating mid-twentieth century technologies associated with airships. Airships can operate between 10,000 and 300,000 feet and can be divided into two variants – aerostats which are tethered and blimps which are free moving.

There are two compelling reasons for this renewed interest. Firstly, in the rarefied atmosphere that the platform has to operate in, a lighter-than-air structure would be easier to manoeuvre and the lightness would require only limited power to propel it. The airships are also free of the vibration experienced in a rigid aircraft, and therefore simply provide a safe and stable operating environment for highly sensitive equipment and sensors. Second, airships are comparatively inexpensive to manufacture, maintain and operate and can stay afloat indefinitely if they are uninhabited. Even when they are crewed, they can be airborne for a long period of time, sufficient to have a real persistence.

The airship is being conceptually looked at for three major roles in the future – persistent surveillance, strategic airlift and missile early warning as well as the bonus of it being a communications relay node.

Developments in the design of airships are oriented towards allowing them to stay over a designated area for months on end to provide persistent surveillance of sufficient fidelity to let commanders make informed decisions. Persistent surveillance and near real-time availability of this information to the decision makers is a much sought after capability in modern military forces. The fixed-wing platforms or satellites currently operational do not provide the uninterrupted surveillance required for the long durations that are demanded by contemporary military forces. It is expected that the near-space airships will ameliorate this particular drawback.

It has been observed that, if used at the lower fringes of near-space, airships could be employed as large strategic airlift platforms that could provide swift transportation of a very high quantity of personnel and equipment – much more than the largest airlift capability currently available from aircraft. Strategic airlift by airships is planned to be achieved by a combination of airship and pure aerodynamic characteristics in the same vehicle. These platforms will be heavier-than-air and will use conventional power and aerodynamics to take off and land, albeit at very slow speeds. The ships would be capable of transporting up to 1,500 tonne payloads (an entire army brigade with its organic equipment) at a speed of 120 kts within a radius of 6,000 kms with an on-station loiter of more than 10 hours. However, operational problems, such as the hazard posed by a combination of low altitude of transit, slow speed and the survivability of a helium-filled platform have so far slowed developmental work.

The latest development has been of cheap, disposable aerostats that are tethered at a lower altitude (around 100,000 feet) than airships. These can be deployed from the back of a Humvee and are designed to float within a predictable pre-determined pattern for as long as 12 hours. Once matured, the aerostats are expected to become a viable early warning device in the larger missile defence system. They can also be used as communications hubs and increase the range of a hand-held radio from the current maximum of 16 km to more than 800 km.

Although proponents of airships have earnestly advanced the above advantages, there are a number of technological difficulties that have yet to be addressed before the concept can be transformed into reality. Uninhabited airships tend to stray away from their designated area of surveillance and are not as survivable as aircraft in rough weather. There are also doubts regarding the runway length requirement of airships being used in the airlift role. The high operating altitude requires light-weight fabrics that can withstand the increased intensity of ultra-violet sunlight, which is one of the major issues being addressed by researchers. There is also uncertainty regarding the atmospheric conditions at the near-space operating altitudes in terms of wind velocity and the power required to be produced by a propulsion system to manoeuvre the airship against high wind velocities.

Current research is oriented towards solving the issue of fabric toughness, tapping solar energy to ensure an uninterrupted energy source for a very long period and improving the fidelity and power of electronic sensors while reducing their size. As in most other regimes of aerospace research, the United States have the most promising on-going programs and are likely to be the first to field any operational capability, maybe within the next decade or so.

Despite the problems being encountered in the design and development of airships, the tangible advantages that can be derived from an operational airship deployed in near-space should encourage further research and development in the area. The most obvious advantage is that it provides a low-cost alternative to nations that do not have a dedicated space program to support defence needs.

Although the airship technology can be considered to be in its infancy, considering that the developments of the mid-twentieth century were minimal, the advantages that high altitude, long endurance airships bring to the conduct of military operations in terms of clearly enhanced situational awareness points to the need for any forward thinking air force to investigate and research the possibilities and to develop advanced concepts for their employment.

Humanitarian Assistance: Operation Sumatra Assist—An Air Operations View

On Boxing Day 2004, an earthquake measuring approximately 9.2 on the Richter scale occurred in the Indian Ocean north of Simeulue Island, off the western coast of the Indonesian island of Sumatra. This caused a series of tsunamis that resulted in the death of some 230 000 people. The greatest loss of life and damage to infrastructure occurred in coastal areas around Banda Aceh, on the north-west tip of Sumatra.

Key Points

- Flexibility, adaptability and innovation remain cardinal principles for the success of any air operation, warlike or otherwise
- Command and control of operations, even at the lower end of the conflict spectrum, is a complex activity
- Sumatra Assist was a clear demonstration of strategic shaping being achieved through well-orchestrated tactical actions

In response to this crisis, the Australian Government instructed the Australian Defence Force to immediately provide humanitarian assistance to the affected area. Operation *Sumatra Assist* was quickly launched. The ADF deployed the following force elements: Air Force—air lift, an Air Operations Centre (AOC), aero-medical evacuation and air load teams; Navy—HMAS *Kanimbla* and embarked Sea King helicopter flight; and Army—aviation, engineering and construction units. In addition, joint-force elements such as the Defence Supplementation Staff (DSS), Joint Movements Group detachment, Joint Logistics Support Force and the Anzac Field Hospital were also sent. At the height of the operation around 900 ADF personnel were involved.

Initially, four C-130H/J Hercules transports from 36 and 37 Squadrons were assigned to the operation and based at Medan (the capital of Sumatra, about 400 kilometres from Banda Aceh) and Butterworth air base in Malaysia. These and similar aircraft provided intra theatre lift from major ports such as Jakarta, Medan and Butterworth into Banda Aceh airport.

The RAAF C-130s accounted for the majority of cargo and passenger transportation between Medan and Banda Aceh, and by the end of the operation had delivered a total of 1200 tonnes of stores.

A troop of four Army UH-1H Iroquois helicopters was also deployed to Banda Aceh. These aircraft were tasked by the local coordinating agency for the tactical level distribution of relief supplies to places of greatest need. Two Sea King aircraft (one of which was tragically lost with the loss of nine Australian service personnel at Nias on 2 April 2005) provided tactical level humanitarian relief and aero-medical evacuation to *Kanimbla's* embarked health facility. A 32 Squadron King Air B350 aircraft was also deployed to Medan for command and control functions and to move small numbers of personnel around the Area of Operations. This aircraft was subsequently replaced by a King Air B200 from the Army.

The non-warlike environment, the passenger loads involved, and the nature of the airfields used for this operation also allowed the use of contracted civil air transport in support of the ADF operation. An ADF leased, civilian-crewed Dash 8 aircraft was based at Butterworth from early February 2005 and primarily used to move personnel between Butterworth, Medan and Banda Aceh. This proved to be a cost effective measure that released the C-130 aircraft for use in relief operations. Such use of contracted aircraft, integrated at the operational level, was a new development for the ADF.

The Australian forces involved in Operation *Sumatra Assist* operated as Joint Task Force 629. The size, disposition and structure of the JTF remained in a continual state of change to meet the dynamic operational needs and the environmental challenges, such as monsoon weather which at times delayed the relief effort. In February 2005, the AOC and the three remaining ADF C-130s moved to Butterworth, primarily due to lack of tarmac space and air traffic control (ATC) delays in operating from Medan. In the closing stages of Operation *Sumatra Assist*–phase one, the JTF HQ was relocated afloat on board HMAS *Kanimbla*.

Throughout the operation, elements of the Australian JTF operated from dispersed locations at Banda Aceh, Butterworth, Medan airport and from HMAS *Kanimbla.* The JTF also provided assistance to other Australian Government and non-government organisations. One example of such assistance was the situational briefing given to Australia Zoo staff providing aid to injured elephants in the Banda Aceh area.

The relief effort from all the nations involved was coordinated through a Coalition AOC established at Medan airport. The AOC staff included representatives of USA, Australia, Indonesia, and Singapore. The use of the AOC proved invaluable in maximising the operational effectiveness and efficiency of the relief effort. Immediate planning and operational control of ADF and RNZAF fixed wing flights was done at the AOC by ADF personnel, with longer term planning—outside three days—being carried out by air planning staff at HQ JTF 629. Load coordination for personnel and supplies was jointly managed by the AOC and Joint Movements Detachment to optimise the delivery of relief aid.

Aero-medical evacuation (both rotary and fixed wing) was coordinated from the AOC by the late SQNLDR Paul McCarthy. Although some dedicated AME missions were flown, the bulk of AME and regular evacuation was done by back-loading on aircraft departing Banda Aceh following the delivery of relief cargo. Seventy AME patients were transported and a large number of people evacuated, in addition to some 2500 Indonesian military personnel who were relocated by ADF aircraft.

The operational challenges encountered during this operation demanded innovative solutions. The tower and approach control at both Medan and Banda Aceh airports were serviced by organic Indonesian ATC, and although relief manning was made available, ATC services were often overwhelmed by the sheer volume of traffic. One solution to this problem was the extensive use of mobile telephone SMS by aircraft crews and AOC staff to closely track and control aircraft movements.

Despite the coordinated planning effort, managing the high number of aircraft movements within the available tarmac space at both Medan and Banda Aceh airports became a significant challenge. Although slot times for both airports were carefully managed by the Coalition AOC, the flying program could not capture inter-theatre lifts from agencies and governments not affiliated with the AOC. Large aircraft 'just turning up' with a load of relief supplies often caused significant delays to planned movements. A build up of relief supplies on the tarmac at Banda Aceh, which were not further distributed efficiently, also adversely affected aircraft movements. Further, VIP visits, such as those by heads of state, often caused significant disruption to the flying program.

The effects of the relief operation proved far more enduring than the direct effect of the immediate crisis response. In the days immediately following the tsunamis, public health experts from around the world had predicted that the death toll from secondary effects—disease and exposure to the elements—would be even greater than the initial disaster. In the months that followed it became apparent that, due to the direct and ensuing indirect effects of the comprehensive and coordinated international relief effort, these predictions were overly pessimistic. The ADF and RAAF were major players in this relief effort, providing direct and indirect humanitarian assistance that undoubtedly saved many lives.

Professional Mastery in the Application of Air Power

Key Points

- Professional mastery is critical to effective application of air power
- Air power must be applied within the bounds of the fundamental concepts of military power projection—necessity, humanity and proportionality
- Professional mastery in combination with moral courage provides decision-makers with the capacity to mitigate strategic surprises
- The breadth of skills required to be an effective air power decision-maker has increased considerably in the recent past

The most important factor in the generation and application of air power, and the one that will determine the success of all operations, is the professional mastery of the practitioners. The blurring of the distinction between combatants and non-combatants and the complexity of the battlespace—urban, built-up areas where the adversary is resident within or in close proximity to innocent civilians—makes air power a difficult force projection capability to employ well.

In recent times the application of air power as part of national power has come under intense scrutiny from different angles. There has been debate regarding its application and how air power can be used to best effect while still being applied within the confines of the three fundamental concepts of military power projection—necessity, humanity and proportionality. Under these circumstances it is of paramount importance for air power advisers to have a deep understanding of all aspects of air operations, in war and operations other than war, and clear professional mastery across the entire spectrum.

Essentially, the effectiveness of air power is contextual. It has to be appreciated that air power alone is not capable of doing it all and other military capabilities are equally important in achieving the ends being sought. Therefore, when air power is applied, its use must be tempered by knowledge that it is capable of escalating a conflict very swiftly, that it has a poor track record when it comes to winning the hearts and minds of the adversary, that the primacy of strike as an air power capability tends to distort the other equally crucial roles that it plays, and that there are significant command elements that are unique to its application as compared to other military capabilities. Employing air power well requires profound wisdom that can only come with professional mastery.

The effective exercise of air power must be tailored to integrate with the national security strategy. This can only be achieved by an air force with the professionalism and skills to focus the application of air power to achieve national objectives. It requires an independent organisation at par with other facets of national power that is capable of adapting dynamically to emergent situations. It is professional mastery that will make the difference between wise application of air power towards this end and the ineffective dissipation of resources. Contributing the necessary air power capabilities to create joint outcomes demands expert decision-making by air and space power professionals. Such professionalism is founded on air power mastery that is created by a holistic understanding of the prevalent doctrine, air strategy, air force capabilities and future demands.

The exercising of professional mastery within a force is a product of the skill of its leaders and the flexibility and robustness of the organisation. Leadership is critical in shaping the force to be effective in operations and the organisation provides the processes by which emerging opportunities can be best exploited. Professional mastery therefore has to exist across the organisational and operational dimensions of the force in order for it to achieve the outcomes valued by the nation.

Professional mastery, which is primarily personal, is necessary both individually and collectively to generate the right balance and combination of logistics, equipment, weapon systems and skilled people in designing an air force. This assumes greater importance in the case of small forces with finite resources but operating at a high tempo. Professional mastery enhances a person's capability to analyse and synthesise available information within a complex strategic context and be able to make the crucial contributions necessary to provide the organisation with the necessary robustness to meet emerging challenges and prevail.

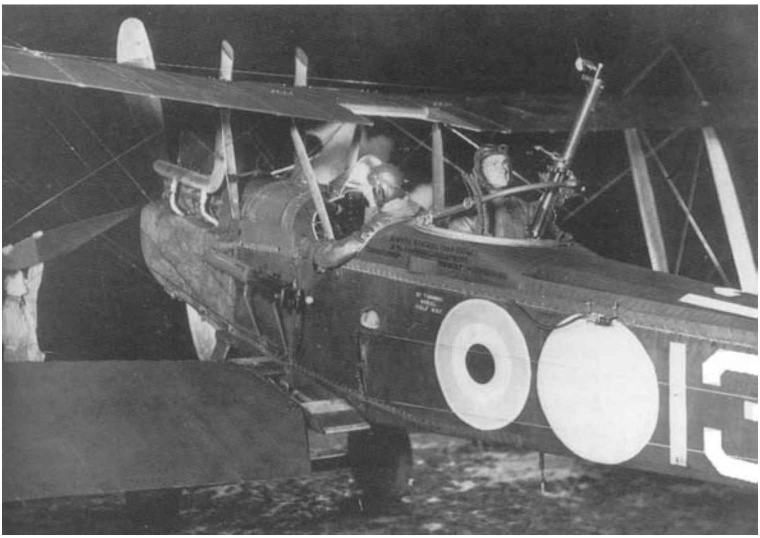
Timely and correct decision-making is a critical element in ensuring success of any operation and the skills required to achieve professional mastery are a vital part of the equation. This includes traditional military and air power education and also other skills that improve an individual's understanding of a whole range of disparate matters, such as cultural issues, religious sensitivities, adversary doctrine, etc.

The face of warfare has changed in the past few decades and the military forces are now constrained to prosecute their operations within the public glare provided by the ever-present media. While this is a laudable development from a democratic viewpoint, wherein the citizenry is provided with an unbiased view of their armed forces in action, it also brings unwelcome interference in the actual conduct of an operation. For a number of reasons air power receives more than its fair share of the media highlights and therefore interference in its application from, at times, poorly informed political leadership. This could prove to be detrimental in the achievement of laid down strategic objectives. Air force personnel with adequate professional mastery could remedy the situation by being able to inform the higher level decision-makers of the reality and providing them with acceptable options. This is a relatively new phenomenon and greatly increases the breadth of skills necessary to be an effective air power decision-maker.

Professional mastery and the confidence in one's capabilities will provide the personnel involved with the moral courage required to provide honest advice, even if such advice is unwelcome and may even have the potential to become politicised. Moral courage underpins the fundamental professional responsibility of all leaders to make informed decisions regarding the application of air power in the pursuit of national security. Moral courage bolstered by professional mastery allows personnel to make decisions in circumstances where information is imperfect, the fog and friction of combat is tangibly evident and the emerging situation is incredibly complex. It is only professional mastery that assists in mitigating strategic surprise and helps to manage risks in an acceptable manner.

Professional mastery is the tenet that links organisational flexibility, proper application of air and space power and force projection capabilities within the ambit of a whole-of-government, National Effects-Based Approach to ensuring the nation's security.

75 Squadron Sabre running up at Darwin, November 1961.



No 3 Sqn RE8 departing on night-bombing, France 1917

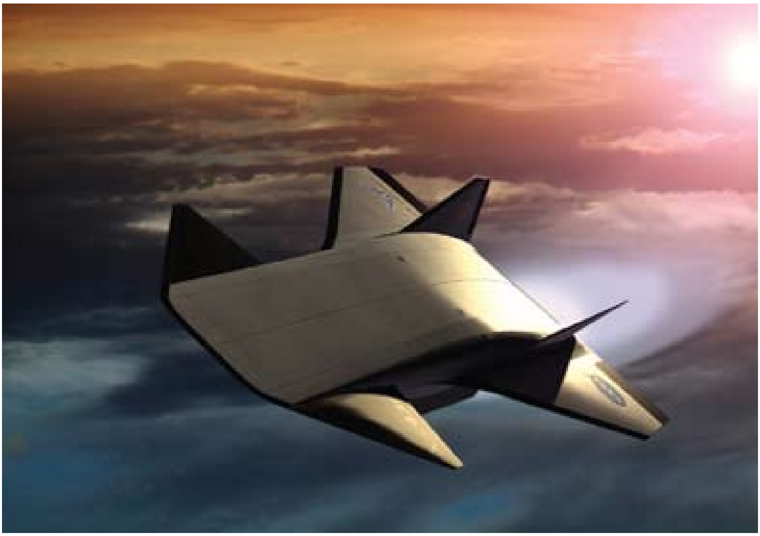
Aerostat developed by Lockheed Martin for deployment in Iraq

Iraqi tanks and vehicles destroyed by air power - Desert Storm

Inside the Air Operations Centre

F-111 dropping flares as active IR counter-measures

The Lockheed Martin X-35 JSF in development. The RAAF will start to induct the F-35 Lighting II around 2012.



An artist's impression of the USAF X43-B hypersonic vehicle in flight (courtesy NASA)

HISTORY

"The value of history in the art of war is not only to elucidate the resemblance of past and present, but also their essential differences."

Sir Julian Corbett

The Smuts Report

The formation of the Royal Air Force in 1918 was directly influenced by two reports written the previous year by J.C. Smuts, a South African general (later field marshal) who had been invited to join the Imperial War Cabinet by Britain's prime minister, David Lloyd George. Rather dryly entitled 'The 1st and 2nd Reports of the Prime Minister's Committee on Air Organization and Home Defence against Air Raids', these documents have become collectively referred to as the 'Smuts Report'. The recommendations they contain, while intended for action by the British air arms only, establish the rationale for independent air forces and include certain doctrinal truths as relevant today as they were 90 years ago.

Key Points

- Smuts was personally well-qualified, and equally well-advised, in tackling the issue of Britain's homeland air defence
- Emphasised unity of command, professional mastery and concentration of force—organisational principles of enduring relevance
- Acknowledged that broader roles of air power require strategic planning in terms of logistics, targeting and force structure

Smuts considered the problems facing Britain during World War I, and arrived at what he considered the best solution in setting right the air defence of Britain and correcting the deficiencies in the organisation of its air arms. After accepting the Smuts Report, the War Cabinet went on to pass the *Air Force (Constitution) Act of 29 November 1917* and in due course the RAF was formed on 1 April 1918.

Born in South Africa to Dutch parents in 1870, Jan Christiaan Smuts completed a comprehensive legal education at Cambridge in 1895. During the Boer War he was an outstanding administrator and field commander with the Boers, rising to prominence as a minister in the government which followed that conflict. Despite his past alliances, Smuts was progressively distanced by the Afrikaner movement due to his seemingly pro-British stance. He had taken his own council when considering the future of his country and could no longer see a rationale for independent Boer republics. Instead, he preferred to see a united and independent South Africa—not as part of Britain's empire but as a member of a British Commonwealth of Nations (he was one of the first statesmen to use the term).

When World War I began, Smuts led South African ground forces that successfully attacked German East Africa. Significantly, he had several aircraft within his command during this campaign and gained valuable understanding of their employment. As a consequence of all this, by the time he arrived in London in March 1917 he already had a well-deserved reputation as a soldier, statesman and intellectual.

The problem besetting the British government stemmed from the air attacks which, starting on 24 December 1914, had been mounted by German Army and Naval air assets in the form of airships and fixed wing aircraft. This bombing campaign over England was not only progressively becoming more effective; the British air defences seemed incapable of halting it. Under extreme public pressure to act, Prime Minister Lloyd George formed a committee on 11 July 1917 to report on the military's response to the bombings and recommend workable solutions to the problem of homeland air defence, along with the broader issues regarding the organisation of Britain's air assets. Smuts, as a member of the War Cabinet, was appointed the key coordinator.

The shortcomings to which Smuts addressed himself were serious. When the Royal Flying Corps (RFC) formed on 13 April 1912, it included both an Army and Naval wing but no central controlling authority responsible for command and control, development or logistics. Each parent service ultimately developed and employed their fledging air arms separately. Attempts at forming various Air Committees and Boards from 25 April 1912 onwards, to coordinate the activities of the two air arms, consistently failed due to a lack of executive power. When the German bombing attacks began there was no integrated air defence network and no synergy of effort between the ground and air forces.

Smuts brought together a team of experienced military officers who were well-versed in aviation, most notably Lieutenant General Sir David Henderson. Well-known as the British Army's leading authority on tactical intelligence (during the Boer War he was Director of Military Intelligence in South Africa), Henderson had been at the forefront of the RFC since its inception. As the first Director-General of Military Aeronautics in 1913–14 he had acquired unparalleled knowledge of the corporate history of military aviation in the UK. He had added to that a thorough knowledge of the tactical application of Air Power, acquired while leading the RFC in France for the first three years of World War I. It seems ironic that Henderson and Smuts, after fighting on opposite sides during the Boer War, should have worked together on creating what was to become such an influential report for the British.

The first of Smuts' reports dealt exclusively with homeland defence and contained four recommendations. The essence of these was the establishment of unified command and control encompassing the Observer Corps, anti-aircraft batteries and RFC aircraft. Smuts emphasised the importance of unity, professional mastery and concentration of force, balanced against resource management to counter multiple raids. The same organisational principles were extant in the British air defence network during the Battle of Britain.

The second report dealt with the organisational dysfunction of the air arms and contained eight recommendations. This report, influenced heavily by Henderson and the other Naval and Army aviators on the team, recommended the amalgamation of the RFC and Royal Naval Air Service, under the control of a newly-created Air Ministry that was to be on an equal footing with the War Office and Admiralty. Smuts also made a provision for operational command of Air Force assets by Army and Navy commanders, thus facilitating joint operations. Further, he stressed the importance of strategic planning in terms of logistics, targeting and force structure. Importantly, the report envisioned interdiction missions independent of Army and Naval operations.

The Smuts Report was grounded in the hard-won lessons gained during World War I. Almost every air power role we know today was demonstrated in some form during that conflict. From strategic strike to close air support, tactical airlift to maritime surveillance, all were carried out between 1914 and 1918. The Smuts Report recognised the diversity of Air Power applications and provided a blueprint for RAF operations in both independent and joint campaigns.

Unfortunately, the legacy of the Smuts Report and World War I subsequently seem to have been lost, and was only rediscovered by the RAF in the Western Desert in 1940–41. Budget cuts and the interservice rivalry for resource allocation in the 1920s led the head of the RAF, Air Chief Marshal Sir Hugh Trenchard, to concentrate predominantly on those roles that maintained a case for the independence of his service, lest it be subsumed by Army and Navy. Consequently there was disproportionate theory, and ultimately doctrine, based around strategic strike.

A similar environment to the 1920s exists today. Limited resources tempt us to focus on the 'high end' of air power capability, to the detriment of the broader roles that air power brings to the fight in the tactical environment. If our doctrine is truly influenced by history, the lessons of World War I and the rationale for the Smuts Report are worthwhile reality checks when we visit our plans for Air Force capability and force structure.

One Family's Long Air Tradition

> **Key Points**
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> - After designing and flying the first Australian-built aircraft in 1910, J.R. Duigan served with the AFC in World War I and worked for the RAAF in World War II
> - His achievement is commemorated with a monument near Lancefield, and a replica of his aircraft is on display in the new Melbourne Museum campus of Museum Victoria
> - Duigan's nephew, T.L. Duigan, played a notable part in the Bismarck Sea battle of 1943 as a RAAF Catalina captain

Most Australians do not hold an image of their country as having been abreast of world class innovation and achievement, especially a century ago. This was certainly not the case in the field of aviation. Apart from the significant experimental research into aeronautics conducted from 1893 outside Wollongong, New South Wales, by Lawrence Hargrave, there is the outstanding example presented by a young Victorian engineer named John Robertson Duigan (1882–1951).

After obtaining electrical and motor engineering qualifications in England in 1902–05, Duigan returned to Australia in 1908 and briefly took employment with a Melbourne firm of electrical engineers. Later that year, however, he moved to a family property called 'Spring Plains' at Mia Mia, near Lancefield, and there embarked on a series of remarkable experiments into flight.

During 1909, Duigan began work on a powered biplane along Farman lines, using local timbers and a 20hp engine built in Melbourne. In this machine he achieved a 'hop' of six metres on 16 July 1910—the first flight of an Australian designed and built aircraft. By early October the machine was achieving distances of nearly 183 metres at an altitude of three to four metres.

Learning that the Department of Defence had, in September 1909, announced a competition with a £5000 prize for the invention of a 'Flying Machine which is adjudged…to be…the best and most suitable for Military purposes', Duigan initially thought to enter his aircraft. He was, however, deterred by one of the conditions stating that entries must be capable of 'poising'. By the time he discovered that this meant merely the capability of turning within a half-mile circle, the closing date of 30 June had already passed.

Duigan submitted a late entry in August, but was ruled out of contention. The Defence Department nonetheless asked for a demonstration of his aircraft, which took place in May 1911. Later that year, the machine completed the last of some 60 flights, reaching about half a mile at heights of 18 metres. It was not flown again and in 1920 Duigan donated it to the Science Museum of Victoria.

After learning to fly in England during 1912, he returned to Australia with his younger brother Reginald Charles Duigan (1889–1966) bringing with them an engine that they planned to use in a new aircraft of their own design. When flown at Keilor early in 1913 the machine crashed and John Duigan was badly bruised. Although repaired, it was not flown again before the brothers tried to sell it to the Defence Department for training use at the Central Flying School, Point Cook; the offer was not taken up.

In March 1916, Duigan was commissioned as a lieutenant in the Australian Flying Corps (AFC) and proceeded overseas in October as a flight commander in the newly-formed No 3 Squadron. Promoted to captain in August 1917, he went with the unit to Cambrai, France, in September and was in action by the end of the following month.

On 9 May 1918 the R.E.8 reconnaissance machine that Duigan was flying was set upon by four German aircraft over Villers-Bretonneux. Although severely wounded, he managed to beat off his attackers—enabling his observer to shoot one of them down—and landed safely. For this feat, he was awarded the Military Cross. After recovering from his wounds, Duigan went to No 7 Training Squadron at Leighterton, England, and was commander of that unit for several weeks in December 1918.

After the war Duigan worked as an electrical engineer and ran a motor engineering business in Yarrawonga until 1941. During World War II he worked for the RAAF in its quality control branch in Melbourne. On 28 May 1960, nine years after he died of cancer, a memorial to his first flight was unveiled beside the Lancefield road by Air Marshal Sir Richard Williams.

This was not the last that the RAAF heard of the Duigan clan. In May 1940 the second son of Reginald, Terence Lawless Duigan (1916–2006), joined the wartime RAAF. 'Terry', as he was known, had actually enlisted at the start of World War II in September 1939 but was not called up until after he graduated from Melbourne University with a Bachelor of Architecture degree.

After receiving his wings in November 1940, Duigan was sent to Rathmines, New South Wales. There he converted onto seaplanes before being posted to No 11 Squadron at Port Moresby to fly Short Empire flying boats on patrol around New Guinea and adjoining islands. He was commissioned in July 1941.

Returning to Rathmines, Duigan converted onto PBY Catalinas, which had also been added to No 11 Squadron and, after undertaking other courses, was back in New Guinea by late January 1942 at the rank of flying officer. He left Port Moresby when the last Catalinas were withdrawn in early May, joining the rest of the squadron in its new base at Cairns in north Queensland. He was mentioned in despatches in December, and granted acting rank of flight lieutenant.

In March 1943, Duigan was captain of a Catalina sent to locate and shadow a Japanese troop convoy that had just left Rabaul bound for the north coast of New Guinea. At 2200 hours on 2 March, the RAAF aircraft found its quarry and maintained constant watch for the next four and a half hours, before approaching daylight required that they turn for home. Before the crew did so, they dropped their bomb load to add to the consternation of the Japanese. The convoy was duly picked up the next morning and subjected to a devastating attack by a combined air armada of American and RAAF squadrons in what has become famous as the Battle of the Bismarck Sea. For his part in this action and other service in this period, Terry Duigan was awarded the Distinguished Flying Cross.

Following a time as an instructor at Rathmines, in 1944 Duigan became one of the first RAAF pilots converted onto the B-24 Liberator and served on this type at Port Moresby, Darwin and Morotai. He was in the US when the war ended, waiting to ferry a new Liberator to Australia.

Terry Duigan pursued a post-war career as an architect in Geelong, Victoria, until he retired. In 1990, on the 80th anniversary of the first Duigan flight, he took it in hand to add a second plaque to the original monument on the Lancefield road. It was he who also designed a monument erected in Cairns to honour the Catalina pilots and crew who made the ultimate sacrifice during World War II. Terry Duigan died in June 2006, sadly bringing to a close an extraordinary link to a little-known past of Australian defence aviation.

Air Power in Defence of Australia: Early Thoughts

A major difficulty that confronted the RAAF in the first years of its existence concerned its inability to convince the Army and Navy that air power had a role to play in Australian defence that justified Air Force's existence as an independent third service. The Chief of the Air Staff, Group Captain Richard Williams, several times in the 1920s attempted to argue what that role might be. These statements represent the earliest expounding of doctrinal principles for the employment of air power for the defence Australia that have been found.

> **Key Points**
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> - as early as 1926 CAS Williams' thinking about employment of air power in defence of Australia emphasised the likely joint nature of operations and importance of defending the sea-air gap
> - because RAAF might be involved in repelling an attack in conjunction with Navy, long before elements of Army became involved, he argued against giving separate control of RAAF assets to Army or Navy in wartime
> - Williams' case was buttressed by precedent of first warlike air operations in defence of Australia in April–May 1918, involving patrols over sealanes around south-eastern coastal waters

The origins of this problem actually predated the formation of the RAAF on 31 March 1921. As early as 29 January 1920 a body met in the Defence Department specifically to examine air defence policy. This committee—called the 'Air Board' (although it bore no relationship to the longstanding body of the same name, which subsequently administered the RAAF once it was established)—was a four-man panel of Army and Navy officers, and the scheme that it submitted on 7 February 1920 was a hasty amalgam of two separate proposals that had been previously devised by Army and Navy. This produced an alleged requirement for an air force of 36 squadrons, totalling 644 aircraft and with another 322 machines in reserve. So far as this entity's role was concerned, the Board's report noted that Australia's isolation, combined with the limited range of existing aircraft, meant that 'independent action by air forces against enemy centres [was] impracticable'. For this reason, 'the action of aircraft in the defence of Australia will be confined to auxiliary work for the Army and Navy as far as can be foreseen at present'.

In April 1925 Williams produced a 'Memorandum Regarding the Air Defence of Australia', which was, in effect, a detailed concept of operations for the RAAF. He realised that nothing had changed to make strategic bombing any more relevant to Australian circumstances, but he maintained that control of sea lines of communication would be the key to national security if Australia was ever attacked, and the use of aircraft represented the best and most cost-effective means of achieving this. The structure he proposed—30 squadrons comprising 324 aircraft—was still large (based on countering Japan's naval air capabilities) and would require a five-fold increase in the RAAF's budget allocation. This factor alone was probably sufficient to ensure that Williams' scheme was simply ignored by the government.

When the RAAF's right to exist as a separate service subsequently came under challenge from the Army and Navy, Williams obviously felt nothing would be gained by attempting to reassert his vision in the absence of government support or endorsement. In 1926 he did, however, seek to specifically counter provisions that he discovered had been included in the Army War Book (the military forces' response plan in the event of war) that the RAAF's army cooperation squadrons would be transferred to Army control at 'the appropriate time' after mobilisation.

On 29 April he wrote to the Secretary of the Defence Department to point out that the Army was mistaken in its notion that the RAAF merely existed to mind air assets in peacetime that would revert to it and Navy in time of war. Equally, the Army belief ignored several fundamental realities, which included that for periods of operations the whole of Air Force might actually be required for 'naval duties', or that on occasions the RAAF might be employed on strike operations 'when the army was totally uninvolved, as in the period before an enemy expeditionary force actually landed'. In such circumstances, he argued, it would be essential that air assets not be 'subordinated to less mobile services prematurely'.

Williams went out of his way to reject any suggestion that the RAAF saw itself as functioning in war independently from the other services at a time when those services were themselves engaged in operations. But, he stressed, just as one service alone was insufficient for national defence, 'nor is any one purely auxiliary to another'. In advocating a joint approach and focusing on Australia's air-sea gap, Williams was actually foreshadowing strategies of five decades later.

The thoughts that Williams was expressing were not so novel that they were without firm precedent, even in the Australian context. Although he had been still overseas with the Australian Flying Corps at the time, in 1918 there had actually been an occasion when aircraft had been employed in the defence of Australia—and very much in the manner that Williams was then describing.

In July 1917 the coastal freighter *Cumberland* was damaged in a mystery explosion ten miles off Gabo Island, near the Victoria–New South Wales border, and subsequently sank. Fairly soon it was determined that a mine had been the cause, and the presence of a whole minefield in the area was later confirmed. When news broke in March 1918 that a German raider named *Wolf* had laid the minefield while passing through Australian waters the year earlier, even claiming (falsely) to have flown its own seaplane over Sydney, Defence authorities were flooded with alleged sightings of enemy aircraft and ships in the south-eastern sealanes.

To quell growing public disquiet, two air detachments were sent from the flying base at Point Cook in late April 1918 to conduct maritime reconnaissance from Yarram in Gippsland, Victoria, and Bega, New South Wales. The first of these parties was under command of Captain F.H. McNamara, VC, and its 20 personnel included seven radio operators supplied by the RAN and seven ground guards provided by the Army.

Each detachment operated one aircraft: McNamara's party a FE2b (until this was crashed and replaced by a M.F. Shorthorn), and the Bega group a M.F. Shorthorn throughout. All aircraft were armed with only a single Lewis machinegun, although 20-pound Hales bombs were subsequently supplied to the Gippsland detachment. Sea-patrols from Yarram were conducted from 21 April until 10 May, and from the Bega racecourse from 29 April until 8 May. Although probably realised at the time to have been totally unnecessary and pointless, these were the first warlike air operations ever conducted within Australia.

The Doctrinal Contribution of AVM Wrigley: A Fresh Assessment

Air Vice-Marshal Henry Wrigley CBE DFC AFC (1892-1987) is widely regarded as Australia's first true air power analyst. His essays and notes on air power, written during the 1920s, were published for the first time in 1990 as *The Decisive Factor: Air Power Doctrine by Air Vice-Marshal Wrigley* (AGPS, Canberra). The book refers to him as 'Australia's first authoritative commentator on air power', and his writings as 'a *de facto* expression of early Australian air power doctrine', noting that the RAAF had no indigenous air power doctrine prior to 1990. The book also cautions that Wrigley should not be thought of as a significant original thinker. Regardless, Wrigley was a clever observer and analyst of air power as it emerged as a new dimension to war fighting in the early 20th century, and it is worth considering whether his analysis of air power issues are still relevant today.

Key Points

- Air Vice-Marshal Henry Wrigley's essays and notes on air power, written during the 1920s, are considered to be the earliest expression of Australian air power doctrine.
- Wrigley's experiences as a reconnaissance pilot in France during World War I moulded his thinking, but he was primarily an astute commentator on the theory and practice that was in force at the time.
- As they were not published until 1990, his writings had little impact on the development of air power in Australia.
- For contemporary pundits, the lesson from Wrigley's history is that if you want to make a difference to today's Air Force and you have a considered view to put, don't wait for somebody else to write your story for you, act now!

Wrigley's writings covered a wide variety of air operations scenarios. His definition of air superiority included not only a capability for air-to-air fighting and making attacks on aerodromes, but also the ability to attack an enemy's means of military-industrial production. Of course, Douhet and others had also advocated attacks on war production, which in World War II was to become a primary goal of the combined strategic bombing offensive. Wrigley, however, more specifically advocated the use of both day and night bombing—the former for its accuracy, the latter for its lower casualty rate among the attacking aircraft. This was prophetic of how the allied bombing of Germany and occupied Europe during World War II was actually conducted.

Wrigley had a number of other insights into what did and did not work well in aerial warfare. He advocated the integration of naval, land and air elements in operations, and the employment of naval reconnaissance from the air. He saw the advantage of 'long range firing' from aircraft—another prophetic vision of the current spread of stand-off and beyond visual range aerial weapons. He emphasised the importance of the 'moral effect' (morale) gained by successful attacks. He advocated the dispersal of aircraft at air bases, a lesson that air forces have learnt the hard way over the years. In another insightful comment he notes that one of the first duties of an invading army ought to be securing or preparing aerodromes. A classic example of the effectiveness of this principle is the rapid securing of a succession of aerodromes in France following the Allied D-Day invasion. In the subsequent air war over Europe, lines of communications and supply became increasingly important targets. Here again, Wrigley had addressed the issue as a possible future development, which he linked back to Napoleon's strategy. Every war following his writings has featured air strikes against transport and communication nodes in a major way.

Although focussing primarily on combat air power, Wrigley's view of air strategy also encompassed reconnaissance, which is, he wrote, 'now almost essential to military operations'. This was a reflection of his own operational background. During World War I he piloted RE8 biplanes with No 69 Squadron, Royal Flying Corps (later renamed No 3 Squadron, Australian Flying Corps). These were primarily reconnaissance aircraft, though occasionally employed as bombers, and Wrigley gained much experience on patrols to locate enemy guns and photograph the changing tactical situation on the front line.

In 1935, Wrigley published his wartime memoires in his book *The Battle Below.* This was one of only a few other works by World War I Australian airmen, and the first by a serving member of the RAAF. Viewed against his earlier unpublished writings, Wrigley's book is a non-analytical account of his experiences. Interesting though they are, he gives what is basically a day-to-day account of the squadron's tasks, with little interpretation of the usefulness of this work in the bigger picture. He describes his squadron's role in each of the offensives it was involved in—Flanders, the Somme, Amiens, the advance to Peronne, Mont St Quentin and the capture of the Hindenburg Line.

The book gives some detailed descriptions of the methods employed by his unit to complete its assigned tasks. One example is the system of relaying information on the accuracy of their firing to artillery units—the clock code system, developed by a Royal Flying Corps officer as early as January 1915. This system was first used two months later in the Battle of Neuve Chapelle in north-west France. In this action, an infantry advance was preceded by a concentrated artillery bombardment across a two kilometre line that was directed, in part, by several squadrons of reconnaissance aircraft. In the clock code system, the pilot signalled a letter-number code in Morse using an early airborne radio. The code told Allied artillery the location of the fall of their shots in relation to the target, using a bulls-eye in which the numbers of a clock-face were superimposed on concentric circles labelled with letters. It was still in use in the mid-1930s when Wrigley published his book.

The Battle Below also makes passing reference to the usefulness of aerial photography and the development of the art of photo interpretation. The whole of the I Anzac Corps front was systematically photographed, and the photos analysed with as little delay as possible. It was a godsend for the strategists and the men in the trenches alike. Its modernised and wider development, remote sensing, is an indispensable tool of modern warfare.

The contemporary usefulness of Wrigley's air power commentaries and analysis was limited, as he had little opportunity to put them into practice.

In the years before World War II, he commanded RAAF Station Laverton, Victoria, and during the war he commanded Southern Area, covering Australia's southern states. He was also Air Member for Personnel, and commanded RAAF Overseas Headquarters in London. Although the latter position took him geographically closer to an air war 'front line', it was largely an administrative posting. He was not in a position to influence the way in which the air war was fought from Britain.

How should we assess the contribution of Henry Wrigley today? His writings were insightful and often prophetic, but as they did not see the light of day until 1990, nearly 70 years after they were written, they were of no practical value in Wrigley's day. Today, Wrigley is probably more widely remembered for an aerial accomplishment he made just after World War I—the first flight across Australia, from Melbourne to Darwin—than for his contributions as an air power thinker. However, *The Decisive Factor* is an important document in understanding the historical development of Australian air power thought.

"N.Z.3" First Joint Exercise for the RAAF

Australia's three armed services are supposed to have come quite late to the idea of conducting regular joint exercises to strengthen and extend their collective ability to deal with a defence emergency. It has been said that, despite the experience of World War II, the Services paid little attention to joint operations for nearly 30 years after 1945. Not until the first in the biennial "Kangaroo" series of exercises, conducted in June 1974, did the Australian Defence Force seriously concern itself with joint training.

Key Points

- "N.Z.3" was the first large-scale joint (and combined) training exercise involving the RAAF, and took place six months before World War II
- Important for testing and refining untried operational procedures for trade protection in local waters
- Proved invaluable for smoothing the transition to actual operations required to secure control in the sea-air gap surrounding Australia

This being the case, it is surprising and especially interesting that the first large-scale joint exercise in this country actually took place six months *before* the start of World War II. While the Royal Australian Air Force had provided assistance to army and navy training from the 1920s, in nearly all cases this involved little more than contributing an air dimension to what remained single-service activity. The "NZ" exercises mounted in the early months of 1939 also began as low-level affairs, but the third in the series culminated in a intensive strategic maritime trade protection exercise.

Although relatively short in duration (17-19 April), "N.Z.3" was heralded in the Press as the largest naval exercise in Australian waters since World War I, designed "to test the ability of the existing sea and air forces to keep open Australia's trade shipping routes." Taking part were nine ships of the Royal Australian Navy: cruisers *Canberra*, *Sydney*, *Hobart* and *Adelaide*; destroyers *Vendetta*, *Vampire* and *Voyager*; plus the sloops *Swan* and

Yarra. Also participating was the British cruiser *Leander*, then on loan to New Zealand. *Leander* and *Adelaide*, with an unidentified merchantman representing a "disguised raider", were the enemy Blue Force.

A total of 46 RAAF aircraft were involved. These were drawn from four squadrons based at Richmond, New South Wales – 9, 3, 22 and 6 (the last a composite of aircraft and crews from 23 Squadron as well) – and four squadrons from Laverton, Victoria – 1, 2, 12 and 21. Apart from the Seagull V amphibians of 9 Squadron (a fleet co-operation unit), all the rest of these aircraft were Anson coastal reconnaissance bombers or Demon fighter-bombers. The Ansons were to work in conjunction with the defending ships of 'Redland' in locating the enemy vessels, while the Demons provided an aerial strike force to assist in notionally eliminating the threat they posed.

Exercise hostilities took place in the focal area of south-east Australia, extending south from Port Stephens, New South Wales, to Cape Otway in Victoria, and all commercial ships passing through coastal waters became participants in the exercise, either wittingly or not. The exercise scenario required aircraft to conduct reconnaissance in the sea lanes and report by radio the details of all shipping that was sighted. For the purpose of the exercise a control room was set up at Laverton, where there was a huge coastal and sea map.

While the Seagull amphibians moved to Mallacoota, just inside the Victorian border near Cape Howe, a striking force of Demons from 3 (Army Co-operation) Squadron was stationed at Canberra along with the Anson detachment from 6 Squadron, with camp facilities being provided by the Royal Military College, Duntroon. Another striking force was formed from Demons of Laverton-based 1 (Bomber) Squadron. An Advanced Landing Ground (ALG) was also established at Yanakie, near Wilsons Promontory, Victoria, as an operational base for 12 Squadron's Ansons, along with three Demons that provided local protection of the ALG from air attack.

Flying a series of parallel track, square and diverging searches, the reconnaissance patrols enjoyed some early successes. By the end of the first day one of the 'enemy' cruisers had been theoretically sunk and the other damaged, though not before six merchant ships had also supposedly been captured or sunk. During the second day a great many merchantmen were sighted and reported, but none of the enemy vessels were located. Finally, on the last day, the armed merchantman operating as a disguised raider was picked up and shadowed; a bombing attack was launched but failed to sink it. Among the Red casualties notionally suffered during the enemy attacks on shipping was the liner RMS *Strathnaver*, which had been 'sunk' as it rounded Cape Otway.

While it appears that no new major lessons of earth-shattering importance emerged from the exercise, at least on the air side, the aircrews undoubtedly received some valuable practice. The Anson had only begun entering RAAF service in numbers during 1937, and although it was not particularly suitable for maritime reconnaissance work it was the best type Australia possessed for performing the role. Moreover, many of the squadrons taking part were operating with scratch crews, so – as the post-exercise report submitted by 12 Squadron noted – "considering the inexperience of personnel the resultant flying and operational work was all that could be expected." The RAAF was also given a lesson (if it had been inclined to accept it) about properly preparing an ALG. The 12 Squadron report noted that the failure to provide accommodation at Yanakie meant that personnel were forced to spend long hours on duty without rest, and "under trying circumstances owing to adverse weather conditions."

The most significant area requiring attention that emerged from the exercise concerned the communication arrangements. As spelt out in a pre-exercise memorandum, the arrangments "for the general direction of Trade Defence operations off the S.E. of Australia … [were] as yet untried." What emerged as a result of N.Z.3 was that the RAAF was still not ready for handling actual operations of this kind. The reporting procedures used produced excessive radio traffic which quickly swamped the capacity of the signals staff at the operations room. So cluttered did the airwaves become that many aircraft were unable to report sightings until after they had landed. (Although technology has improved communications facilities extensively, the lack of bandwidth is still a 'choke-point' in the dissemination of information in conflict.) In this situation it was inevitable that essential intelligence would be lost, as occurred on at least one occasion. During the second day of the exercise a freighter was supposedly sunk off Westernport before dawn, but the first knowledge that the RAAF at Laverton had of this came when an official bulletin appeared in Melbourne newspapers late that afternoon.

Considering that Australia had to contend during World War II with the activities of several German merchant raiders in and around its waters (*Pinguin*, *Komet* and *Orion* in 1940, and *Kormoran* in 1941), not to mention the Japanese submarine campaign waged off Australia's east coast during 1942-43, the participation of the RAN and RAAF in joint training in trade protection was absolutely apppropriate and necessary at the time.

D.C.T. Bennett: Airman Extraordinary

Air Vice-Marshal Don Bennett, the man who led the famous Pathfinder Force of World War II after which this newsletter is named, was arguably the most proficient and innovative aviator ever produced by the Royal Australian Air Force. Strangely, he receives little recognition in the RAAF of today, and few serving members have probably even heard of him. This article describes why he deserves to be better remembered, while pointing to the possible reasons he is not.

Key Points

- Bennett was the most proficient and innovative aviator ever produced by the RAAF who is well-recognised beyond solely Australian circles
- His wartime leadership of Pathfinder Force within RAF Bomber Command as a 33-year-old air vice-marshal was arguably his greatest achievement
- The post-war souring of his career was due to his lack of 'people skills', which plagued his later efforts in both politics and civil aviation

Donald Clifford Tyndall Bennett joined the RAAF on 16 July 1930 and began pilot training at Point Cook, where he graduated second in theory and first in practical flying. Through a scheme operating since 1926, under which a proportion of each Point Cook course was passed across to the Royal Air Force on short service commissions, Bennett went to England in 1931. There he flew biplane fighter aircraft and flying boats, in all logging 1350 hours on 21 different aircraft types.

In August 1935 Bennett left the RAF as a Flying Officer. He did so holding a first-class civil navigator's licence, a wireless operator's licence, three categories of the ground engineers licence, a B class commercial pilot's licence and a flying instructor's certificate. That year he also wrote *The Complete Air Navigator*, which became the essential textbook on air navigation and remained in print for over 30 years. Bennett himself was just 25 years old.

In January 1936 Bennett joined Imperial Airways. He operated the European routes and flew the Handley Page 42 to India and Kenya and Empire flying boats from Southampton to Egyptian and South African ports. In 1938 he published *The Air Mariner*, another book concerned with the handling of flying boats. That same year he was placed in command of a small four-engined aircraft named *Mercury*, which was launched from the back of a flying boat. In this he successfully made the first commercial trans-Atlantic flight while setting a new record for the east-to-west crossing of the North Atlantic. In recognition he was awarded the Johnston memorial trophy and the Oswald Watt gold medal. In October 1938 Bennett flew *Mercury* non-stop from Scotland to South Africa setting a long distance record for seaplanes. The next year he took part in proving the concept of air-to-air refuelling, which was intended to make possible non-stop Atlantic commercial flights.

In July 1940 Bennett was appointed flying superintendent of the Atlantic Ferry Service established to bring American aircraft to Britain. In mid-winter he personally led the first flight of seven *Hudson* aircraft to make the hazardous crossing. In September 1941, Bennett rejoined the RAF as an acting wing commander and within three months was given command of 77 Squadron equipped with *Whitney* bombers. He consistently flew operations. In April 1942 he took over command of 10 Squadron equipped with the *Halifax*. When attacking the German battleship *Tripitz* in Trondheim Fjord, Norway, his aircraft was shot down. Bennett evaded capture with several of his crew and reached neutral Sweden. After release from internment and return to Britain he was awarded the Distinguished Service Order.

Bennett's greatest achievement was yet to come. In July 1942 he was given the rank of acting group captain and directed by the formidable Air Marshal Sir Arthur Harris to form and lead what was to be known as the Pathfinder Force within Bomber Command. The establishment of such a force designed to find and mark targets for night bombing raids was deemed essential if Bomber Command were to continue its offensive. Few aircraft were reaching let alone hitting their nominated targets and, with a loss rate of four to five per cent of sorties dispatched, Bomber Command was achieving very little at great cost and was close to being dissolved. The appointment of Bennett, with his superlative navigational and technical skills, was crucial to Bomber Command's eventual contribution to allied victory.

Pathfinder Force, with its ability to guide bomber formations to their targets through the use of radar and pyrotechnics, greatly improved accuracy and therefore the effectiveness of the area bombing campaign. Bennett saw the potential of the then underestimated *Mosquito*, and this magnificent aircraft (able to carry a 1814 kilogram load to Berlin) was used principally as the leading aircraft of the Pathfinder marking forces. Frequently, and obviously against regulations, he would fly a *Mosquito* himself to the target to observe the marking procedures and the subsequent attack carried out by the main force of Bomber Command.

In January 1943, the Pathfinder Force was designated 8 Group of Bomber Command and Bennett was promoted to acting air commodore. At the same time he was appointed Commander of the British Empire. In December 1943, at the age of 33, he was promoted to air vice-marshal—the youngest officer to hold such rank in either the RAF or the RAAF. In 1944 Bennett was appointed CB and to the Russian Order of Alexander Nevesky. He was also elected a fellow of the Royal Aeronautical and the Royal Meteorological societies. Not bad for the Queensland-born son of a stock and station agent and grazier who left Brisbane Grammar School without distinction.

Still, the end of the war held a sour end for Bennett. Of all the senior RAF commanders he was not knighted, for he possessed a further and dysfunctional talent: he made enemies easily. He had few, if any, of what today are called 'people skills'. Bennett exhibited an impatient, dictatorial and pedantic style of command and having had a strict Methodist upbringing he never drank, smoked or was heard to swear. Such characteristics in the then masculine world of military aviation may have contributed to making him a difficult colleague.

Harris said of Bennett: 'He could not suffer fools gladly and by his own high standards there were many fools… Being still a young man he underrated experience and over-rated knowledge.' At the same time, however, Harris acknowledged that Bennett was the most efficient airman he had ever met. While he was certainly arrogant and abrasive, many who served with him held him and his many skills in awe. His reputation for never asking anybody to do something he could not do himself was fully warranted.

Bennett's career after the war embraced both politics and civil aviation. He won a second Oswald Watt gold medal for making a survey flight to South America in 1946, but otherwise his efforts in both fields were a disappointment. His term as chief executive of British South African Airways ended in acrimony and his dismissal in 1948; his political views became progressively unsavoury as he flirted with the far right. He formed his own air transport company, which returned good profits during the 1948–49 Berlin Airlift and until 1951, and he then formed a company supplying sports cars in kit form, which he owned until 1983. When he died in 1986 in England, he was still remembered as a superb aviator. The title one biographer gave him was 'Pathfinder Bennett—Airman Extraordinary'. How remarkable then that this famous figure had his start in flying with the RAAF.

The Air Campaign Over the Kokoda Trail

Kokoda has been called Australia's most significant campaign of World War II. Although plans for an actual invasion of Australia had already been abandoned before operations got underway, the Japanese advance towards Port Moresby brought them closer to Australia than in any other phase of the war. Support and supply from the air was an indispensable factor in the success of the Allies in defeating that campaign.

Key Points

- During the 1942 Kokoda campaign, aerial resupply of allied troops and air attacks on Japanese supply routes played a crucial part in the outcome
- The impact on the Kokoda campaign of the concurrent victory won at Milne Bay, in large part by allied air power, is not fully appreciated
- Air power can produce effects, often far from the scene of ground fighting, that are decisive in determining the joint campaign

On 21 July 1942 Japanese troops came ashore near Gona on the north coast of Papua and began moving inland, thrusting southwards. Opposing them was a single infantry brigade of Australian militia, poorly trained, poorly equipped and ill prepared. A week later, the 39th Battalion was forced to withdraw from Kokoda and its important airfield. The order for Japanese forces to attack Moresby over the Owen Stanley ranges was postponed until later in August, when the advance was to be coordinated with a landing at Milne Bay on the south-eastern tip of Papua. Allied air power helped to win the battle for Milne Bay, the enemy's first defeat on land, which proved to be another decisive factor in the New Guinea campaign.

In September, with the Japanese just 30 kilometres from Moresby, the RAAF's 30 Squadron employed its new Beaufighters to begin attacking the enemy's supply and communication lines along the trail from Buna to Kokoda. Under US Fifth Air Force control, the squadron quickly proved the Beaufighter (dubbed *Whispering Death* by the Japanese) to be one of the RAAF's most potent weapons.

At this time, thanks to improvements in the supply line, the tactical situation swung in favour of the Australians. Supplies were now being trucked most of the way forward to the Australian artillery at Ower's Corner on the southern end of the trail, which was within firing range of enemy forces. The Japanese, on the other hand, had to carry their supplies all the way from the north coast, coping with attacks on strategic bottlenecks along the route by US General Kenney's air forces. Aircraft ranging from RAAF Kittyhawks to USAAF Flying Fortresses eventually destroyed the important Wairopi ('wire rope') bridge over the Kumusi River below Kokoda.

Supplying the troops was the key to Allied success, but the supplies were at times inadequate. 'For the moment air supply is paramount,' wrote Australia's General Blamey to US General MacArthur on 5 October. The gravity of the situation was highlighted in a report from Major-General A.S. Allen, commanding the 7th Division, two days later:

> *Unless supply etc. dropping of 50,000 pounds [23 tonnes] daily, plus additional to build up reserve is assured, complete revision of plans will have to be made and large proportion of troops withdrawn to Imita Ridge position. Any attempt then to hold a determined enemy advance … and to occupy Kokoda will be jeopardised beyond all reason.*

The logistics of getting adequate supplies, with limited available aircraft, to the hard-pressed troops crossing the Owen Stanleys was prodigious. In September, the air support force under Kenney's command could only muster some 26 dedicated transport aircraft (primarily USAAF, as RAAF Douglas Dakotas would not come into service until the following February). These had to be supplemented with bombers such as Mitchells, which were then unavailable for their primary task. The weather rarely cooperated, and flying over mountainous terrain in cloud was fraught with danger.

To compound the problem, airdropping was a difficult art that had not yet been perfected. Official historian Douglas Gillison describes the method in *The Royal Australian Air Force 1939-1942* in the following terms:

> *Parachutes were limited in number and were reserved for ammunition, medical supplies and other fragile goods; the rest were wrapped in blankets which were bound by wire and tossed free from the aircraft … Damage to ammunition so dropped created a special problem; the troops sometimes found it faulty, with serious results.*

During October and November the Allied advance north was assisted when the airfields at Myola and Kokoda were secured, allowing the first Dakota with rations and medical supplies to land at Kokoda on 5 November. The use of native carriers for resupply and evacuation of casualties along the route, however, remained crucial. In mid-December an unusual force bolstered the available transport aircraft: 15 Hudson bombers from the RAAF training unit at Bairnsdale, Victoria, which were moved to Port Moresby to form the bulk of the Special Transport Flight. For a month they made the hazardous run over the Owen Stanleys to deliver stores for the troops.

Also, in November, 4 Squadron RAAF arrived at Moresby in support of the 7th Division and the US 32nd Division. Its Wirraways were able to use their slow speed to advantage in the reconnaissance role. On one of the first missions, the crew of a Wirraway that crash-landed at Wairopi managed to make their way through the jungle to Kokoda.

The squadron flew weather reconnaissance missions over the Kokoda Gap in the Owen Stanleys, which allowed a lower and safer air route into Kokoda. It also carried out tactical reconnaissance of enemy troop movements, photography, message dropping, and even strafing and divebombing. Artillery spotting from just 1000 feet over enemy positions was particularly hazardous.

Reconnaissance over New Guinea was difficult, the dense jungle often being almost impenetrable even from treetop height. Often the only way to identify the position of enemy guns was to attract fire from them! Over the north coast, the Wirraways flew low enough to make out fresh tracks along the beaches. They also dropped supplies to troops in the field (although this had the disadvantage of giving away their position).

By mid-November, the reinforced Australian forces had pushed on past the Kumusi River and reached the north coast. The battle for the Kokoda Trail was over, although Japanese units continued to resist strongly in the extremely difficult coastal terrain around Buna, Gona and Sananada until mid-January 1943. Air power had helped ensure that the iconic Kokoda campaign ended in the Allies' favour.

Coast Watchers: An Early ISR Network

The importance of tactical networks to air operations was recognised long before the advent of computers and digital communications. An often overlooked example of such a network is the Coast Watch Organisation (CWO) of World War II. RAAF personnel were members of this organisation which played a crucial role in the combined military operations conducted against Japan.

Key Points

- Coast Watchers are one of the iconic behind-enemy-lines organisations of World War II, but the RAAF dimension of their activities is largely unknown
- The critical importance of an ISR network to air operations demonstrated by Coast Watch Organisation is equally relevant today.

Set up by the Royal Australian Navy in 1922, the CWO originally utilised unpaid civilians to report on shipping movements along most of the Australian coastline. By 1939 the network had been extended to cover most of Papua, New Guinea and the Solomon Islands and numbered over 700 observers drawn from among planters, missionaries and administrators in the islands. Reports generated by these Coast Watchers were sent by telegraph or radio to the Naval Intelligence Office in Melbourne, where they were assessed for reliability before being used to compile a current 'picture' of ship positions around Australia. Regular intelligence reports were then despatched to various military headquarters.

Thus, when Australia declared war on Germany in 1939, Australia's first tactical network was already in place and functioning. By August 1940, an almost complete arc of coverage from the New Guinea border with Dutch East Indies to the eastern tip of the Solomon Islands—a piquet line of some 4000 kilometres—provided advanced warning of any enemy approach towards Australia from the northeast. Although the CWO had been set up to monitor shipping movements, the RAAF realised its value in also reporting hostile aircraft activity. By early 1941, reports from CWO observers in the northern islands were being passed to the Area Combined Headquarters at Townsville. Naval and air intelligence officers worked side-by-side, assessing incoming reports and disseminating relevant intelligence and warnings.

Following the advance of Japanese forces through Malaya and the Philippines and the enemy's reconnaissance of Rabaul, the CWO prepared for the continuation of their activities should Japan occupy New Guinea and adjoining islands. Areas that were likely to be of strategic importance to the enemy were identified and observers were pre-positioned to cover these areas. In order to give the observers protection under the Geneva Convention if captured, many observers were enlisted or commissioned into one of the services.

When the Japanese overwhelmed the Australian garrison at Rabaul in late January 1942, several local residents who were displaced by the fighting ended up joining the Air Force and returning to the region as Coast Watchers. Among these were two plantation officials who were veterans of World War I (one decorated with the Military Cross), and a young Assistant District Officer named Leigh Vial. For several days Vial led a group of Australian Army and RAAF personnel in evading the enemy as they trekked across the island of New Britain, to be picked up by flying boat and flown to Port Moresby. With his fitness and detailed knowledge of the geography and people of New Guinea, Vial was an ideal Coast Watcher and he immediately volunteered. The process of having him commissioned into the Navy would take weeks—time that was not available given the enemy's rapid advance—but a RAAF commission could be achieved more quickly. Within a week, Leigh Vial had been appointed and trained on the CWO radio, codes and reporting methods. The RAAF flew Pilot Officer Vial to Salamaua where he installed himself in the jungle-covered hills only a few days before Japanese forces occupied the area on 8 March.

From his concealed observation post at Nuk Nuk, Vial reported all Japanese military activity around Salamaua. Armed with the detailed knowledge of enemy positions, Allied commanders launched air attacks on the Japanese from safe distances. On 10 March, 104 aircraft from the US aircraft carriers *Lexington* and *Yorktown* swept across Papua and made bombing and torpedo attacks on enemy shipping in Lae and Salamaua harbours. Flying Fortresses operating from bases in Australia made similar attacks, sinking several Japanese ships. For six months, Pilot Officer Vial's accurate reports of enemy aircraft taking off from Salamaua airfield or passing along the coast from Lae gave the Allies advance warning of air attacks on Port Moresby. The reports allowed defences at Port Moresby to be alerted and aircraft dispersed, preventing great loss of life and protecting valuable assets.

The life of a Coast Watcher was a dangerous one. On many occasions, the Japanese sent aircraft and ground patrols to flush Vial out, without success. On two occasions, he remained silently hidden in trees as enemy troops searched the ground beneath him. His calm voice making detailed reports of aircraft movements while he was in constant danger of being captured earned him the nickname 'Golden Voice', a title which later embarrassed the modest man considerably.

After six months at Salamaua, difficult climatic conditions, combined with poor diet, began to have their effect on Vial, who suffered bouts of blindness brought on by lack of vitamins. He was replaced on 10 August by an Army officer and set out on foot for Wau, where he was airlifted to Port Moresby. There, he was promoted to Flying Officer and wrote a booklet on jungle survival for aircrew. He continued to work for the RAAF in Port Moresby, being responsible for coordinating the dropping of propaganda leaflets, some aimed at the enemy and some at the people of New Guinea.

Vial's achievement was summarised by the Air Intelligence Officer for 9 Operational Group, who reported in August that:

> During the period of six months in which Vial was at his post, he transmitted as many as nine signals a day, giving valuable information of enemy positions, and not on any

> single occasion did he neglect to get his message through, and this showed a total disregard for his own safety.

In recognition of his work as a Coast Watcher, on 12 September Leigh Vial was presented with the US Distinguished Service Cross.

On 30 April 1943, a US Liberator bomber was tasked to drop supplies to an Australian Army reconnaissance team who were patrolling through the difficult Central Highlands region. Flight Lieutenant (TBC) Vial, having a detailed knowledge of the area, went on the flight to assist the crew with their navigation and in identifying the drop location. During the mission, the aircraft crashed near present-day Goroka, killing all on board. Vial's body was later recovered and buried at Lae Cemetery.

In all, eleven RAAF members are known to have served as Coast Watchers alongside their counterparts from other services in the South West Pacific Area. Among a group well-decorated for their courageous service, the RAAF men earned their share of recognition. Apart from Vial's DSC, there were two American Legion of Merits and a Silver Star, an MBE and four mentions in dispatches.

The disparate group of courageous and self-reliant men (and one woman) carried out some of the most critical intelligence-gathering work in the Allied defence of northern Australia and New Guinea. Their reports gave the Allies a decisive advantage in some of the most crucial battles of the war. The principles and values developed by the Coast Watchers in World War II continue to this day in our military information networks. Then, as now, networks and the people who operate them are critical to air operations.

Wau, New Guinea: The Forgotten Airlift

Allied guerrilla operations against Japanese forces in the Bulolo Valley of Papua New Guinea from May 1942, culminating in the Battle of Wau in January 1943, were as important to Allied victory in the South-West Pacific as the better known battles of Milne Bay and Kokoda. At Wau, air support—particularly airlift—was critical to the Allied success. Without vital airlift, the effective defence of Wau would not have been possible.

Key Points

- Allied victory at Wau entailed a major joint and combined operation
- Rugged, jungle-covered topography made large-scale surface resupply impossible and made air power critical to success
- This battle was an outstanding example of cooperation and coordination between Allied ground and air forces

Following Japanese landings at Lae and Salamaua on the north coast of New Guinea in March 1942, members of the New Guinea Volunteer Rifles (NGVR) retreated into the mountains where they conducted guerrilla operations from a base at Wau. Their only form of resupply was native carriers who brought loads through the rugged Owen Stanley Mountains from the south coast. As this trickle of supplies could barely support the small guerrilla force, no major Allied land operation was possible without a major upgrade to the surface supply line or a major airlift operation.

In order to increase the pressure on the Japanese forces around Lae and Salamaua, more troops and supplies needed to be flown in. Wau was the only secure airfield. On 22 May the airlift of the Australian 2/5th Independent Company from Port Moresby commenced. DC-3/C-47 aircraft flown by USAAF crews flew twenty sorties to Wau over four days, moving 305 troops and their equipment. American P-39 Airacobra fighters escorted the transport aircraft to protect them from attacks by

Lae-based Zero fighters. Weather in the Wau area was unpredictable at best, and caused many missions to be aborted.

The 2/5th Independent Company, combined with the NGVR to form Kanga Force, conducted many successful raids against the enemy garrison at Lae-Salamaua over the next four months. Kanga Force was re-supplied principally by air, both by landings at Wau airfield and airdropping to force elements deployed at various locations south of Salamaua. The Japanese continued to build up forces at Lae-Salamaua, moving 900 troops to within easy striking distance of Wau and Bulolo. In October the 290-man 2/7th Independent Company was airlifted from Port Moresby to Wau to strengthen Kanga Force, which intensified its raids on Japanese units.

On 10 January 1943, a Japanese naval force unloaded hundreds of troops and tonnes of supplies at Lae, despite ongoing Allied air attacks. General Sir Thomas Blamey, Commander of Allied Land Forces, was concerned that the enemy intended to take Wau and moved 17th Brigade from Milne Bay to Port Moresby in preparation for transferring it to Wau. The airlift of this 2000-strong brigade into Wau began on 14 January but was limited by the availability of transport aircraft. Around ten C-47 sorties per day was the maximum that the USAAF troop carrier squadrons could provide. Again, the tropical weather reduced or stopped the airlift for days at a time. By 23 January, the number of aircraft available to the Wau airlift increased markedly. Allied forces had succeeded in capturing the Buna-Gona area, reducing the need for airlift support to that operation, and another USAAF Troop Carrier Group with 52 C-47s had arrived at Port Moresby. From this point on, at least thirty airlift sorties per day were flown into Wau, weather permitting. USAAF P-39 fighter patrols again provided protection from enemy fighters.

The Japanese, meanwhile, had renewed their advance towards Wau. By 28 January, the Australian force had consolidated its defensive positions around Wau airfield. If the airfield was lost, resupply on a sufficient scale would be impossible and the Allied force would be in a very vulnerable position. On 29 January, the weather cooperated, enabling the last 814 troops of 17th Brigade to be flown in during a record sixty sorties. On 30 January, guns and gunners of the Australian 2/1st Field Regiment were delivered by air to Wau. Within two hours of being unloaded from the aircraft, these guns were providing artillery support to Australian ground forces. RAAF Beaufighter aircraft of No. 30 Squadron, based in Port Moresby, provided close air support to the troops, while Wirraway aircraft of No. 4 Squadron, operating from Wau airfield, provided reconnaissance and artillery spotting for the ground units.

On the morning of 30 January, the Japanese began their major attack against Wau, advancing to within a few kilometres of the perimeter held by 17 Brigade. Despite some small arms rounds striking targets on the airfield, the defences held and the airfield remained usable. On 3 February the Commander of 17th Brigade was able to report that Wau airfield was now secure and enemy forces were being pushed back. Unable to take Wau from the ground, the Japanese began air attacks on 6 February when nine bombers attacked, escorted by about twenty single-engined fighters. One USAAF C47 transport was shot down by Zeros, but the enemy lost four bombers and seventeen fighters to American fighters and Australian anti-aircraft batteries.

The Allied Forces continued the airlift of troops and supplies, with army engineer companies repairing and upgrading Wau and Bulolo airfields. No. 306 Radar Station, RAAF, and the 156th Light Anti-Aircraft Battery of the Royal Australian Artillery were airlifted to Wau to augment the USAAF fighters in providing protection against Japanese air attack. The destruction of the Japanese reinforcements by Allied air attacks in the Battle of the Bismarck Sea in March 1943 ensured that the enemy never again had the strength to conduct offensive operations in the Lae-Salamaua area. The Australian 15th and 29th Brigades and the American 162nd Regiment joined the 17th Brigade in hounding the Japanese all the way to the coast. Due to the difficult terrain, much of the resupply of these units was by airdrop. The enemy retreated to Salamaua which finally fell to the Allied forces on 11 September 1943.

Over a nineteen-day period, the Wau airlift had moved approximately 2,763 troops and 817 tonnes of supplies into Wau. In the busiest four days of the battle (29 Jan-1 Feb), 247 sorties were flown into the airfield. Coordination of the overall airlift while the aircraft were airborne was the responsibility of No. 4 RAAF Fighter Sector at Port Moresby. At its peak, the airlift involved three formations each of eighteen transports, each formation protected by up to fifty fighters. As Wau airfield had only limited parking area, sequencing the aircraft to land was a vital function. On top of all this, weather often prevented aircraft from reaching Wau, on some occasions requiring a whole formation of aircraft to return to Port Moresby.

The Battle for Wau was fought in an area that was extremely difficult to resupply by surface means. Thus, the success of the Allied ground force was dependent on airlift, which in turn, depended on maintaining control of the air and effectively securing the airfield. This battle was an excellent example of a successful joint and combined operation. The rapid reassignment of airlift assets from supporting operations in the Buna-Gona area to airlifting forces into Wau shows the inherent flexibility of air power and the need to have the tasking of the airlift force prioritised at a strategic level.

Ancestors of the UAV

In Issues 8 and 36 of *Pathfinder*, we looked at current developments in Uninhabited Air Vehicles (UAVs) and their combat equivalents, UCAVs. It is interesting to note that when UCAV development began in America during the 1970s, the concept of using unpiloted aircraft for military applications had already been around for some 30 years. These earlier examples served not as surveillance or attack aircraft but in the simpler role of target drone, requiring less sophisticated technology.

Key Points

- Idea of unpiloted combat aircraft not new and was conceived during World War II
- Origins of UAV as a controllable robot aircraft first trialed in US Projects Aphrodite and Anvil
- Target-drone Jindivik is the Australian ancestor of the UAV

The first attempts at using robot warfare in the air occurred during World War II. The Germans Luftwaffe conceived the *Mistel* program, which involved mating a fighter with an explosive-filled Ju.88 bomber. The two aircraft took off together with the manned fighter mounted above the unmanned bomber, and flew until the pilot released the bomber after aiming it in the general direction of the target. *Mistel* saw limited use from mid-1944, mainly against Russia, although a few examples are believed to have detonated in rural England. It does not appear that the pilot had any control over the bomber during its descent, so the concept of having a remotely controlled, manoeuvrable as well as unmanned vehicle in the sky did not apply.

More relevant to the UAV story are two similar World War II American programs. Under the first of these, known as *Project Aphrodite*, the US Eighth Air Force in England filled several Flying Fortress bombers with ten tonnes of the powerful explosive Torpex and targeted German V-weapon launch sites on the French coast. Instead of mating an aircraft onto the bomber, the 'mother' ship (a Liberator bomber or another Fortress) was flown separately at a safe distance, and controlled the 'baby' using a radio link-up to its autopilot. The two crewmen of the 'baby' parachuted out once radio control had been established shortly after take-off. Nineteen Aphrodite missions were flown during the second half of 1944, with little success due to control problems and cloud.

The US Navy had an identical program (*Project Anvil*) involving Liberator drones, only these were fitted with TV cameras to facilitate control by the 'mother' ship in acquiring the target once the 'baby' was free of cloud. On 12 August 1944 Lt Joe Kennedy Jr (older brother of the future US president) was killed while piloting a baby ship that accidentally blew up shortly after take-off, before the crew had bailed out; the explosion was surely one of the largest ever witnessed in the skies over England.

1952 saw the maiden flight of an Australian UAV: the Government Aircraft Factory's radio-controlled Jindivik, a jet-powered target drone designed for use in guided missile programs. It followed trials of a piloted version, the Pika, two years earlier. Unlike earlier US cases where existing conventional aircraft were converted as target drones, the Jindivik was purpose-designed. It has been hailed as Australian aviation's greatest success story and was in service in Australia (with the RAAF and Weapons Research Establishment at Woomera, SA, and with the RAN at Jervis Bay), Britain, Sweden and also with the US Navy.

Jindivik is an Aboriginal word meaning, appropriately, 'hunted one'. The drone was designed to a 1948 British specification for a high-speed pilotless target aircraft, Britain being the primary overseas customer. One hundred Mk I and Mk II Jindiviks were delivered, followed by more than four hundred of the Mk III and Mk IV and other variants before production ceased in 1986. Like most aircraft, the Jindivik was improved over the years with more powerful engines, and updated electronics and control systems, which enabled it to simulate aircraft and cruise missiles. Because it was an expensive asset, in its later years the Jindivik itself was not the actual target, but either launched or towed behind it an auxiliary target or flare. Camera pods could be carried for post-mission evaluation of missile intercepts.

The aircraft was controlled by a crew on the ground, which over the years evolved into a five-member team including azimuth, pitch and master controllers, together with a navigator. Its Armstrong-Siddeley turbojet engine propelled it at around 540 knots at heights of up to 54,000 feet. Flight duration was about 100 minutes. The take-off run was on a tricycle trolley that was left behind, and landings were made on a retractable skid. Some Jindiviks reportedly made over 300 landings. Although originally conceived for high altitude flight, with a radio altimeter fitted the Jindivik could also be flown at very low altitudes.

Over the decades, many missile systems were developed with the aid of the Jindivik. It has also seen other roles, notably surveillance. Jindivik was phased out of Australian use in 1998, to be replaced by the Kalkara, but production was temporarily reinstated in 1994 and again in 1997 to meet British orders for more examples. The type was last known to have flown in RAF service in north Wales on 26 October 2004, giving it a 50-year longevity.

Apart from the Jindivik, some unusual pilotless drones appeared at Woomera. The U.10 was a radio-controlled version of the Canberra bomber, of which 17 RAF examples were sent to the Weapons Research Establishment in the late 1950s. These served as targets for Bloodhound and Thunderbird surface-to-air missiles. In addition, more than a dozen RAAF Meteor jet fighters were converted to U.21A drones, and used as target drones during the 1960s.

There are other, lesser-known Australian UAV connections. For example, the former RAAF Phantom jet fighters (see *Pathfinder* Issue 23) were converted to QF-4G radio-controlled target drones by the USAF. These aircraft were not only radio controlled but, to an extent, self-controlled using GPS navigation. Most have ended their days over the deserts of the USA during the last decade.

THE DEFENCE OF DARWIN, 1964

When the Federation of Malaysia was created in September 1963, Indonesia's President Sukarno adopted a policy of 'confrontation' towards the new state that included cross-border military incursions by land, sea and air. As the tempo of these operations progressively stepped up over the next twelve months, the powers underwriting Malaysia's defence in the Far East Strategic Reserve—Britain, Australia and New Zealand—found themselves facing the prospect of having to counter Indonesian air strikes with strikes of their own against Indonesian bases and facilities. Plans for such operations were developed under the codename 'Addington'.

Key Points

- Deployment of 76 Squadron to Darwin due to strained relations with Indonesia during Confrontation
- Exposed significant deficiencies in arrangements for defence of northern Australia
- Only time control of the air operations undertaken in Australia from time of World War II until 2002–03

Australia faced an additional complication in that, if matters did escalate to the stage of limited war, then northern parts of the Australian mainland could also become targets of Indonesian attack. This possibility assumed even greater likelihood given provisions under 'Plan Addington' which would see Darwin used as a base for British V-bombers undertaking strikes against Indonesia.

A contingency plan was accordingly prepared in January 1964 to provide for the defence of Darwin, especially its aerodrome complex, radar installations, shipping and port facilities. Under this plan, codenamed Operation *Handover*, two squadrons consisting of a total of thirty-two Sabre Mk 30 jet fighters were to be deployed from Williamtown, New South Wales, supported by four Neptune maritime patrol aircraft and Hercules, Dakota and Caribou transports. A strike/reconnaissance capability from Darwin was to be provided by Canberra bombers from No 82 Wing at Amberley, Queensland.

Despite suspected Indonesian air intrusions into Malaysian airspace, it was only with the insertion of Indonesian paratroops into northern Johore on 2 September 1964 that matters reached a critical juncture. Judging that the implementation of operations under Plan Addington might be imminent, the Australian Government ordered the dispatch of the sixteen Sabres of No 76 Squadron and supporting maintenance personnel from Williamtown to Darwin on 7 September. Although this was only a 'half Handover', it was in fact the total operational fighter force then available in Australia, as No 75 Squadron had been declared non-operational in preparation for its re-equipment with new Mirage IIIO aircraft and its pilots and ground crew dispersed as reinforcements for No 78 Wing at Butterworth, Malaysia, as well as No 76 Squadron itself.

The deployment began on the morning of 8 September, with the Sabres—accompanied by a Canberra from Amberley—staging through Edinburgh, South Australia, and Alice Springs. Three Hercules included in the move carried the squadron's base support personnel, Sidewinder air-to-air missiles and freight, while another contained an Iroquois helicopter from Fairbairn airbase at Canberra to provide search-and-rescue capability. A fifth Hercules flew direct to Darwin with personnel and equipment.

For the next five weeks, six Sabres were kept at constant operational readiness for take-off within five and fifteen minutes of a warning from the ground radar unit. It was a tense period, but there was only one interception made—and that was of a RAAF Canberra bomber. Aircraft not held on alert undertook a range of training missions. Alert levels were reduced from 17 October, and three days later eight aircraft and a commensurate proportion of supporting personnel were returned to Williamtown. Aircrew numbers were further decreased when pilots were sent to take part in an army cooperation exercise at RAAF Base Fairbairn.

While these reductions reflected an easing in the international tensions that had prompted the deployment, the seriousness of the concerns that prompted it in the first place should be doubted. The RAAF appeared to have been the only service placed on alert, as naval coast watch stations remained inactive (thereby depriving the Darwin defence system of important intelligence and early warning) and the Army light anti-aircraft battery—although deployed to Darwin—remained non-operational. Adding to the impression that the RAAF deployment had been for the sake of deterrence only, the Area Air Defence Commander at Darwin was deprived of vital intelligence to the extent that he only learnt by chance, from a friend passing through Darwin on a commercial flight, that during part of the critical period the Indonesians had moved their entire force of medium bombers to West Iran.

It was just as well that the situation never advanced beyond the precautionary stage, because the Darwin base was seriously deficient in ground defence measures. There was little protection available to either aircraft or personnel in the event of an air attack, notwithstanding the lessons that ought to have been learnt from the Japanese raids of 1942. The crisis which prompted Operation *Handover* was fortunately short-lived, with Indonesia abandoning its 'confrontation' policy after it experienced a failed communist coup in September 1965. Jakarta signed a peace treaty with Malaysia in Bangkok in August 1966.

Shortfalls identified during the deployment were at least remedied. From June 1965 Darwin received a detachment of the RAAF's No 30 SAM Squadron to bolster local defence from air attack; the detachment's Bloodhound Mk 1 missiles stayed until 1968. The eight Sabres which remained at Darwin after 20 October 1964 became a standing detachment of No 81 Wing and ensured that there was a continuing fighter presence in the north. The need for another emergency deployment to ensure the defence of Australia's northern gateway was subsequently removed by the permanent basing of No 75 Squadron at Darwin from 1983. Five years later the squadron transferred its F/A-18 Hornets to a new base at Tindal outside the town of Katherine, 350 kilometres inland but less than fifteen minutes flying time away from Darwin.

The real significance of the 1964 deployment lies in the fact that it was the first time a control of the air mission had been conducted in the direct defence of Australian security since World War II. It was, in fact, the only time such a mission was carried out in this country until standing combat air patrols were mounted over the Queensland resort town of Coolum during the Commonwealth Heads of Government meeting in March 2002, and over Canberra during the visit of the US president in October 2003.

TSR-2: A British Story With an Australian Chapter

With the era of the F-111 coming to a close, it is timely to reflect on the development of this aircraft and the rivals that existed at the time of its selection. The principal competitor was the British Aircraft Corporation's Tactical Strike and Reconnaissance (TSR-2) aircraft. However, as indicated by Sir Sydney Camm's comment, the development and subsequent abrupt cancellation of the project in 1965 was politically charged. While it was suggested at the time that Australia played a key role in the demise of the TSR-2, there appears to have been many other contributors to its downfall.

Key Points

- The main contender when Australia ordered the F-111 from America in 1963 was the British-designed TSR-2, which was also still in development
- It is alleged that the RAAF decision to buy the F-111 caused the TSR-2 project to be abandoned
- In reality, the costs and technical problems which initially plagued the TSR-2 due to the aircraft's complexity (just like the F-111 later) led the British Labour government elected in 1965 to cancel the program

From the mid 1950s, the RAF and subsequently the RAAF identified the need to replace the Canberra bomber, focusing on a nuclear-capable aircraft (see Pathfinder #29). Given the rapid advances in anti-aircraft weaponry capability, having supersonic strike aircraft that could slip under radar surveillance was seen as a priority. The development of the TSR-2 was also the result of the British Government's focus in the late 1950s on rationalising the eight main British aircraft manufacturers that then existed. On New Year's Day 1959, Vickers-Armstrong and English Electric, amalgamated as the new British Aircraft Corporation (BAC), were awarded the contract to combine their earlier individual designs into the TSR-2. Later that year Bristol-Siddeley were awarded the contract for development of the Olympus engines which were to power the aircraft.

Like the development of any aircraft, the TSR-2 had its technical problems. In late 1964, three completed prototypes had made it off the production line and the maiden flight was undertaken by XR219 from Boscombe Down. A three-month delay between the first and second test flights occurred, due to the engines on the aircraft not being up to specification, trouble with the undercarriage, and fuel pump oscillation that led to cockpit vibration at the same frequency as the human eyeball which affected the vision of the pilot. While these were not minor problems, two other factors of greater import arose that sounded the death-knell for the TSR-2: a change of government, and projected costs. The newly elected Labour Government which promised defence expenditure cutting measures in its election campaign announced in the 1965 Budget that the TSR-2 was cancelled 'forthwith' and the remaining aircraft on the production line were sent to scrap merchants. It is said that the melted TSR-2 parts went on to serve the nation as washing machines.

It was also claimed that the Labour Party and Treasury officials believed that America would provide the UK with F-111 aircraft at a fixed price, something that BAC could not offer, and this would amount to a saving of 300 million pounds over the TSR-2. The UK took out an option on 24 F-111s to be in service by 1967 but once this order got caught up in the same delivery delays that Australia experienced the commitment was cancelled. These decisions made the British aircraft industry feel abandoned by their own government, which failed to appreciate the advanced sales methods of the Americans and also that in many cases the US adopted aircraft production techniques that were developed in the UK.

Australia expressed a high degree of interest in the TSR-2 when the TFX (later to become the F-111) was still on the drawing board. While the majority of Australia's air force budget from 1959 to 1965 was devoted to the purchase of the Mirage III, Australia was actively canvassing for a bomber replacement. In August 1960, the Commonwealth Chiefs of Staff were briefed on the TSR-2 which had a marked effect on the Australian delegation. In March 1962, the Chairman of BAC came to Australia to brief Prime Minister Menzies, Minister of Defence Townley and the Chairman, Chiefs of Staff Committee, Air Marshal Scherger to discuss the TSR-2. Subsequent to this meeting, Scherger was kept 'fully and frankly' informed of the progress of the TSR-2 but a few fateful events swayed Scherger and the Australian Government against the aircraft.

First, the UK Ministry of Defence turned down a suggestion by BAC that the later stages of the flight program involving terrain following and weapon delivery should be carried out at Woomera. Second, in April 1963 Scherger went to Paris for a SEATO conference and paid a short visit to London during which he met with Lord Mountbatten, the UK Chief of Defence Staff. Mountbatten expressed doubt that anything would come of the TSR-2 project on the grounds of cost and complexity, and made it clear that he was arguing in favour of the Buccaneer aircraft over the TSR-2. In his book *Murder of the TSR2,* Stephen Hastings, a decorated World War II army officer and Conservative MP (as well as a director of aircraft company Handley Page), claims 'that three and half years of painstaking promotion, technical explanation and sales preparation during which a seemingly impregnable position had been built up by BAC, were dissipated overnight'.

On Scherger's return to Australia, in May 1963, the Australian Government announced that they had authorised the Chief of the Air Staff, Air Marshal Sir Valston Hancock, to evaluate the Canberra replacement. He decided to consider the French Mirage IV, the British TSR-2, and the US Phantom and Vigilante, in that order. At that point the F-111 did not feature on the shortlist. When Hancock visited the UK, it was suggested that V-bombers could be provided to Australia as an interim arrangement until TSR-2 deliveries were made. However, this offer was conditional upon the force being both crewed and under the command of the RAF—a proposal that clearly did not appeal to the Australian Government or the RAAF.

Another telling shortcoming in the TSR-2 development process was that BAC did not receive a firm order from the UK Government for 21 development and pre-production TSR-2 aircraft until shortly after the

Australian decision to order the F-111 in October 1963. After that, the TSR-2 project did not gain sufficient momentum and was finally ended by the fateful Labour Government decision.

Today only two TSR-2s remain. One (XR 220) is at the RAF Museum at Cosford and the other (XR 222) at the Imperial War Museum, Duxford. The only TSR-2 to fly (XR 219) and two unfinished air frames (XR 221 and XR 223) were used as gunnery targets. The haste with which the Labour Government made its decision has been the source of argument and bitterness ever since. The F-111 has served Australia well, but had it not been for a combination of factors Australia might have been farewelling the TSR-2 in 2010.

WOMEN: AN UNTAPPED RESOURCE

As announced by the Prime Minister last year, it is planned to increase the ADF's authorised full-time strength from approximately 51,000 to 57,000 by 2016. This includes an increase in the size of the RAAF of 8.1 per cent over the next ten years. To achieve this, a recruiting rate 39 per cent greater than the present one will need to be sustained over the next decade. Considering the demography of the nation, is this an impossible target to achieve? Or has a large part of the population been overlooked when considering potential recruits?

> **Key Points**
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> - Historically, the RAAF has been at the forefront in utilising womanpower in non-traditional (ie. not nursing) capacities in war
> - The main barriers to women seeking careers of the highest standard in the RAAF of today have already been brought down
> - In a period of intense pressure on achieving recruitment targets for sustaining and growing the ADF, is the RAAF getting the maximum benefit from using the talents of Australia's female population?

Until the pressures of World War II forced a change in policies, the only area open to women in the Australian armed services was nursing, a role that women had carried out successfully since the time of Florence Nightingale in the nineteenth century. When the RAAF came into being during the 1920s, it was required to largely share medical and dental facilities with the Army as an economy measure, and it was not until 1940 that the RAAF separated out its medical services. This included a nursing service, the RAAFNS, which was established on 26 July that year along similar lines to the RAF service set up in June 1918. Between 1940 and 1955, over 600 nurses joined, serving in World War II, the Korean War and the Malaysian conflict where they lived and worked under the same conditions as their male counterparts. During the Vietnam War, RAAFNS members flew many long and demanding medical evacuation flights ("medivacs") from Vietnam back to Australia. Some members also served with American units in the Philippines, conducting medivacs back to USA.

In March 1941, the RAAF formed the Women's Australian Auxiliary Air Force (WAAAF). This was the first and the largest of the three women's services to be formed in World War II. Initially, members of the WAAAF were recruited on 12-month contracts to temporarily fill critical musterings such as wireless telegraphists, clerks and cooks in the expanding Air Force. It was expected that the WAAAF would return to civilian life once sufficient numbers of male recruits had been trained. However, the need for trained personnel continued to grow and WAAAF members took on other roles, until by 1945, 77 per cent of RAAF positions were available to them. Women maintained and armed aircraft, operated radars, drove trucks and instructed in drill—all jobs previously considered the domain of males. However, despite the RAAFNS members serving with distinction in combat areas overseas without difficulty, Government policy would not permit WAAAF members to serve overseas or in Australia north of the line joining Cairns and Geraldton. In line with the social structure of that time, the WAAAF was seen as a temporary service that was only needed during wartime. With the end of the war the need disappeared and the service was disbanded in December 1947.

With commencement of the Korean War in 1950, the RAAF once again needed skilled workers quickly. The Women's Royal Australian Air Force (WRAAF) was formed as a permanent (that is, not auxiliary) force in July 1950 to fill positions such as cooks, drivers, clerks, medical orderlies and teleprinter operators. As the need for skilled staff increased, the WRAAF increased in size and restrictions on employment (such as not being allowed to serve overseas) were eased. By the late 1970s, Australian society had largely accepted the equality of women with men and that separate services for men and women were not required. As a result, in May 1977 the members of the WRAAF and RAAFNS were integrated into the RAAF with equal pay and conditions.

In the RAAF today, women work successfully alongside men in every branch and mustering except Ground Defence Officer and Airfield Defence

Guard. Female RAAF members have served overseas on combat support tasks and humanitarian missions, living under the same field conditions as their male counterparts. Within the RAAF, women have achieved many milestones. These include attaining two star rank, command of a flying squadron (in particular, a squadron that was introducing a new aircraft and a new capability to the RAAF), command of an Australian overseas task force in Sudan, and being dux of many courses (including Pilots Course and Test Pilot Course).

Women made up fractionally over 50 per cent of the nation's population in June 2006, yet only 13.3 per cent of full-time ADF members at that time were female. The 2087 women then in the Permanent Air Force represented a higher percentage (15.7) than the female component of the Army (10.0), but not the Navy (17.5). Although the percentage of female officers in the RAAF (16.7) was again higher than the Army (14.0), it still lagged behind the Navy (19.3). So, while the RAAF's performance to date is by no means the worst, the question remains: does this represent best utilisation of the female sector of the recruitment pool available to the RAAF? This consideration must not be at the recruiting end alone. Are females being given fair consideration in selection for courses and promotions? Are social and sporting amenities on bases equally suited to men and women? There are many questions to be answered.

In this time of intense competition for the best people in a shrinking pool, can the RAAF, as a service, afford to have women filling fewer than one in five positions?

RAAF Evacuation of Australians From Iran, 1979

> **Key Points**
> - Flexibility and responsiveness of air power can avert possible explosive situations
> - Professional mastery of air force personnel is the foundation from which air power competencies can be optimally employed in support of national security requirements.

In late 1978, the RAAF maintained a contingent of Iroquois helicopters at Ismailia near the Suez Canal in Egypt as part of the United Nations Emergency Force monitoring the peace between Egypt and Israel. Regular C130 Hercules flights were conducted between Australia and Ismailia to resupply the detachment and changeover personnel. On 28 December 1978, a C130E from No 37 Squadron departed RAAF Richmond on one of the Ismailia Resupply flights, transiting to the Middle East via Darwin, Butterworth, Bombay, Abu Dhabi and Bahrain.

By 1978 the 37-year reign of Mohammad Reza Pahlavi, the Shah of Iran, was coming to an end. The "White Revolution" he had been pursuing since 1963, involving land reform, the sale of state-owned enterprises to private interests, extending voting rights to women and the elimination of illiteracy, had alienated traditionalists—especially powerful and privileged Shiite religious leaders—who viewed such initiatives as part of a dangerous trend towards Westernisation. The Shah's violent suppression of political opponents and religious leaders led to increasing civil unrest which would eventually result in revolution. In late 1978, the country was in turmoil and the lives of westerners, including embassy staff and their families, were in great danger.

When the RAAF C130E, under the command of Flight Lieutenant John Gosper and co-piloted by Flight Lieutenant (now Air Commodore) Dennis Green, landed at Bahrain on 3 January 1979 on its way from Ismailia back to Australia, it was met by the staff from the Australian

Consulate. The crew were briefed on the deteriorating situation in Tehran and requested to remain on standby in their hotel awaiting further instructions. With the possibility that they may be required to evacuate a large number of people, the crew unloaded the aircraft and prepared it for an evacuation flight. On the morning of 6 January, the crew were briefed on the conditions at Tehran and the need to evacuate Australian citizens from there. The briefing was short on facts regarding the actual conditions at Tehran, but included an assessment that it was safe enough for the evacuation to be attempted. A RAAF nurse, Squadron Leader Rita Blackstock, who was a passenger on the Ismailia to Australia flight, was included in the crew to go to Tehran so that she could deal with any medical problems that the evacuees may have.

The aircraft departed Bahrain and headed north towards Iran. Entering Iranian airspace, the crew noticed the complete lack of air traffic control and reverted to visual flying procedures, remaining clear of cloud and keeping a lookout for any other aircraft. Landing at Tehran's Mehrabad airport, the crew saw that a number of Iranian Army tanks were on the airfield and were tracking the aircraft with their guns as it taxied in. After shutting down, one crewmember exited the aircraft but was stopped by soldiers with rifles and ordered back on the aircraft at gunpoint. Eventually, some Australian Embassy staff arrived and assured the soldiers that the crew were peaceful and were only there to evacuate foreigners. The soldiers then searched the aircraft, apparently looking for weapons or other signs of hostile intent. Finding none, they allowed the loading of 33 passengers to proceed. The passengers were Australian, New Zealand and Canadian citizens, mostly embassy staff and their families. The small amount of luggage they carried showed the haste with which they had departed their homes. The passengers reported that the atmosphere in Tehran was chaotic and dangerous, with many people running around with guns but not adhering to any recognisable authority. After about two hours on the ground, the crew prepared to depart for Bahrain.

Several chartered civilian airliners up to Boeing 747 size had arrived at Tehran airport and parked wherever they could find space, often blocking taxiways. Taxying around these aircraft and avoiding tanks and other Army vehicles, the C130E finally reached the runway and took off. When the crew radioed Bahrain ATC, they were asked for their aircraft callsign and registration. The Bahraini controller then replied that the registration they gave did not appear on the list of international aircraft registrations and therefore the identity of the aircraft was in doubt. In a place like the Middle East when a revolution is going on, unidentified aircraft could be shot down without warning. The Iranian Air Force had been supplied with a large number of F-14 Tomcat fighters and was probably capable at that time of intercepting any aircraft that they considered hostile. The crew were understandably alarmed and after some further discussions convinced the controller that the aircraft should be cleared to fly to Bahrain. After landing, the crew and their aircraft were carefully checked by the Bahrain Police before the passengers were allowed to disembark.

The next day, most of the passengers returned to their homeland by civil airlines. The RAAF C130 and its crew resumed their Ismailia resupply mission, returning to Australia via Abu Dhabi, Madras and Butterworth. For completing this humanitarian task under dangerous conditions, each C130 crewmember was awarded an Australian Service Medal with Special Operations clasp.

In Iran, the Shah was forced to leave the country on 16 January 1979 and go into exile. The religious leader, Ayatollah Khomenei, returned to Tehran from exile two weeks later, on 1 February, spreading his anti-western and pro-Islamic politics, and causing further civil unrest. Within days the Australian government decided that the situation had deteriorated to the point where the remaining embassy staff at Tehran could no longer stay there. On 7 February another RAAF C130E, flown by Flight Lieutenant Frank Martin and Flying Officer Barry Eddington, left Richmond on another Ismailia resupply flight, during which it was also tasked to fly from Bahrain to Tehran and bring out the last of the staff from Australia's embassy.

The degree of turmoil in Iran was illustrated in November 1979 when a group of militant university students, supported by the new Islamic regime, seized the US embassy in Tehran and held 66 American citizens hostage in a drama which lasted 444 days. A US attempt at rescuing the hostages on

25 April 1980 foundered with an accident to several aircraft at a refuelling base in the desert 200 miles southeast of Tehran, resulting in eight men killed and aircraft and equipment worth nearly $200 million being left behind. The safe evacuations which the RAAF carried out had potentially spared Australia all the agonies of a similar hostage situation.

This episode clearly demonstrates the flexibility, adaptability and responsiveness of air power in containing provocative and deteriorating situations. It is also illustrative that these core characteristics of air power are resident in all the capabilities within an Air Force that could be utilised where a national response to an emerging crisis is required. Underlying this extraordinary flexibility is the professional mastery of the personnel involved. The professional mastery of the crew involved, applied in a complex and potentially dangerous scenario was essential to the successful conduct of the evacuation.

LIST OF CONTRIBUTORS

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