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WINTER 2022
VOLUME 74 NO.2

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MANAGING EDITOR'S MESSAGE

WELCOME TO THE WINTER 2022 edition of the Air Force Association magazine, *Wings*. In this edition we begin two new series that we hope you will enjoy, together with the regular features and a couple of intriguing stories from military history.

One series traces the world's endeavours to explore and utilise space, and begins with an introduction to the recently established Defence Space Command and a pertinent forward by Australia's inaugural Space Commander, Air Vice Marshal Catherine Roberts.

The second new series features the formation display teams of the Western world, fittingly opening with a personal account of our very own Deltas, the first team in the world to enthral spectators with a front-line fighter aircraft presentation – the spirited, elegant and noisy Mirage III.

Visit our website, wingsmagazine.org, to arrange a personal or gift subscription to receive a regular copy in the mail and to read previous issues.

Ron Haack,
Wings ***managing editor***

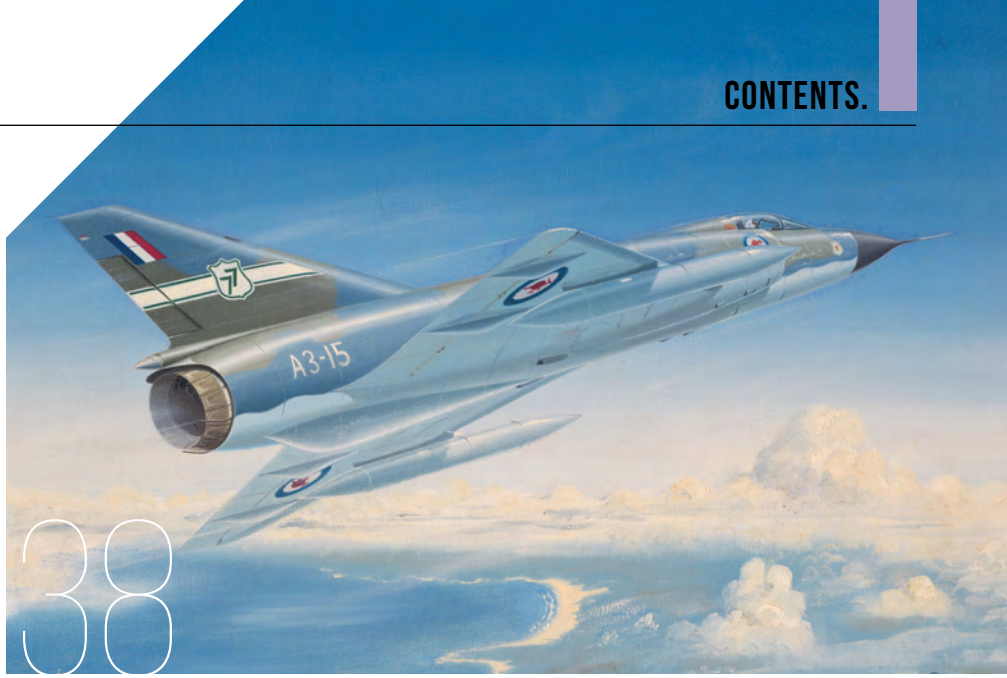
WINGS EDITORIAL DEADLINES 2022

Wings welcomes editorial submissions and letters to the editor. Please note the following deadlines for submissions.

EDITION	DEADLINE
Spring (September)	15 July 2022
Summer (December)	30 September 2022

Please send submissions and letters to: editor@raafapublications.org.au, including your name and details. Submissions may be edited for length and clarity. We cannot guarantee all material will be published.

AIR FORCE ASSOCIATION



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MESSAGE FROM

SPACE COMMAND

IT IS A TRUE HONOUR to write this foreword for the winter 2022 edition of *Wings* magazine. This issue, and the publication itself, does an amazing job highlighting key Defence activities and developments across the globe, as well as our collaborations with industry, allies, government and links with Air Force Association and former members.

Connection among the Australian Defence constellation – Navy, Army, Air Force, the Australian Public Service, as well as industry and partners – is something I am deeply passionate about. Space effects underpin almost every aspect of military power and Australia's national security infrastructure. Space effects have become so ubiquitous to Defence operations that their criticality to modern warfighting can go unnoticed, but they underpin almost every digital system in use by the Australian Defence Force today.

Air Force's latest capabilities, including aircraft systems, Precision Guided Munition and Joint Precision Air Drop Systems, all rely on precision, navigation and timing data from space-based GPS. Air Force uses satellite communications to deliver communications and data to military aircraft globally.

For Australia to retain our control of each of the key operational domains, air, land, sea, cyber and space, we must remain in a state of perpetual alertness and, crucially, that means collaboration and clear communication between all Defence stakeholders.

Since I was appointed as Commander Defence Space Command this year, serving under our Chief of Air Force, Air Marshal Mel Hupfeld, who is the space domain lead, I have emphasised the importance of heightening the national awareness of sovereign access to space, and the need for enhancing our domestic capability to defend that right to access.

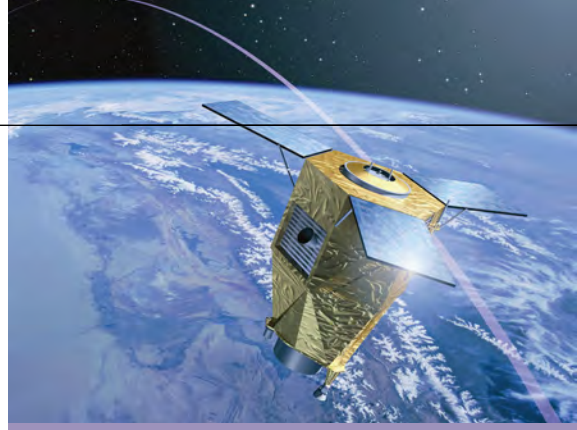
During the launch of Defence Space Command earlier this year, AIRMSHL Hupfeld said that advancing Australia's space power requires "a shift in thinking that recognises and supports space as a contested operational domain rather than simply being an enabler to other domains," and this is a fundamental truth.

The benefits of access to space are very clear – we need eyes and ears in orbit to know where strategic risks lie, when and where they might arrive, and how to deploy our defence capabilities accordingly.

We all understand the importance of defending our oceans, our land, and the skies above us, but we also need to be able to defend our access to space. Defence Space Command crosses service boundaries, atmospheric layers and orbits in our quest to use the fundamental properties of the space environment to support ADF operations.

In this issue, *Wings* explores some of the key opportunities Australia holds in the space domain. Thank you to the Air Force Association, and *Wings*, for acting as the conduit for connection across our remarkable Air Force family.

Air Vice-Marshal Cath Roberts AO, CSC
Commander Defence Space Command



ON THE COVER
Artist's impression of a Pleiades satellite, one of a pair of European Space Agency earth-observation satellites offering very-high resolution optical imagery.

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AIR FORCE ASSOCIATION

PRESIDENT'S DESK

THE AIR FORCE CENTENARY MEMORIAL DEDICATION CEREMONY held at RAAF Base Point Cook, Victoria on 30 March 2022 was the final event in Air Force's 100th Anniversary (AF2021) commemorations. I felt proud and privileged to be present and lay a wreath representing the 'Then' as part of the AF2021 theme of 'Then. Now. Always'.

The new memorial, at the southern end of the Main Parade Ground opposite the Australian Flying Corps Memorial, is contemporary in appearance, styled on an officer's rank band and an enlisted rank's chevron. It's a memorial to the 350,000 former and current serving Air Force personnel and the 11,191 who have lost their lives in service to provide a better future for all Australians.

On the evening prior to the dedication ceremony, I witnessed a beam of light from the memorial that soared to the cloud base, acknowledging the fallen 3,143 Air Force aviators who have no known graves. It was an emotional and memorable sight. I've been advised the light beam will be shown on special occasions.

Earlier that day, I attended the reopening ceremony of the Chapel of the Holy Trinity at the base. The chapel building was initially the RAAF Academy Assembly Hall. On 20 June 1987, the chapel was consecrated as a multi-denominational church in the presence of Air Marshal Jake Newham, Chief of the Air Staff and his designated successor Air Marshal Ray Funnell. Apart from being a place of worship, the chapel has an important role in the safekeeping the RAAF's laid up Colours. The RAAF's Queen's Colour that was retired at last year's Queen's Colour Parade on 31 March at Government House, Canberra was marched in for safekeeping. It has joined the 28 other Colours beautifully presented on the back wall of the refurbished chapel.

AFA TROPHY

This year's winner of the Air Force Association Trophy was Air Mobility Group. I presented the trophy at the Air Force Awards Dinner held on 29 March at the refurbished Officers' Mess, RAAF Base Point Cook. Like many others who experienced the wonderful occasion, it was a pleasure to see the mess building reinstated. It's part of our history and capable of providing purposeful use for generations to come. The wellbeing value of fellowship again became apparent as I saw firsthand the enjoyment of people re-engaging with long-time friends and colleagues.

I am pleased to say I have witnessed over the past three years a developing closer connection between former and serving Air Force veterans. That is certainly the case between Air Force and the Air Force Association, evident in the recent signing of a Memorandum of Understanding that describes the relationship between the two organisations. There has been ongoing liaison and mutual support throughout Air Force's 100th anniversary year. And now the Association has been invited to participate and support Air Force's five-year historic events program. I look forward to any opportunity to further develop the bond between Air Force and the Association.

Carl Schiller
National President

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To join the Association, visit raafa.org and follow the JOIN US link. For assistance, contact the Association by phone or email. See page 15 for contact details.

EDITED BY Bob Treloar

Air Command leadership change

AIR VICE-MARSHAL DARREN GOLDIE, the incoming Air Commander Australia, was formally appointed at a Change of Command Ceremony at RAAF Base Glenbrook, NSW on 7 April 2022.

Outgoing Air Commander Australia, Air Vice-Marshal Joe Iervasi, said it had been a privilege and honour to serve as Air Commander Australia for nearly three years.

"Air Command units have overcome an extremely diverse and unique set of challenges the past few years, some of which we have never had to face before," Air Vice-Marshal Iervasi said.

"From bushfires, floods, pandemics to non-combatant evacuation operations in Afghanistan, we have had to navigate the unknown and I couldn't be more proud of the women and men of our Air Force today.

"It's important that our aviators reflect on the resilience they've demonstrated, particularly through the past two years, and have confidence in the dynamic skill sets they've acquired, when faced with new challenges in the future."

Air Commander Australia is responsible for the provision of operational support to the Chief of Air Force and the joint force by preparing the workforce to generate, project and sustain air and space power effects to protect and advance Australia's national interests.

Coming from the Prime Minister and Cabinet office where he provided strategic foreign policy advice to government, Air Vice-Marshal Goldie looks to inspire Air Force aviators and the Australian public through his new appointment.

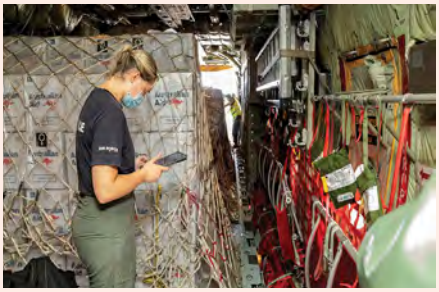
"Our nation needs us to be prepared, which necessitates focused training, and ongoing prioritisation of our resources," he said. "My focus now is to meet the people of Air Command face-to-face – I need to know what we can do better and how I can help to achieve that."

Source: Department of Defence

ABOVE Air Vice-Marshal Joe Iervasi (right) passes a ceremonial sword to Air Vice-Marshal Darren Goldie to signal the change of command. Photo: Corporal Kylie Gibson.

Hercules clock 850,000 FLYING HOURS

An RAAF C-130J Hercules aircraft, loaded with humanitarian assistance and supplies departs RAAF Base Amberley bound for Tonga. Photo: Leading Aircraftwoman Kate Czerny.



RAAF C-130 HERCULES TRANSPORT AIRCRAFT, manufactured by Lockheed Corporation have flown over 850,000 hours – the equivalent of more than 97 years airborne, and have visited every continent, including Antarctica. The milestone was achieved in January during a flight by a No.37 Squadron C-130J Hercules from RAAF Base Richmond to Amberley.

Since 1958, the RAAF has flown four different variants of the Hercules, carrying urgent relief supplies over long distances to remote airfields, often at short notice. The current fleet, which has flown over 150,000 hours, was preceded by 12 C-130As from 1958 to 1978 (148,000 hours); 12 C-130Es from 1966 to 2000 (307,000 hours); and 12 C-130Hs from 1978 to 2012 (244,000 hours).

The number of passengers carried runs into the millions, and includes Defence personnel on operations, civilian communities, heads of government, celebrities, and even animals requiring urgent air transport.

In recent years, the fleet has been upgraded to deliver greater communications connectivity. Crew and passengers can conduct mission planning and remain globally connected throughout their flight, wherever they may be deployed.

Source: Department of Defence

LEFT Loadmaster Corporal Siovahn Daley, of No.37 Squadron, conducts pre-flight checks on humanitarian assistance and supplies onboard a C-130J Hercules at RAAF Base Amberley for Operation Tonga Assist 2022. Photo: Leading Aircraftwoman Kate Czerny.

60 YEARS ON, STILL THE FASTEST AIRCRAFT EVER

A-12 in flight.

ALTHOUGH IT FIRST FLEW 60 YEARS AGO, the A-12 tactical reconnaissance aircraft remains the fastest and highest flying piloted operational jet aircraft ever built.

The A-12, a product of Lockheed Skunkworks' Oxcart Project, and predecessor to the SR-71 Blackbird, made its first flight from Groom Lake (Area 51), Nevada, USA on 26 April 1962.

Existence of the A-12, a Central Intelligence Agency (CIA) asset was highly classified; only declassified after retirement in 1968. It was flown exclusively by CIA pilots, hence, the records it set were overshadowed by the more openly revealed SR-71.

Fifteen A-12s were built at Burbank, California: 12 single-seat reconnaissance aircraft, one tandem twin-seat trainer and a further two modified to carry an unmanned drone. The reconnaissance version carried a sophisticated optical camera system capable of capturing images with a 30cm resolution from 80,000 feet altitude. Skunkworks boss Kelly Johnson proposed an interceptor version of the A-12, designated YF-12, and three were built. However, despite promising test results and an order for 93 aircraft, the option was discarded due escalating costs of the Vietnam war.

CANADA SELECTS F-35 TO REPLACE HORNETS

THE CANADIAN GOVERNMENT has selected the F-35A Lightning II to replace its fleet of CF-18A/B aircraft over the Saab Gripen E and the F/A-18E/F Super Hornet Block III.

The Royal Canadian Air Force (RCAF) fleet of 75 CF-18A/B+ and 18 former RAAF F/A-18A/B Hornets are overdue for retirement and will be replaced with 66 Block 4 standard F-35A aircraft with an introduction to service in 2025.

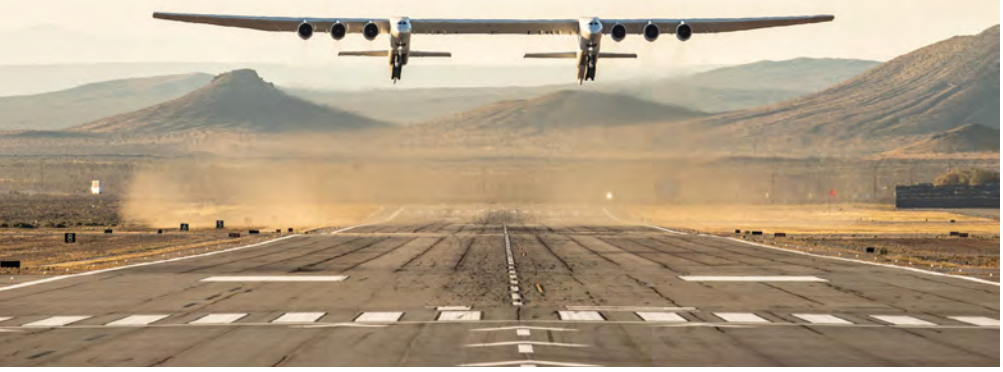
The Lightning II procurement is the most significant investment in the RCAF in more than 30 years.


F-35A Lightning IIs on the ramp at Eielson Air Force Base, Alaska.

Defence missiles package fast-tracked

UNDER A NEW $3.5 BILLION FAST-TRACKED AGREEMENT, Australian fighter and attack aircraft, and navy vessels, will be armed with long-range strike missiles able to strike targets at a range of 900km. The missiles will arrive three years ahead of schedule for the RAAF and five years ahead of schedule for the Navy. High-tech sea mines will also arrive three years earlier under the agreement. Australia is working towards sovereign manufacturing capabilities in the medium term but in the short term is acquiring weapons from US partners. Raytheon Australia and Lockheed Martin Australia have officially been announced as strategic partners under the $1 billion sovereign weapons manufacturing enterprise.

CARRIER AIRCRAFT TEST FLIGHTS



THE ROC CARRIER AIRCRAFT, the biggest airplane ever built, successfully completed its fifth test flight in early May. Manufactured by Stratolaunch, the twin-fuselage aircraft is designed to carry and launch a rocket-powered hypersonic vehicle that can reach speeds above Mach 5 and transition to low-Earth orbit.

During the latest test flight, the aircraft flew for four hours and 58 minutes over the Mojave Desert and reached an altitude of 6,858m.

The all-composite aircraft has a payload capacity of 245,000kg, is powered by six Pratt & Whitney PW4056 turbofans, has a 117m wingspan and two 91m fuselages.

Stratolaunch anticipates beginning hypersonic flight tests and delivering services to government and commercial customers in 2023.

LEFT
The Roc carrier aircraft.
Photo: Stratolaunch.

$875m for ADF bases upgrade

THE FEDERAL GOVERNMENT HAS announced it will invest $875 million during the next financial year to upgrade ADF bases and selected airfields, as well as ports, barracks and training areas.

The upgrade program will include 234 projects and is a component of the $38 billion expansion of the ADF expected over the next 18 years and follows an earlier $244 million commitment to upgrade RAAF Base Curtin, near Derby in Western Australia.

Source: Australian Aviation

An F-111C aircraft and landing at RAAF Curtin.
Photo: Department of Defence

USAF B-2 lands at AMBERLEY

FOR THE FIRST TIME in its operational deployment, a USAF B-2 Spirit bomber has visited Australian. The aircraft of the 393rd Bomb Squadron, 509th Bomber Wing flew a 31-hour transit from Whitman Air Force Base, Missouri, USA to RAAF Base Amberley, Qld in March. The visit was part of an Enhanced Air Cooperation program and to support Exercise Diamond Shield 22, an intensive training component of the Air Warfare Instructors Course.

Scan the QR code to witness the B-2 arrival. Courtesy of Channel 7 Brisbane.

C-390 MILLENNIUM

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When it comes to humanitarian missions, the rapid reconfiguration, speed and flexibility of the C-390 Millennium has proven indispensible for the Brazilian Air Force. During the height of the COVID pandemic, they employed the C-390 to deliver vital medical supplies, including ambulances and liquid oxygen, to remote communities in the Amazon Basin. After the 2021 Haiti earthquake, a C-390 was used by the Brazilian Air Force to deliver 10.5 tonnes of medicines, food and health equipment to help victims and support the emergency relief operation. And when a devastating explosion occurred in the port area of Beirut, Lebanon, the Brazilian Air Force got vital medicines and food supplies 'on the ground' in just under 16 hours. Proven in the field and in the toughest of environments, the C-390 has now been chosen by the Portuguese and Hungarian air forces to lead their humanitarian missions.

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F-35 centre stage IN ASIA-PACIFIC

US Marine Corps demonstrating the F-35B STOVL variant in Singapore.

WITH AUSTRALIA, Japan and Korea well advanced in their plans to field the Lockheed Martin F-35 in the Asia-Pacific region, and the US prioritising regional deployment, the low-observable fighter is rapidly becoming the dominant asset among West-aligned forces.

South Korea has taken delivery of 40 F-35A aircraft and has approved a follow-on batch of 20 and possibly a similar number of F-35B short take-off/vertical landing (STOVL) aircraft that could operate from assault carriers.

Prohibited from joining the industrial program by domestic law, Japan elected for an off-the-shelf approach to acquiring the F-35, acquiring 105 aircraft – 63 F-35As and 42 F-35B STOVL aircraft. Japan intends the latter to operate from dispersed bases on the country's western islands and from the navy's two Izumo-class helicopter carriers.

Singapore has F-35Bs due for delivery in 2026, which will initially remain in the US for training. Thailand may also join the F-35 family.

Source: AINonline

C-27J Spartan at an unprepared facility.

COVID support to Solomons

THE RAAF DEPLOYED two C-27J Spartan transport aircraft to the Solomon Islands in February to deliver medical and other essential supplies to provinces experiencing a surge in COVID-19 cases. In response to a request from the Solomon Islands Government, the aircraft transported personal protective equipment for health workers and emergency food aid to the provinces hardest hit by the pandemic.

The aircraft delivered six Australian-supplied 'bricks' of medical equipment and consumables to be distributed in provincial hospitals. An Australian Medical Assistance Team deployed to Solomon Islands in January to work with health officials in Honiara.

Source: Asia Pacific Defence Reporter

P-8A POSEIDON IN TRILATERAL TRAINING

A RAAF P-8A POSEIDON maritime patrol aircraft and Royal Australian Navy frigate HMAS *Arunta* completed their contribution to a trilateral military exercise alongside US Navy destroyer USS *Momsen* and Japanese Maritime Self-Defense Force destroyer JS *Yudachi* in the South China Sea in March.

The Indian-led exercise provided personnel with experience operating at sea in a large multilateral force and was designed to enhance interoperability and communications between the partners.

HMAS *Arunta*'s contribution forms part of a regional presence deployment program, the Navy's first for 2022.

Source: Australian Aviation

LEFT P-8A Poseidon in trilateral training.

DEFENCE LAUNCHES SPACE COMMAND

AUSTRALIA'S NEW DEFENCE SPACE COMMAND officially began operations on 22 March. While acknowledging that the command will have a modest start compared with similar, well-established bodies operated by Australia's allies, the likelihood of development into a US-style Space Force was noted. A manual, *Defence Space Strategy*, provides guidance and priorities for the space command. It is forward looking, aiming to focus efforts on advancing and expanding the command's capabilities.

Defence Space Command brings members of Air Force, Army, Navy and the Australian Public Service together under an integrated headquarters reporting to the Chief of Air Force as the Space Domain Lead, and includes industry contractors. It will work alongside the Australian Space Agency, which is part of the Department of Industry, Science, Energy and Resources, as well as industry partners and research and scientific institutions.

The Space Commander, Air Vice-Marshal Cath Roberts, a former head of the Aerospace System Division and Air Force Capability, stated that space is the ultimate high ground. What we see from space gives us an unsurpassed advantage in surveillance and intelligence. It is central to how we will fight and win in the future across multi-domain operations, using advanced hypersonics, precision strike missiles and guided weapons.

The Australian Government's objective is to invest $7 billion over the coming decade in new military space capabilities to counter threats, assure continued access to space-based intelligence, surveillance and reconnaissance, and to uphold the free use of space.

Australian Department of Defence and the US National Reconnaissance Office have committed to a broad range of cooperative satellite activities to expand Australia's space knowledge and capabilities, marking a strengthening of the alliance to support mutual objectives in the space domain.

Source: Australian Defence Magazine

For more on Space Command, see page 22.

Invictus Games The Hague

MEDAL WINNERS

THE AUSTRALIAN DEFENCE FORCE and Invictus Australia partnered to support 32 Australian competitors at the fifth Invictus Games, in The Hague, Netherlands, in April. The Invictus Games is an international adaptive sporting event for serving and former serving military personnel who have been wounded, injured or become ill during their military service. Twenty nations competed in 10 adaptive sports.

Team Australia included four RAAF veterans: Gabriel Ramon won silver medals in the men's IF4 shot put and heavyweight powerlifting; Ashley Muir took silver in the men's IRB3 cycling road race; Stephen French won silver in the IF5 men's discus; and Flight Sergeant Nathan King won silver in the IF1 men's discus and bronze in the men's ISD 50m backstroke. Muir and French were also part of bronze-medal-winning wheelchair rugby team.

ABOVE RIGHT From top: Gabriel Ramon competes in the shot put; Ashley Muir during the bronze medal wheelchair rugby match against France; Nathan King in the men's ISD 50m backstroke.

LEFT Stephen French celebrates his silver medal. Photos: SGT Oliver Carter.

RAAF Poseidon under LASER ATTACK

WHILE FLYING OVER THE ARAFURA SEA in February, a RAAF P-8A Poseidon aircraft from No.11 Squadron was illuminated by a laser from a Chinese warship. The People's Liberation Army (PLA) Navy vessel, in company with another PLA Navy ship, sailed east through the Arafura Sea and the Torres Strait to the Coral Sea, transiting Australia's exclusive economic zone.

The laser attack had the potential to seriously harm the aircraft's crew and was considered an act of unprovoked intimidation. Pilots targeted by laser attacks have reported disorienting flashes, pain, spasms and spots in their vision, including temporary blindness. Military-grade lasers have the capability to damage aircraft sensors. The actions were not considered in keeping with the professional standards of military forces.

Source: Australian Aviation

A PLAN Luyang-class guided-missile destroyer (left) and Yuzhao-class amphibious transport dock vessel leave the Torres Strait and enter the Coral Sea, 18 February 2022. Photo: ADF.

Airlift to Ukraine

THE ACCELERATED AIRLIFT of Australian military assistance for the government of Ukraine continued in May with a load of heavy supplies including M777 howitzers and Australian-built Bushmaster protected mobility vehicles being transported by Ukrainian-based cargo aviation company Antonov Airlines. The airlift followed an Australian Government announcement that it would send 20 Bushmasters, including two ambulance variants, and six M777 howitzers with ammunition to aid the Ukraine response to Russia's aggression.

ABOVE A Bushmaster bound for Ukraine is loaded onto a cargo aircraft at RAAF Base Amberley. Photo: CPL Jesse Kane.

AFA strengthens TIES TO RAAF

THE AIR FORCE ASSOCIATION will be working in closer collaboration with the RAAF following the signing of a memorandum of understanding (MOU) focused on reinforcing shared values, history and heritage for the benefit of veterans and serving members.

AFA National President Carl Schiller said the five-year MOU, signed in March, acknowledged the important roles both organisations have in protecting Australia's military aviation history as well as providing critical support for our most valued asset – our people.

"We want to ensure there is a strong and enduring relationship between our two organisations to preserve our rich heritage while also providing support and recognition for veterans and those who are serving today," Mr Schiller said.

He said that over the next five years there would be a focus on areas of mutual interest such as leadership and proficiency awards, history and artefacts, veterans' support, and the promotion of AFA membership.

"Both the RAAF and the AFA have a strong interest in the history of the Air Force going back to its origins in the Australian Flying Corps and there are plans for greater engagement around how we can continue to promote our heritage," Mr Schiller said.

AFA Director of Communications Deanna Nott sees the MOU as an opportunity to build an information and ideas exchange between the two organisations.

"There are many areas where we can collaborate and be aligned to a shared vision for the benefit of Air Force personnel today and into the future," said Wing Commander Nott, who currently serves as the RAAF's Deputy Director of Values and Behaviour. "Through this agreement, we will be enabling our shared stakeholders to have a greater understanding of each organisation, and to hear from us in a coordinated and cohesive way."

75SQN F-35A hangar event.

75SQN CELEBRATIONS

NO.75 SQUADRON WAS formed at Townsville on 4 March 1942 and to celebrate the day 80 years on, 75SQN hosted a family day followed by a squadron function in the hangar within the new F-35A facility at RAAF Base Tindal, NT.

Special guests included the executives from No.81 Wing: Officer Commanding Group Captain Matthew McCormack; Commanding Officer Wing Commander Benjamin Sawley; and Wing Warrant Officer Guy Erba.

As a part of the festivities, GPCAPT McCormack presented the prestigious Kittyhawk Trophy to 75SQN for its tremendous efforts in 2021 supporting, maintaining and operating the F/A-18A/B Classic Hornet in its final year of Australian operations.

ABOVE GPCAPT Matthew McCormack presenting the Kittyhawk Trophy to WGCDR Martin Parker.

RIGHT WGCDR Martin Parker and AC Jackson Slomczewski cutting the cake.

101st Birthday HONOURS

PAST AND SERVING AIR FORCE members along with the representatives from the broader Adelaide community came together with Her Excellency, The Honourable Frances Adamson AC, Governor of South Australia and Honorary Air Commodore, No.24 Squadron, at the Air Force Memorial, Torrens Parade Ground, Adelaide, to celebrate the RAAF's 101st birthday and honour those who have served and paid the ultimate sacrifice.

After the service, attendees shared stories over morning tea, hosted by the Air Force Association (South Australia) in the Torrens Parade Ground Drill Hall. During the morning tea, AFA-SA President, Dr Robert Back AM, presented Honorary AFA-SA membership to Robyn Knight from Moonta and Lainie Anderson from Adelaide, who have both contributed to the preservation of Air Force heritage in South Australia.

Ms Knight was the lead organiser of the Sir Richard Williams statue unveiled in Moonta in November 2021 as part of the Air Force centenary celebrations. Without her drive, leadership and sheer hard work, the statue would not have been possible.

Ms Anderson, now fondly known as the crazy plane lady, was the ambassador of the highly successful Epic Flight Centenary in 2019, South Australia's celebrations of the centenary of the Great Air Race and the incredible flight by the Vickers Vimy flown by Captain Ross Smith, his brother Captain Keith Smith and support crew, Wally Shiers and Jim Bennett.

The morning tea also featured the release of a new book, *Strong to Serve – An Australian Spitfire Pilots War over Europe* by RAAF Officer Joe Mack. The book is a biography of South Australian RAAF veteran Fred Riley who flew with No.130 (The Punjab) Squadron, Royal Air Force, during World War II. Fred flew Spitfires in the air defence of England and conducted fighter intercept, fighter escort, reconnaissance and battlefield interdiction missions over the Continent. He flew missions in the D-Day landings, Operation Market Garden and the Battle of the Bulge, and recorded two aerial victories. The book is available from Big Sky Publishing (bigskypublishing.com.au).

Fred's story was the subject of the recent 101st Anniversary of the Formation of the RAAF Commemorative Service at the Air Force Memorial, Torrens Parade Ground. Unfortunately, Fred was in failing health and could not attend but his granddaughters were present and streamed the service and speech to Fred, which reportedly brought a big smile to his face.

TOP AFA-SA President Dr Robert Black with Her Excellency, The Honourable Frances Adamson, Robyn Knight and GPCAPT Andrew Hoffman, Acting Senior Air Force Representative.

ABOVE Dr Black presented the Governor with copies of two books, *Strong to Serve* and *South Australian Eagles*, the profile of 30 South Australian aviators by Greg Weller.

Fred was one of the few remaining South Australian-based RAAF WWII veterans and at the age of 103, was one of the oldest veterans in the state. Sadly, he passed away less than a week after the ceremony on 5 April. He certainly lived up to the 130SQN motto of 'Strong to serve'.

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EDITED BY John Kindler

Zero-emission SPACEPLANE

Artist Impression of Hypersonix Spaceplane.

AUSTRALIAN START-UP HYPERSONIX LAUNCH SYSTEMS has signed a master research collaboration agreement (MRCA) with the University of Sydney to research and develop a zero-emission, supersonic spaceplane, commencing this year.

According to the company, the vehicle would be capable of deploying small satellites into low-Earth orbit. Dubbed Delta Velos, it would be powered by four green hydrogen-fuelled scramjet (supersonic-combustion ramjet) engines, enabling carbon-neutral propulsion. Engine configuration would include the first 3D-printed fixed geometry scramjet in Australia, completed under a grant awarded to the company in 2020.

In March 2021, Hypersonix and Boeing Australia signed a joint agreement to study the sustainability of scramjets in space as a cost-effective alternative to rocket propulsion.

University of Sydney's researchers led by materials engineer Professor Simon Ringer alongside Hypersonix chief technology officer Dr Michael Smart will develop flight-critical components, including the vehicle launch system, further versions of the scramjet and vehicle fuselage.

From 2022, Hypersonix will work on a series of small proof-of-concept launch vehicles to demonstrate the spaceplane's viability. The first, called DART AE – a smaller version of Delta – will be powered by one scramjet engine, with a range of 500km. It is set to launch in the first quarter of 2023.

If successful, Delta Velos would become the first Australian-designed spaceplane, and one of very few – after NASA's Space Shuttle and Boeing's X-37 – to become a commercial reality.

Source: Defence Connect


Loading a Paveway II Configured BLU-111 (AUS)B/B to a RAAF Lightning II.

Australian WARHEADS DELIVERED

LOCALLY MANUFACTURED NEXT-GENERATION, BLU-111(AUS)B/B warheads have been delivered to No.3 Squadron of No.81 Wing at RAAF Base Williamtown, NSW.

The BLU-111(AUS)B/B warhead, built with improved safety characteristics, will replace the Mk82 explosive as the primary 500lb (227kg) high-explosive warhead for RAAF air-to-surface operations.

The development and production of the BLU-111(AUS)B/B has been an ongoing collaboration between the United States Government, Defence and Australian industry, specifically the manufacturer, Australian Munitions. Local production commenced following the successful delivery of the BLU-126(AUS)/B, 500lb low-collateral bomb, which demonstrated capacity to produce reduced sensitivity warheads using locally manufactured ingredients for the explosive fill.

The design is based on the US manufactured BLU-111B/B tailored to meet Australian production processes. The BLU-111(AUS)B/B warhead represents a generational change in explosives manufacture using polymer-bonded explosive fill and packing design features that reduce the likelihood of inadvertent detonation.

Source: Defence Connect

HERCULES UPGRADE

C-130J at lift-off.

THE FIRST RAAF C-130J HERCULES to undergo Block 8.1 hardware and software upgrade has touched down at RAAF Base Richmond following modification by Lockheed Martin and the United States Air Force in the US. The remaining 11 aircraft are expected to be upgraded locally at RAAF Base Richmond with the support of Airbus Australia Pacific.

According to Defence, the hardware and software modifications improve the accuracy of the Hercules' navigation systems, especially in remote areas across the Asia-Pacific region. The upgrade also provides an enhanced friend-or-foe identification system and guarantees the aircraft remain compliant with global air traffic management regulations.

Block 8.1 will make it easier for crews to operate the Hercules in a range of complex airspace environments, from civilian airspace around airports to frontline airfields.

Source: Defence Connect

HAWK LEAD-IN-FIGHTER CONTRACT EXTENSION

THE HAWK LEAD-IN FIGHTER will continue to train Australia's frontline fighter pilots through to 2031 following a $1.5 billion commitment by the government. A new contract extends existing maintenance, engineering and supply chain services and will be the foundation for progressive upgrades of mission systems.

An Adour engine upgrade to Mk 951 standard will be incorporated by 2025 and will align the aircraft with the UK Royal Air Force's T2 Hawk aircraft. Following the 2019 Lead-In Fighter Capability upgrade of the 33-strong fleet, the Hawk aircraft is among the most capable jet trainers of its type in the world.

The mission systems upgrade will progressively enhance the Hawk's performance as a fast jet trainer, meeting the needs of pilots preparing to fly the F-35 Joint Strike Fighter and other modern aircraft.

The Hawk Lead-In Fighter program currently sustains a direct workforce of 350 at BAE Systems' Williamtown facility and at RAAF Base Pearce, and an industry supply chain of 180 Australian businesses.

ABOVE 76SQN Hawk lead-in-fighter trainer.

ABOVE Pilatus PC-21.

New pilot training system for ADF

LOCKHEED MARTIN AUSTRALIA (LMA) has delivered a new training system to the ADF to support the professional development of Navy, Army, and Air Force pilots.

LMA, in collaboration with Team 21 industry partners Pilatus and Jet Aviation, and the RAAF, developed the Air 5428 training system that encompasses PC-21 aircraft, flight simulators, cockpit trainers, mission planning and maintenance support functions.

To complete the Air 5428 acquisition phase, LMA and Team 21 performed over 3,500 flight simulator and 10,000 aircraft flying events; achieving greater than 97 percent mission success and 100 percent ground school success against contracted performance metrics. To date, the Pilot Training System has graduated 35 Air Force, 11 Navy and 27 Army pilots.

SMALL UAS DESIGNED FOR ARMY

AUSTRALIAN AND VETERAN-OWNED SYPAQ SYSTEMS has submitted a sovereign solution for Land 129 Phase 4B, which will deliver a man-portable small unmanned aerial system (SUAS) for the Army.

Dubbed CorvoX, the system will provide Army commanders with the intelligence, surveillance and reconnaissance support needed to maintain 'over the hill, down the road and around the corner' situational awareness.

Designed, developed and demonstrated specifically to meet the unique requirements of Land 129 Phase 4B, CorvoX combines vertical take-off, hover and landing capabilities with fixed wing flight mode – all designed to reduce the physical and cognitive load on the operator.

CorvoX in flight.

LOCAL PARTNERS FOR BOEING SATELLITES

BOEING HAS COMMITTED more than $5 million to an 18-month development program to train, qualify and transfer proprietary intellectual property and knowledge to its Australian partners as part of its satellite manufacturing plans under JP9102.

Quickstep Holdings, Crystalaid, Ferra, Nupress, Cablex, Lovitt and Levett have signed memorandums of agreement to be part of Boeing's advanced satellite manufacturing team.

The local suppliers will manufacture a wide variety of products from complex bus, payload and solar array composite structural assemblies to circuit card assemblies, harnesses and various mechanism and machine part assemblies, said JP9102 program manager Kathryn Burr, boosting Boeing's local satellite manufacturing capability. Additive manufacturing partnerships are already in place with RMIT and Titomic. Boeing's JP9102 Australian industry team also includes Saber Astronautics, Clearbox Systems, Leidos, ViaSat and the Indigenous Defence and Infrastructure Consortium.

Innovaero joins Defence Industry Security Program

INNOVAERO TECHNOLOGIES HAS been awarded membership to the Defence Industry Security Program (DISP). Membership will enable Innovaero to work on information and assets managed by the ADF, as well as Australian intelligence and law enforcement agencies.

Based in Kardinya, WA, Innovaero is a 100 percent Australian-owned aeronautical product design, certification and manufacturing company, with clients in Australia and the United States.

DISP certification opens a wide variety of opportunities for Innovaero, which the company has begun exploring with the Commonwealth and defence primes.

Local firms to develop C-130J armour

THE COMMONWEALTH HAS awarded Aerospace & Mechanical Consulting Engineers, in partnership with Armor Composite Engineering, a $2.13 million contract to continue development of unique lightweight armour for Defence's C-130J Hercules airlifter.

Aerospace & Mechanical Consulting Engineers director John Eldridge said the new contract would enable the small businesses to expand their armour production footprint within Australia and allied countries.

Source: Defence Connect

LOYAL WINGMAN NAMED GHOST BAT

IN MARCH, BOEING'S AIRPOWER TEAMING SYSTEM, or Loyal Wingman, was formally named the MQ-28A Ghost Bat at a ceremony at RAAF Base Amberley, during which the second prototype, PRV-002, a flight test vehicle, was seen in public with a sensor payload for the first time.

A variety of payloads will be carried in the MQ-28A's reconfigurable nose. Director Boeing Airpower Teaming System Glen Ferguson said mission payload configurations were in the ground test phase, and he expected aircraft to be in production by the middle of the decade.

Head of Air Force Capability, Air Vice-Marshal Robert Denney said the introduction of the Air Teaming System into Air Force service would provide a highly advanced capability for Australia. "No other nation has developed a teaming air capability, but with this aircraft we are well on our way to producing one; an operational system that can deliver a unique capability for our defence force."

AVM Denney said mission sets envisaged for Ghost Bat included intelligence, surveillance and reconnaissance, air-to-air and air-to-ground combat roles.

Former Defence Minister Peter Dutton said the government would commit more money to the program [beyond the $155 million it is already spending] but did not reveal how many platforms it would require. "But there is great utility in having scale and being able to launch an aircraft like this, because it complements what we're doing with our fast jets and our other assets," he said. "I think it makes that a huge success story now and into the future."

Source: Australian Defence

BAE Systems appoints new Australia CEO

AMID KEY CHANGES to the global company's leadership team, BAE Systems Australia CEO Gabby Costigan has been promoted to group managing director of business development. Her successor will be UK chief technology officer Ben Hudson.

A veteran of the Australian Army, Hudson has extensive international defence-sector experience and has developed, delivered and supported complex systems for customers across Australasia, the Asia Pacific, the Middle East, Europe and North America. Prior to joining BAE Systems, he led the global vehicle systems portfolio for Rheinmetall, based in Germany, held senior roles with General Dynamics, based in Switzerland and served as an Officer in the Australian Army, including active service in East Timor. Hudson is a dual Australian and British national with a degree in Mechanical Engineering and holds an MBA from London Business School.

Source: Defence Connect

SKYGUARDIAN AXED

DEFENCE HAS CONFIRMED the scrapping of the AIR 7003 Phase 1 project to deliver long-range, remotely piloted intelligence, surveillance and reconnaissance and strike capability to the RAAF.

The $1.3 billion program was to deliver General Atomics-built MQ-9B SkyGuardian armed medium altitude long endurance remotely piloted aircraft systems. The government had already spent approximately $10 million on the program, which secured approval for up to 12 aircraft from the US State Department in April last year.

A Defence spokesperson said SkyGuardian had been scrapped following advice from Defence officials; government deciding to reallocate funds for Project REDSPICE (Resilience, Effects, Defence, Space, Intelligence, Cyber and Enablers) – a $9.9 billion investment over the next decade in the Australian Signals Directorate.

Source: Defence Connect

Victorian firm wins US Poseidon contract

THE US NAVY (USN) has awarded a US$2.46 million ($3.4 million) contract to Victorian manufacturing firm AirFab for the delivery of 22 specialised wide-band satellite telecommunications system work stands designed to provide technicians safe access to the P-8A Poseidon wide-band satellite communication station and conduct fuselage inspections without overextending. AirFab developed the work stands in collaboration with the RAAF and the USN.

The materials used in the stands are Australian made, with the steel and aluminium sourced from local manufacturers.

P-8A Poseidon.

Dual-nation FIGHTER JET SENSOR PROJECT

THE UK AND JAPAN have signed a letter of agreement to research a new sensor system for fighter jets to enable enhanced threat detection capabilities.

Initial reports explain that the radio emissions sensor, dubbed Jaguar, will be designed to enable military actors to better identify threats across all domains, through enhanced target location and "denying surveillance technology operated by our adversaries".

Developed as part of the UK Government's Combat Air Strategy, the five-year project is expected to create 75 jobs. It will be managed under the guidance of Leonardo UK and the Japanese defence industry.

Source: Defence Connect

HANWHA TO BUILD AT AVALON

HANWHA DEFENSE AUSTRALIA (HAD) is building a $170 million Armoured Vehicle Centre of Excellence at Avalon Airport, Victoria. The 32,000 square metre facility will be built on land leased from logistics company Linfox at the airport's industrial precinct. HDA will fulfill the initial $1 billion LAND 8116 Phase 1 contract announced in December, to build 30 Self-Propelled Howitzers, 15 Armoured Ammunition Resupply Vehicles, and weapon-locating radars for the Australian Army.

Hanwha, South Korea's biggest defence contractor, is also among the final two contenders for the Land 400 Phase 2 program to deliver 450 fighting vehicles.

Source: AuManufacturing

ABOVE Artist impression of Hanwha Australian facilities.

ABOVE K-TIG team.

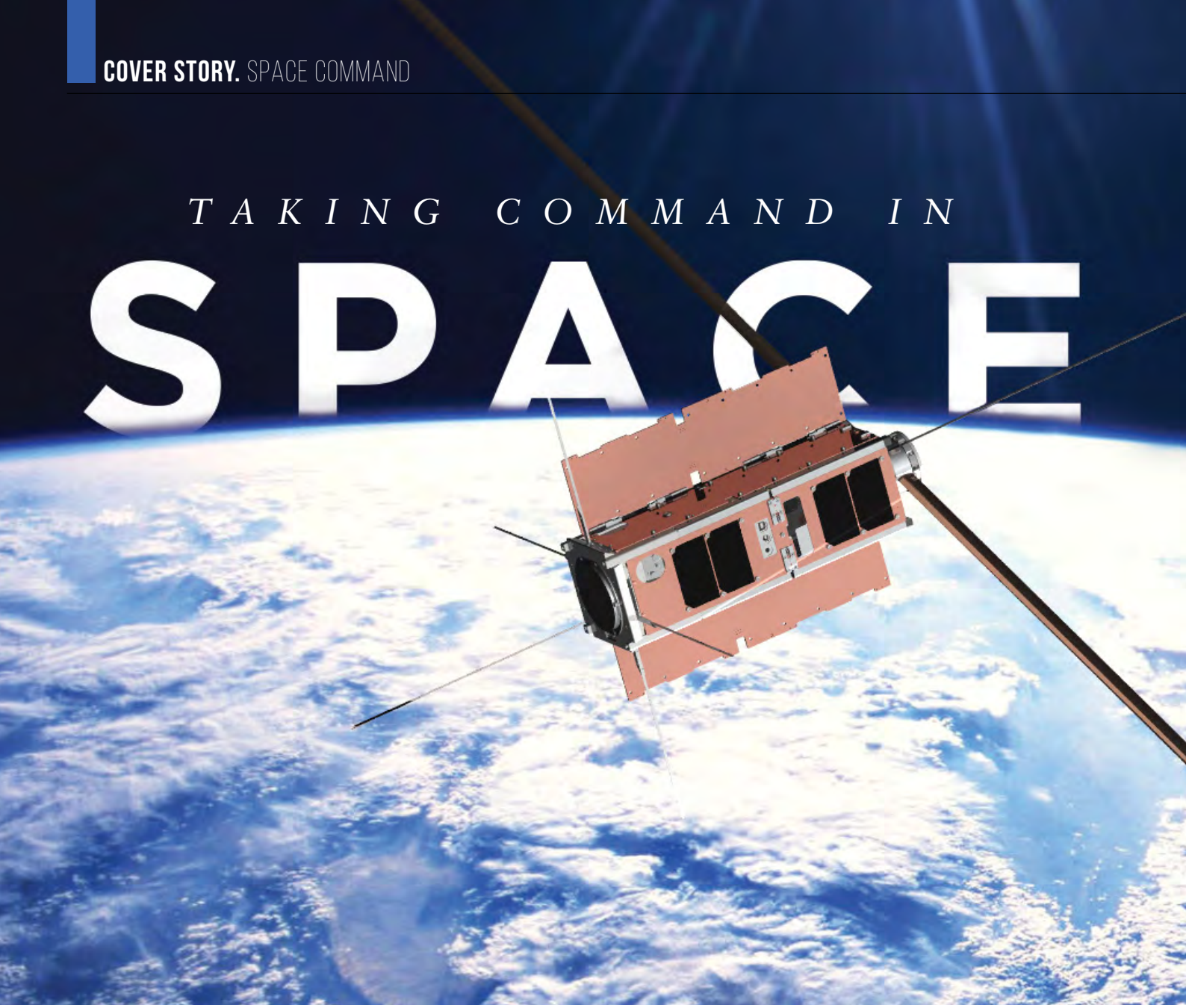
Robotic welder enters Factory of the Future

WELDING MANUFACTURER K-TIG plans to build a research and development facility within BAE Systems Maritime Australia and Flinders University's Factory of the Future, where it hopes to expand its robotic welding capabilities.

K-TIG managing director Adrian Smith said the facility in Adelaide's Tonsley Innovation District would support Australia's domestic shipbuilding capacity and the development of local industry.

BAE Systems Australia Continuous Naval Shipbuilding Director Sharon Wilson said the project had enormous potential. "What K-TIG provides has the potential to deliver game-changing technologies to the broader industrial sector, making industry more competitive and this could see flow on benefits for exports," she said.

TAKING COMMAND IN SPACE



FOLLOWING THE LAUNCH OF DEFENCE SPACE COMMAND, WE SPOKE WITH THE INAUGURAL SPACE COMMANDER, **AIR VICE-MARSHAL CATHERINE ROBERTS,** ABOUT THIS IMPORTANT MILESTONE AND AUSTRALIA'S ADVANTAGES IN THE SPACE DOMAIN.

ABOVE Lunch-box sized satellite (CubeSat) for the Buccaneer and Biarri space missions.

RIGHT Air Vice-Marshal Cath Roberts holds an engineering model of the M2 CubeSat at UNSW Canberra. Photo: SGT Oliver Carter.

IT'S HARD TO OVERESTIMATE how much of our daily lives are reliant on space – from our mobile phones to the internet, GPS to traffic management – entire systems and cities are reliant on space communications.

Losing access to space would completely change life as we know it. It would have significant consequences for our military, whose forces rely on space for communications, intelligence and navigation.

As the ultimate high ground, space is critical to the warfighting effectiveness of Defence. A threat to our access to space is a threat to the national security of Australia. With that in mind, it's easy to understand why in 2020, the Defence Strategic

Update created the 'space domain' as an operational environment in its own right, alongside the longer existing domains of air, maritime, land and cyber.

The Australian Government has also committed about $7 billion over the next 10 years to significantly increase Defence's space capabilities and assure Australia's continued access to space, space services and geospatial information.

DEFENCE SPACE COMMAND

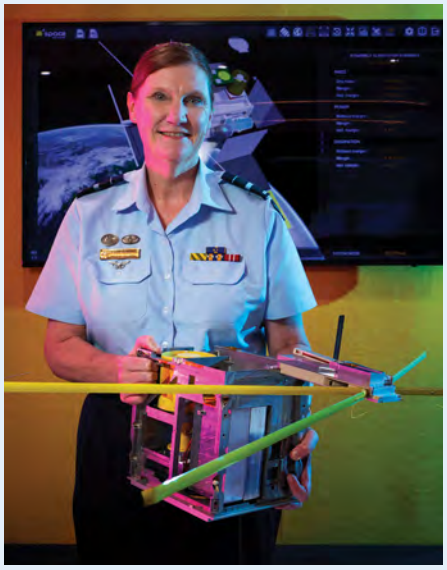
Central to its strategy, Defence launched Space Command in March 2022 as a single organisation to coordinate and manage its endeavours in space. The new Defence Space Command brings together members of Navy, Army, Air Force, the Australian Public Service and contractors under an integrated headquarters hosted within Air Force. Chief of Air Force, Air Marshal Mel Hupfeld has been designated as the lead for the space domain in addition to the air domain. He is responsible for coordinating Defence's space activities and the overall integration of space effects. That includes policy, space control, space services and technology, and stakeholder engagement with whole of government agencies, such as the Australian Space Agency, and industry.

Defence Space Command, led by Air Vice-Marshal Catherine Roberts, the inaugural Space Commander, will assure Australia's access to space to defend Australia and our national interests.

"I am honoured to lead Defence's mission in space," Air Vice-Marshal Roberts says. "It has been a lifelong aspiration for me."

Air Vice-Marshal Roberts traces her space aspirations back to watching Neil Armstrong climb down the ladder of the lunar lander on 21 July 1969 when she was just three years old. She grew up to be one of the first 10 women to study aerospace engineering at the Royal Melbourne Institute of Technology and has had a prosperous 35-year career in the Air Force, gaining plentiful experience to set her up for her new role.

"I look forward to working with local and international partners and bringing the very best of Australian space smarts to defend our nation," she says.



ABOVE Air Surveillance Operators from No.1 Remote Sensor Unit at the Air Force's Space Surveillance Telescope in Western Australia. From left: Flight Sergeant Peter Merritt, Sergeant Emma Barker, Leading Aircraftwoman Amy Clements and Leading Aircraftman Corey Tuddenham. Photo: Department of Defence.

PEOPLE POWER

As Space Commander, Air Vice-Marshal Roberts feels Australia has three key advantages in the space domain – firstly its people.

"Australians are characterised by an inventive spirit," she says. "We have an incredible pool of smart people to draw upon, and there is enormous opportunity to bolster local capability."

One of the goals for the new command is to be agile – sharing people talent across the ADF and between departments, industry and academia.

Air Vice-Marshal Roberts cites a great example of local inventiveness and collaboration as the M2 CubeSat mission launch that she oversaw in March 2021. It is Australia's most complex CubeSat mission to date, with the satellite splitting into two distinct CubeSats and orbiting in formation.

The CubeSat was almost entirely designed and built in Australia in a collaboration between Air Force, University of NSW Canberra Space, and a domestic supply chain of about 30 Australian companies.

"The amount of capability squeezed into these artificial-intelligence-enabled satellites is amazing. One of the payloads contained the first neuromorphic [processors that mimic neuro-biological architecture of the human nervous system] sensor to be placed into orbit, developed by Western Sydney University's International Centre for Neuromorphic Systems," she says.

"The M2 allows small satellites to be used for evaluation of technologies that may eventually be placed onto more complex space systems.

"Space is very much a team game. To do things that have never been done before requires people who are excited by stretching boundaries, exploring the unknown and doing things differently."

LAND DOWN UNDER

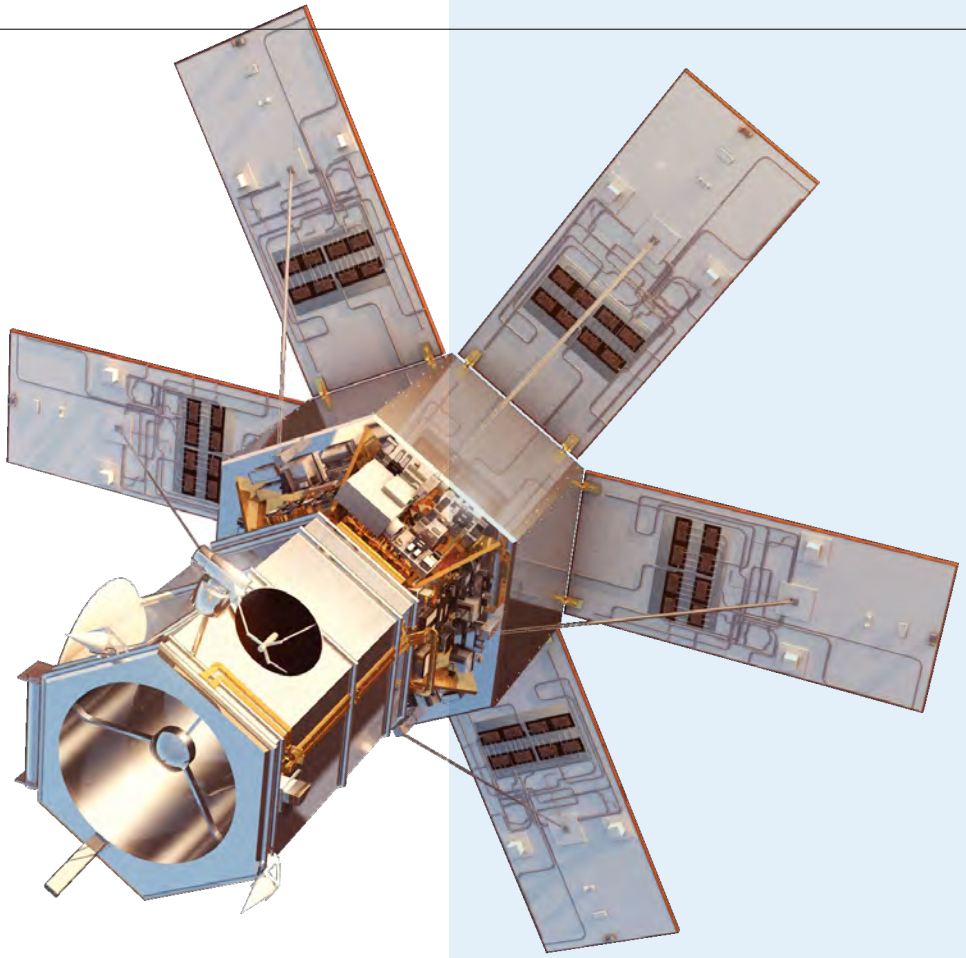
The second key advantage that the new Space Commander sees is Australia's geographical location in the Southern Hemisphere. "Our vast open land and our weather allows us to host infrastructure that support all space mission areas," she says.

For example, the Space Surveillance Telescope at Exmouth, WA, is a world-leading, 360-degree telescope that enables Defence to better track and identify objects and threats in space, including space debris, as well as predict and avoid potential collisions.

"In partnership with our allies and international partners, we must protect billions of dollars' worth of commercial and military assets against space debris, collisions and destructive acts," the Space Commander says.

"Space is becoming more congested and contested. Over 6,000 satellites are orbiting the Earth, and thousands more are being launched every year. The recent destruction of a Russian satellite generated a significant debris field in low-Earth orbit that will remain a threat to both satellites and astronauts for years."

Investing in Australian controlled space capabilities is a strategic focus of the new Defence Space Command. "We are enhancing our sovereign controlled capabilities so that Australia has the ability to see what we need to see, communicate over satellites, and generate space control effects more



TOP Artist's impression of WorldView-4 satellite.

ABOVE Electro Optic Systems (EOS) Mechanical Engineer Rita Tri operating in the EOS control room at Mount Stromlo Observatory, Canberra. Photo: LAC Adam Abela.

ABOVE The Australian Defence Force owned Wideband Global Satellite 6, a United Launch Alliance Delta 4 rocket and its military communications satellite payload ready for launch. Photo: Spaceftigtht Now/Justin Ray.

independently. That will change our paradigm from being a space consumer to being an active contributor to combined space operations."

The Exmouth telescope will also become an important part of the global Space Surveillance Network that provides space domain awareness to both Australia and the United States. Just as the Honeysuckle Creek station near Canberra famously received the inspiring images of Neil Armstrong walking on the moon in 1969, the Exmouth telescope allows Australia to capture unique imagery that it can share with international partners, such as the US, to give critical 24-hour coverage for important missions.

SPECIAL RELATIONSHIPS

It's those international partnerships and Australia's place in the international space community as a responsible space actor that Air Vice-Marshal Roberts identifies as Australia's third key advantage in the space domain.

"We are a participant of the Combined Space Operations [CSpO] initiative," she says. "It aims to improve information sharing on space and recognises that collaboration on space is a key force multiplier for all the countries involved."

Under a common vision, the nations (including Australia, Canada, France, Germany, New Zealand, the United Kingdom and the United States) have agreed on guiding principles and lines of effort to improve combined military space operations, foster cooperation and coordination and to collectively promote responsible behaviour in space.

"Beyond CSpO, we have significant scientific and technology and industry partnerships and have been partnering in satellite communications for decades," says Air Vice-Marshal Roberts.

"Australia needs to rapidly develop capabilities for our space future and we can't do it alone. It is critical that we are able to effectively leverage our partners' expertise into the very best space capability by working closer together with Defence, industry, academia and international partners.

"While technologies and systems are important, they are only part of what enables the delivery of space power. Our people and partners will bring the curiosity and creativity required to conceive the space power that we will need to meet future challenges.

"I am proud to be selected to lead Defence's mission in space. Together we will reach for the stars to protect Australia – our freedom, our values and our way of life."

ABOVE LEFT Service Attachés and Advisor's Group Engagement Program members at the Australian Space Discovery Centre, Adelaide. Photo: LAC Sam Price.

LEFT United States Air Force C-Band Radar AN/FPS-34 IS used to track satellites.

LOCAL SATELLITE PRODUCTION

MORE THAN $70 MILLION HAS BEEN ALLOCATED TO CREATE A DEVELOPMENT AND MANUFACTURING SITE FOR LARGER EARTH OBSERVATION SATELLITES.

A MANUFACTURING HUB for larger Earth observation satellites weighing up to 500kg will be established in NSW through a $71 million investment and collaboration between Electro Optic Systems (EOS), Nova Systems, University of Technology (UTS) Tech Lab, Gilmour Space, and the Federal and NSW governments.

The 2022-23 Federal Budget included $1.16 billion to 2038-39 and $38.5 million per annum ongoing for the first phase of a National Space Mission for Earth Observation, which would see Australia design, build and operate four new satellites. The Australian Satellite Manufacturing Hub (ASMH) will be a vital part of that mission. Located at the South Jerrabomberra Regional Jobs Precinct and the UTS Tech Lab, Sydney, it will provide secure facilities to enable research and development collaboration between industry, leading Australian universities and the CSIRO, as well as facilitate the design, prototype development, manufacture, integration and validation test of large satellites and payloads.

NSW Minister for Enterprise, Investment and Trade Stuart Ayres said: "The project will enhance our manufacturing capabilities, drive commercialisation of space R&D [research and development] and act as a catalyst for investment in priority space and defence sectors."

EOS Space Systems CEO Glen Tindall said the collaborative manufacturing capability would fill recognised gaps in Australia's current space manufacturing landscape "by enabling the local development of large, high-quality, reliable spacecraft and optical payloads that are capable of fulfilling complex missions which deliver national economic benefit".

Nova Systems CEO Jim McDowell added: "The Australian Satellite Manufacturing Hub will drive a nationwide approach to developing Australia's space qualified ecosystem and will see the assembly and integration of larger satellites, space vehicles and components."

The ASMH will establish a presence at the UTS Tech Lab facility, adjacent to the Sydney Innovation and Technology Precinct in Botany, and UTS Vice Chancellor Andrew Parfitt said the university was committed to growing opportunities in the space sector for Australia, NSW and partners across industry and research.

"UTS Tech Lab will play a vital role in the research and development of

SPACE MISSION

The National Space Mission for Earth Observation will be led by the Australian Space Agency in partnership with the CSIRO, Geoscience Australia, the Bureau of Meteorology and Department of Defence.

Australia has been supporting international space missions for more than 60 years and has a strong track record in Earth observation, which plays a vital role in forecasting weather, responding to natural disasters and managing the environment.

CSIRO Chief Executive Dr Larry Marshall said the new program would exploit Australia's natural advantage. "Our southern hemisphere location and natural diversity including forests, deserts, and coastal areas, means we're ideally placed to establish a world-leading satellite calibration and validation ground station network," he said.

"Through the new suite of satellites, we will further develop the nation's sovereign satellite capability, improving our ability to respond to seemingly impossible challenges."

cutting-edge satellite technologies as well as in the fostering of deep university-industry collaboration," he said.

As well as building a domestic satellite manufacturing capability and developing a skilled workforce to support the space sector, the ASMH will address key opportunity areas identified in the Space National Manufacturing Priority Road Map, such as nano and small satellite development, propellants and fuels, payload design, sensors, solar panels, structural components, optics, new space related technologies and materials, optical wireless communication technologies and key ground segment subsystems.

LEFT NASA satellite image.

INSET From left: Glen Tindall, CEO, EOS Space Systems; NSW Senator Jim Molan; former Minister for Industry, Energy and Emissions Reduction Angus Taylor, Liberal candidate for Eden-Monaro Dr Jerry Nockles, Director Defence NSW, Investment NSW Mike Gallagher, Managing Director, Nova Systems Australia and New Zealand Adam Smith.

SATELLITE PARTNERS

ELECTRO OPTIC SYSTEMS (EOS) OPERATES IN TWO DIVISIONS:

Defence Systems specialises in technology for weapon systems optimisation and integration, as well as intelligence, surveillance and reconnaissance, and command, control, communications and computer (C4) systems for land warfare. **Space Systems** includes all EOS space and communications businesses and operates as three entities: SpaceLink, EM Solutions and Space Technologies. SpaceLink is developing a constellation of medium Earth orbit satellites to create the communications superhighway for the space economy. EM Solutions provides global satellite communications services and systems. Space Technologies specialises in applying EOS-developed optical sensors to detect, track, classify and characterise objects in space.

NOVA SYSTEMS is an Australian-owned and controlled engineering services and technology solutions company. It delivers specialist systems engineering advisory and management services alongside advanced digital technology, software and systems integration solutions. Nova Systems has been involved in the Australian space environment through Defence for some time, and earlier this year it opened a new satellite ground station facility at Peterborough, Southern Australia.

UTS TECH LAB is a collaborative research facility that co-locates large-scale engineering infrastructure with specialist laboratories dedicated to communications, sensor development and computer sciences, including data analytics and artificial intelligence. Industry partners can access experts, labs and specialist equipment, funding opportunities, student talent and office space in the expanding precinct in Botany.

TIME
A QUANTUM LEAP IN TIME

PHYSICISTS ARE WORKING WITH QUANTUM TIME TRANSFER TECHNOLOGY TO DEVELOP AN INCREDIBLY ACCURATE AND SECURE CLOCK THAT MAY PROVE VITAL FOR DEFENCE.

DEFENCE PHYSICISTS DR BEN SPARKES AND NICOLE YUEN are developing an unimaginably accurate timing network, using quantum time transfer technology. They recently demonstrated the ability to transmit and receive a stream of correlated photons (pairs of photons separated by an infinitesimal 10^{13} seconds, one ten trillionth of a second) down a dark tunnel at Defence Science and Technology Group (DSTG) Edinburgh, SA. Nicole is now designing optics that will entangle the photons, creating a highly secure timing system for Defence. More on entanglement later, but why build an alternative to the existing GPS timing system?

The Global Positioning System (GPS) has been widely available for decades and Defence operations have evolved a deep reliance on the precision position and timing signals it provides. Access to GPS is critical for navigation, battle-field manoeuvre, precision guided munitions, widespread force coordination and secure communication networks. However, in a contested environment, GPS signals are subject to jamming and spoofing by adversary forces. While jamming can be detected and corrective action taken, spoofing, in the form of covertly broadcasting GPS-like timing signals to fool receivers into reporting deliberately false position, navigation and timing (PNT) information, is very difficult to detect. Hence, Defence's desire to create a sovereign, assured and locally deployed PNT system.

PRINCIPLE PROVEN

"We recently demonstrated the transmission of a stream of a million pairs of correlated photons per second over 100 metres," Ben says. "Our aim is to use those photons to measure time at better accuracy than the existing GPS system. We'll also continue injecting noise and losses to see how well the system can perform in degraded environments. We've already demonstrated that the system continues to work with five hundred times more background photons than correlated photons."

According to Ben, the duo recently demonstrated operations at 100 picosecond (one trillionth of a second) timing, which is an order of magnitude better than satellite GPS. It's a great first step, and they're now aiming for longer transmission range, a dynamic source and receiver and with more degraded environments.

"Our proof-of-principle trials indicate that quantum time-transfer should be robust against significant integrity loss and jamming," Ben says. "The beauty of the technology is we can tailor it to meet Defence's communications or navigation system requirements. Our eventual system, using entangled photons, will be 100 percent secure (in cyber terms what's known as 'unspoofable') in that fake time signals will be recognised thanks to the laws of physics. Such a link could be jammed by saturating the receiver, but if the link is receiving entangled photons correctly then physics guarantees what it is saying is correct."

DSTG has a significant quantum technology program with most of its quantum technology researchers embedded in university teams around Australia. Ben and Nicole spend a portion of their time at the University of Adelaide's Institute for Photonics and Advanced Sensors.

WHAT IS ENTANGLEMENT?

Nicole is now charged with wrangling, and entangling, photons. She explains that entanglement starts with a laser generating a stream of photons. The next important piece of the puzzle is a non-linear crystal.

"You fire the laser through the crystal,

LEFT
Defence physicists Dr Ben Sparkes and Nicole Yuen.

BELOW
Ben working in the lab.

and the photons split up and become polarised in a correlated way – they have opposite polarisations (one horizontal and one vertical)," she explains.

Combining mirrors and other optics in specific orientations creates a triangular optical path around the crystal before bouncing the correlated photons through in two directions.

"That's where entanglement takes place," says Nicole. "Without the entangling step, all you'd have is a beam of vertically polarised photons and a second beam of horizontally polarised photons. As Ben describes it, we destroy the 'which way' information. We don't know if a photon in the left beam is vertically or horizontally polarised. All we know is that its partner in the right beam has the opposite polarisation."

Ben adds: "You can use that quantum time transfer foundation to create secret keys, which is what quantum cryptography relies on. In effect, quantum cryptography comes for no added cost with a quantum time transfer system. As long as you build the source correctly, and that's Nicole's challenge at the moment."

END GOAL FOR DEFENCE

Ben and Nicole are collaborating with Adelaide-based QuantX Labs (formerly Cryoclock), maker of the world's most accurate clock, accurate to within a second over 40 million years. QuantX's ruby sapphire clock is currently being used to improve Defence's Jindalee Operational Radar Network system.

"Our aim is to synchronise two of those QuantX clocks so they're ticking at exactly the same time," Ben explains. "Moving forward, our aim is to develop an end-to-end quantum-secure time-transfer system that synchronises drone-deployable miniature atomic clocks (which suffer from long-term drift) to ultra-precise ground station clocks. Using free-space optical communication channels, we aim to connect a multitude of Defence assets by transforming cubeSats, uncrewed aerial vehicles and drones into the nodes of a Defence secure quantum timing and position network."

The research supports Defence's Quantum Assured PNT STaR Shot, which aims to ensure that the ADF and its coalition partners can operate in complex and contested environments with uninterrupted access to position, navigation and timing information. More information about Defence's STaR Shots can be found at dst.defence.gov.au/strategy/star-shots.

AIR TRAFFIC CONTROL FOR SPACE

LATE LAST YEAR, DSTG ORBITAL SPACE ANALYST ROSLYN LAU TOOK PART IN AN INTERNATIONAL TRAINING EVENT TESTING THE LATEST TOOLS THAT WILL HELP DEFENCE PROTECT AND DEFEND SPACE ASSETS.

IN 2019, A NEW INTERNATIONAL EXPERIMENTATION SERIES called Commercial Sprint Advanced Concept Training (SACT) began as an innovation and collaboration testbed for advancing aspects of space operations.

SACT is a week-long event coordinated by the United States Space Force, held three or four times each year to test the combat readiness of its space force organisation and capabilities. The exercise uses simulated and live data from real-world, commercial and defence sensors to monitor objects in space. SACT also includes a civil space component that allows military members to practise working with civilian and commercial space operators.

Australia leads the space monitoring cell for the Pacific region as part of the SACT exercise. Combined with the Meridian (European) cell and the Americas cell, the three cells each participate for eight hours to enable 24 hour/day operations.

During a SACT exercise, participants in the relevant control centre conduct civil space monitoring activities while receiving additional surveillance requests from military teams. Commercial sensor networks located around the world and in space are tasked to track specific objects, and changes to orbiting satellites are analysed. Sensor data is compared with known and expected satellite positions, and the expected manoeuvres of live spacecraft.

Last November, Defence orbital space analyst Roslyn Lau took part in SACT 22-1 in the Australian operations centre at the Lot 14 space industry hub in the Adelaide CBD.

Roslyn works with DSTG, where one of her team's research focuses is space domain awareness and space control. It's closely aligned with Defence's Space Control Program, including Defence's JP 9360 project which is pursuing an expanded space domain awareness capability facilitated via commercial ground and space-based space surveillance systems.

"For a space domain awareness system, you use all your sensors to try to find 'resident space objects' such as satellites and space debris," says Roslyn. "It's like an air traffic control system for space. Safety of flight and space traffic management aspects are likely to become civilian tasks. We are working on the Defence aspects, including decision-making and 'protect and defend' protocols. We want to ensure our equipment up there is protected and defended, and that means helping ensure Defence has the right sensor suite to monitor space.

"During SACT 22-1, I worked with the Saber Astronautics team in the Pacific mission control centre. My job was to help fuse the information from participating sensor data feeds and use apps to develop and visualise intelligence."

Roslyn says the eight-hour shifts were intense. "You definitely get an adrenaline rush because you don't want to let your local team down," she says. "At the end of the shift you have half an hour to hand over your results to the Europeans, so you don't want to let them down either. We're experimenting with different handover techniques."

According to Roslyn, the SACT exercises are a win-win experience. For Defence, it's a five-day trial of the latest tools. "There are lots of industry players developing new products, so every three months we get to see new capabilities and how much things have grown, which is great. For industry, it's a chance to work together and demonstrate their wares and capabilities to Defence, in a real-world scenario with real data."

Just days before Roslyn's SACT exercise, a Russian missile blew up a derelict Soviet surveillance satellite dating from the 1980s. *US Air Force* magazine reported that the two-and-a-half-ton Cosmos 1408 satellite burst into pieces, spreading a cloud of 1,500 trackable pieces of space junk into low-Earth orbit, plus hundreds of thousands more specks too small to track. Roslyn says the debris was rapidly spreading out during the SACT event, with the fragments morphing from a banana-shaped debris field into an orbiting circle much like a ring of Saturn. The debris field will spread and remain a danger to other objects, including crewed spacecraft, for years, perhaps decades, to come.

"Especially with the Cosmos breakup, Australia is paying a lot more attention to space," Roslyn says. "Our role helping Defence to protect and defend space assets will only become more important."

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AERIAL BALLET

FORMER RAAF PILOT **DAVID ROBSON** SHARES A PERSONAL REFLECTION ON FLYING AEROBATICS IN UNMODIFIED SUPERSONIC MIRAGE III FIGHTERS FOR THE AIR FORCE'S GOLDEN JUBILEE.

LAST YEAR MARKED THE centenary of the Royal Australian Air Force and the occasion was celebrated accordingly. But there was also much celebration when the RAAF turned 50 in 1971. Two aerobatic teams were formed to celebrate the Golden Jubilee, including a unique team of front-line fighters named the Deltas.

In late 1970, The Roulettes aerobatic team, flying Macchi MB-326 aircraft, was formed by Training Command at East Sale, Victoria to celebrate the Jubilee. Not to be outdone, the Air Officer Commanding Operational Command at the time, Air Commodore 'Bay' Adams, commissioned No.77 Squadron to form an aerobatic team of Mirage fighter aircraft.

The five months from the end of 1970 to early 1971 was a spectacular period for the squadron, tasked to form an aerobatic display team to showcase the Air Force to the nation. I was most fortunate to be a member of the squadron at that time.

BEGINNINGS

Tasked to commence training in November 1970, we started the routine workup with the lead aircraft rehearsing and developing a solo sequence, bearing in mind that four-plus aircraft must be able to hang off the leader's wing throughout the sequence.

At the same time, the wingmen started practising at a safe altitude by following each other through steep turns, turn reversals and, eventually, barrel rolls and loops in line-astern then echelon. After training as a pair, we added the third aircraft, then the fourth – then the fifth.

Like individual musicians in an orchestra or players in a football team, each pilot seemed to settle best into a particular position and role within the team. We then fixed the positions for the tour and our aircraft became our individual mounts. The final 'symphony' itself became a complex series of formation manoeuvres and changes with the solo aircraft passing in synchronised harmony (a true *pas de deux*). The total team performance extended to 20 minutes of pure aerial ballet – with dramatic sound effects from seven afterburners in full song.

The initial concept had been for a standard team of four aircraft. We realised, and persuaded Operational Command, of the need for a solo. The Mirage needed much sky to perform its manoeuvres and therefore a solo aircraft was needed to fill in the time gaps and to always have an aircraft in front of the crowd. The formations for a team of four aircraft were limited (Card Four and Diamond Four) so we argued for a fifth aircraft (to add Vic, Goose and Card Five). The solo joined the team for a Delta formation of six. However, something was missing. We wanted a little more excitement for the crowd – low and fast, head-on passes. Thus, we added a second solo aircraft for some exciting cross-over manoeuvres. It was to be a unique team for a unique occasion – and we wanted it to be done professionally while at the same time, hold the public's attention.

I believe we were the first team in the world to use unmodified supersonic fighters.

For a formation aerobatic display, the Mirage was unforgettable. The rate-of-roll, thrust, field-of-view and precision that was available to the fighter pilot, was unmatched. The aeroplane was easy to fly and very stable. The team was well rehearsed and well chosen. The routine was well practised. Yes, the Mirage was easy to fly. The incredible machine wrapped its pilot like a glove – the same as in a Formula One racing car – and gave him the power and confidence to express any manoeuvre. However, fuel was limited, and the tailless delta had enormous induced drag at high angles of attack – which is where the team spent most of its time. Thrust and fuel management became second nature.

THE TEAM

The Delta pilots and ground staff were 'normal' 77SQN fighter pilots, equipment personnel and maintenance staff temporarily diverted from routine squadron operational training exercises for the period of the team's existence. The average age of the pilots was under 26 and most had prior operational experience in Malaysia, Singapore and Thailand. Bill Simmonds flew Meteors in Korea and was credited with a MiG kill. I served in Southeast Asia and in Vietnam as a Forward Air Controller (FAC). Chris Mirow served in Vietnam as a FAC after his tour with the Deltas.

The flying team comprised: Delta 1, Squadron Leader Bruce Grayson; Delta 2, Flight Lieutenant John Archer; Delta 3, Flying Officer Chris Mirow; Delta 4, Flying Officer Alf Allen; Delta 5, Flight Lieutenant Nick Ford. Solo 1, our Commanding Officer, Wing Commander Bill Simmonds; Solo 2, myself (Flight Lieutenant Dave Robson); and Delta 6, Flight Lieutenant Jack Smith (display opening and ferry pilot).

The ground component was: team manager and commentator, Squadron Leader Hugh Collits; team engineer, Squadron Leader Pete Watson; equipment officer, Flying Officer Garth Buick; and Flight-Line WOE, Warrant Officer Ron Easton.

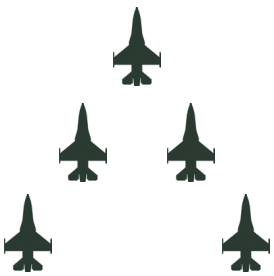
RAAF DISPLAYS

Displays were held at RAAF Bases Pearce, Edinburgh, Laverton, Canberra, Richmond, Amberley and Townsville. In addition to RAAF units, Allied air forces contributed to individual displays. There were F111s from the US Air Force, and Vulcans and Lightnings from the Royal Air Force (RAF). There was no official display at RAAF Williamtown and we felt the support personnel and their families deserved a treat, so we had our own Deltas display and an open day at No.77 Squadron. The Deltas were the last event on show day and we had a free rein of the airspace. The sound of seven Mirages was spectacular enough to keep the crowd engaged until the very end.

The final team manoeuvre was the

CARD FIVE

GOOSE



VIC FIVE

The Deltas flying team, from left, Chris Mirrow, Alf Allen, Hugh Collits, Bruce Grayson, Bill Simmonds, John Archer, Dave Robson and Nick Ford.

stunning horizontal bomb-burst through which the solos then spiralled upwards.

Support pilots under Jack Smith's direction ferried the aircraft when the display pilots were otherwise committed. Jack also opened the air shows with a low pass – very fast and very noisy, from behind the crowd line. It certainly caught their attention! His reflection on the Canberra display is interesting.

The high-speed show opener was intended to occur just before a large formation of helicopters, transport, maritime patrol, and training aircraft flying along the display line crossed our track at 90 degrees. My run in was delayed and required a 600 knot (100kph) sprint from Lake George to Fairbairn. I arrived from behind the spectators with no warning, a lot of noise and climbed into the blue on a perfect Canberra autumn day. I don't know how many heart attacks or premature births I may have caused as the Vic formation arrived at the same time.

In retrospect, I think it proves the adage that noise and speed go down well at an air show, as after our return when walking away from the aircraft, we were applauded by the crowd. I repeated this 'show opener' at RAAF Richmond on Sunday 4 April, only more sedately at 450 kts, this time being on time departing the initial point.

Canberra is nearly 2,000 feet above sea level and the runway was not long. It was a beautiful day in Canberra – quite warm. The team took off from the longer north-south runway, but the crowd was aligned to the shorter runway 12/30. The solos therefore rolled from that runway and hoped for overspeed which cut in just before lift-off. Overspeed provided an additional, but marginal, increase in thrust. The display was perfect, but Mount Ainslie was directly on the run-in path that I used to position for the crossovers. I will never forget the blurred faces of the crowd on the top of the viewing area as I accelerated past them below the top of the hill, at 600 knots plus, in full afterburner.

After shut-down and because the public was between the flight-line and the briefing office, the team had to

walk through the crowd. There was a spontaneous applause with many people seeking autographs.

RAAF Laverton was perhaps the best display. The Melbourne public did us proud, with an estimated crowd of more than 120,00 people. Cars were parked along every side of the base as well as filling the base car parks. The traffic took hours to clear after the show.

The runways at Laverton were too short for regular use by the Mirage and tarmac space was limited, so Avalon and Tullamarine were used. The Deltas had the unique opportunity to use Tullamarine airport before it had opened for commercial use. We were also hosted by the Travelodge when it first opened.

The display was begun from a seven aircraft Vic formation from which the solos would break off while the team positioned for the first run from behind the crowd. However, the solo aircraft had already consumed more fuel than the others, were now on the outside of the formation burning even more fuel before the display commenced, and the transit and start of the display was delayed by other air traffic.

As a result, as I pulled up to commence the final rapid vertical rolling climb, I reached minimum fuel. I was expecting the low-fuel state and knew I would be heading north for that final manoeuvre. I simply arced over from 8,000 feet towards Tullamarine, joined base turn and landed. I had five minutes of flight fuel left! Solo 1 was not far behind me. We waited at the holding point for the team to return and land.

The day after the show we headed back to Williamtown. On the way we rendezvoused with a RAF 617 Squadron Vulcan off the coast of Nowra and flew home – like a mother goose with its Delta chicks. We diverted via Sydney Harbour and along the coast to Williamtown.

At the Amberley show, we used the airborne start for the display from the Vic Seven formation. During the rehearsal, the Solos were asked to adjust the crossover point by 200 feet along the runway (at a closing speed of 2,000 feet per second that was a change of the crossover by one tenth of a second! We were getting good).

The final display was at Townsville after which the team was disbanded. It is difficult to explain our feelings at that point. The workload and excitement dropped enormously and were replaced with

disappointment. Yes, we would continue to fly training missions with the squadron, and we would progress in our careers but there was a sense of loss that we would never again fly that routine with that team in those aircraft.

The incredible success of the team was due to the tireless efforts of the support personnel.

The Deltas flew 331 aerobatic sorties, 328 hours and performed in front of more than three quarters of a million people. Seven front-line supersonic fighters working up in only five months and performing over crowds of more than 100,000 people at a time.

There is a bond that develops between fighter pilots who have shared such intense and unforgettable experiences. A bond also develops with your personal aircraft. A3-15 served me faithfully and without unserviceabilities throughout the tour. Our parting was sad indeed. Behind my mask and visor, I shed a tear. I later commissioned a portrait of her (see page 38).

David Robson served with No.77 Squadron and was one of the architects of the Deltas aerobatic team, designing the logo, aircraft colour scheme and, with other team members, the display sequence. He later became a Mirage test pilot, accruing over 1,000 hours on the Mirage. After 21 years in the RAAF, he transitioned to civilian life and was a flying instructor, author, designer and artist.

MAKING SMOKE

To generate the smoke trails used during the display, we used the gun bay fuel tank which could be isolated from the fuel system and selected on demand to provide smoke. The tank was filled with hydraulic fluid which vapourised in the tailpipe. A modification was developed which carried the liquid via an external tube to the tailpipe area.

That worked in dry thrust but disappeared in afterburner. A second tube was added and supplied a second slug of fluid when triggered by movement of the afterburner nozzle vanes on afterburner selection. The switch in the cockpit was extended so that the pilot could reach down and flick the smoke on or off without having to look inside.

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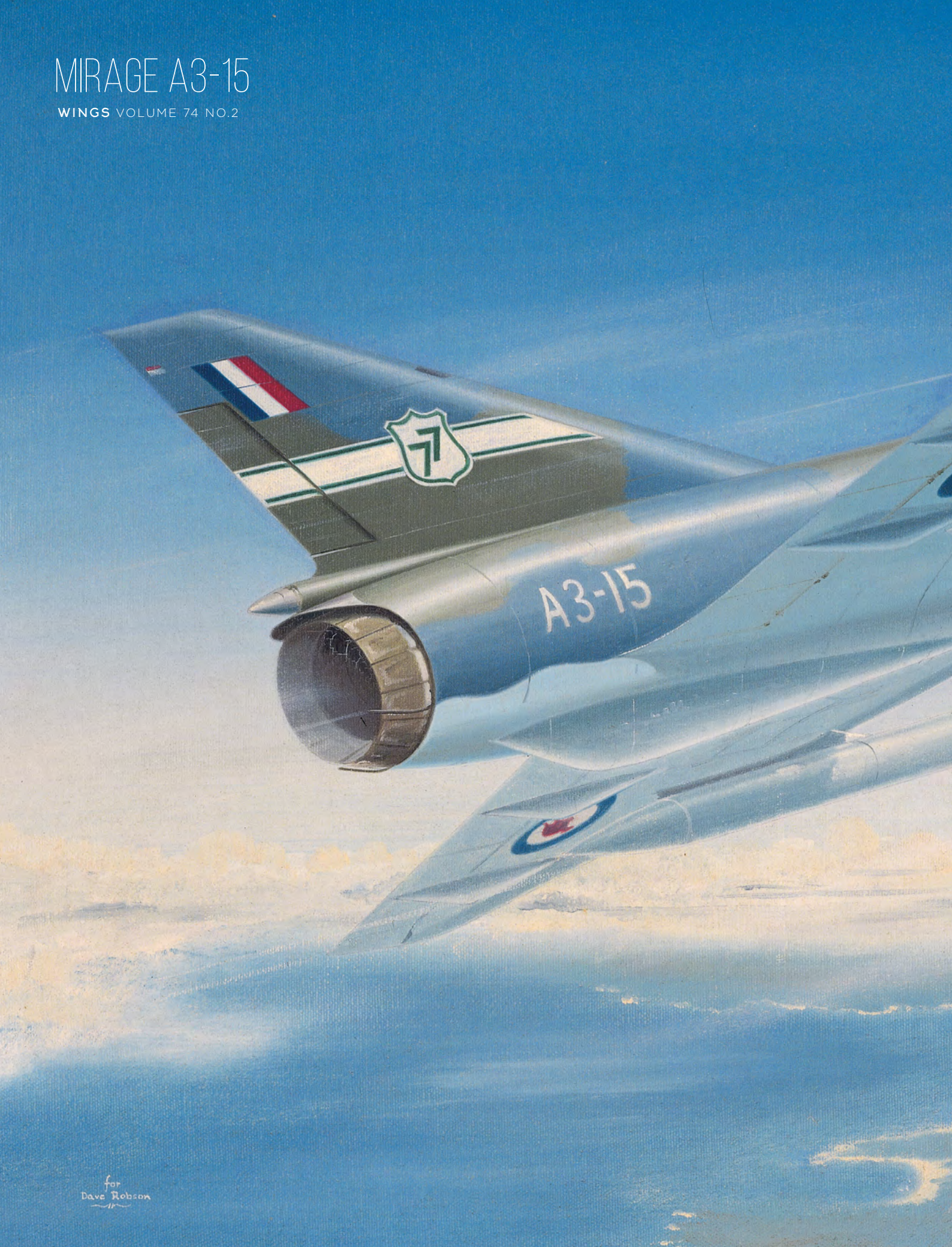
MIRAGE A3-15

WINGS VOLUME 74 NO.2



Mirage A3-15 flown by Flight Lieutenant David Robson, No.77 Squadron and The Deltas. Dave commissioned Chris Golds, a former RAF fighter pilot, to paint A3-15 from a composite of photos of the aircraft and the coastline off Williamtown, NSW; every RAAF fighter pilot will recognise the sand spit.

LIGHTNING STRIKES TWICE

CREATED MORE THAN 60 YEARS APART, TWO LOCKHEED FIGHTER AIRCRAFT EARNED THE NAME LIGHTNING.

ABOVE One of 13 YP-38 service test aircraft.

WORLD-CLASS FIGHTER AIRCRAFT have always demanded – and often spawned – cutting-edge technology. Two such aircraft from Lockheed are separated by more than 60 years. The unique P-38 Lightning predates both World War II and the 1943 birth of Lockheed's Skunk Works, while the F-35 Lightning II, which is now coming into RAAF service, originated soon after Lockheed's 1995 merger with Martin Marietta.

THE XP-38 AND YP-38 LIGHTNING

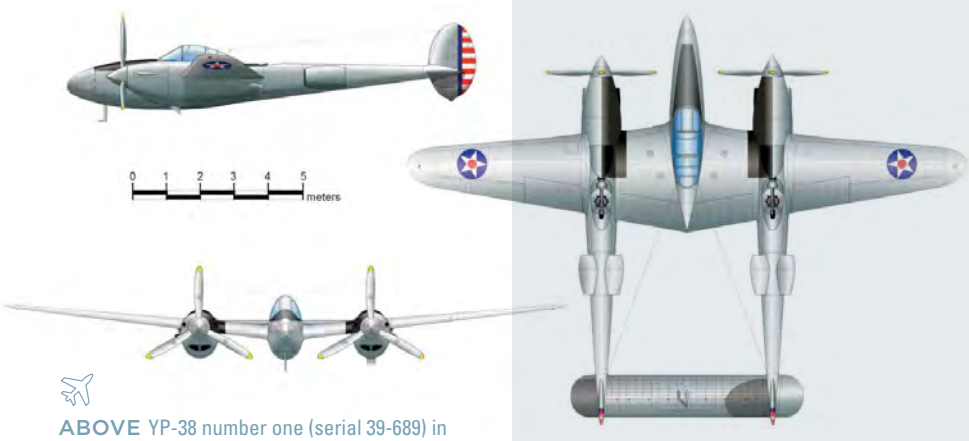
If hindsight is 20/20, then foresight must be all-seeing – or so it would seem when it came to the extraordinary vision of Lockheed vice president and chief engineer Hall Hibbard and chief research engineer 'Kelly' Johnson. Those two highly skilled personalities foresaw the creation of the perfect fit for the requirements of Circular Proposal X-608 (CP X-608) put forth in February 1937 by the US Army Air Corps (USAAC, renamed US Army Air Force in June 1941).

The proposal called for a twin-engine interceptor to pursue and destroy enemy aircraft at high altitude. It was to have a maximum level speed of at least 360 miles per hour (580kph) and the ability to reach an altitude of 20,000 feet within six minutes. Those unheard-of performance goals required the design of an advanced fighter in the truest sense.

For propulsion, Hibbard and Johnson settled on a pair of Allison 12-cylinder, water-cooled, V-1710C piston engines of 1,500 horsepower (emergency rating) each, with exhaust-driven turbosuperchargers and counter-rotating propellers. Next, Johnson drew up a number of configurations. The one that

BELOW Milo Burcham shows a new P-38 anti-compressibility dive flap to America's top fighter ace, Major Richard Bong (40 aerial victories). Those flaps were fitted to many P-38s from late 1943, allowing safe diving speeds of well over 500mph (800kph). Photo: Denny Lombard. LM.

ABOVE P-38 cockpit, in this case a P-38G. The control yoke with 'wheel' design was a departure from the usual fighter control stick.



ABOVE YP-38 number one (serial 39-689) in three-view. In November 1941, 689's tail unit broke away during a high-speed dive, killing Lockheed test pilot Ralph Virden. Artwork: Giuseppe De Chiara.

made the most sense to them, designated Model 22-64-01, featured twin booms to support the horizontal and vertical stabilisers and house the engines. The engines were mounted outboard of a central cockpit gondola which, unusually, also contained a nosewheel for a tricycle-type undercarriage.

That arrangement allowed for heavy and concentrated firepower in the nose, without the need to be synchronised to fire through a propeller disc. The armament chosen was constrained only by a 1,000-pound [455kg] maximum weight requirement: two .50-inch calibre Browning M2 heavy machine guns with 200 rounds per gun, two .30-inch Brownings with 500 rounds per gun, and a single Madsen 23mm T-1 Army Ordnance auto-cannon with a rotary magazine. Later the .30-inch guns were replaced by M2s.

Lockheed presented its projections for CP X-608 to the Air Corps' Air Materiel Command in April 1937. Model 22 promised to exceed the requirement with a top speed of 400mph (644kph), unprecedented for a production fighter, and it was almost immediately accepted. The USAAC ordered a single experimental airplane, designated XP-38, under USAAC contract AC-9974 approved in June 1937, and the airplane was issued USAAC serial number 37-457.

Construction of the prototype began in July and was completed 18 months later, just before Christmas 1938. It wasn't armed, and its livery was polished aluminium with USAAC markings. It was unlike any fighter design seen before. Availability of the desired Allison engines

XP-38 SPECIFICATIONS

CREW: One

POWERPLANT: Two 1,090-horsepower (813 kW) turbosupercharged, water-cooled 12-cylinder V-1710 Allison piston engines with inward-rotating, three-bladed propellers

LENGTH: 11.53m

WINGSPAN: 15.85m

EMPTY WEIGHT: 5,220kg

GROSS TAKEOFF WEIGHT: 6,993kg

delayed flight readiness, but after the holidays the XP-38 was prepared for its inaugural test flight out of March Field near Riverside, California, to where it had been moved under tight security.

On 27 January 1939, Lockheed test pilot Ben Kelsey, who as project officer had sold the airplane to the USAAC, took it into the air. Subsequent test flights by Kelsey and Lockheed's aircraft chief engineering test pilot Marshall 'Babe' Headle demonstrated a top speed of 413mph (665kph) at 20,000 feet. Thus, the Lightning, as it was appropriately named, became the first true 400mph fighter on the planet.

The XP-38 wasn't perfect, however, and demonstrated a few problems. The wing flaps caused vibration and on the ground, failure of the wheel brakes put the airplane in a ditch on one occasion. Those difficulties were systematically addressed and corrected.

XP-38 DOWN

The USAAC authorised a transcontinental record demonstration of the Lightning's speed and on 11 February 1939 Kelsey departed March Field, California for Mitchel Field, New York. He made refuelling stops in Amarillo, Texas and Dayton, Ohio. On his final leg, just prior to landing at Mitchel Field, the engines lost power and Kelsey made a forced landing on the Cold Stream Golf Course in Hempstead, New York.

Kelsey survived. The XP-38 did not, but it had proved itself a winner. Hibbard and Johnson filed for its patent on 27 June 1939, exactly six months after its first flight, and the following year a 14-year patent was granted. The USAAC had

ordered 13 prototype YP-38 service test aircraft, and it wasn't until September 1940 that the first of those took wing, with Headle at the controls.

A year earlier, the USAAC had also ordered 29 reconnaissance RP-38s and 36 RP-38Ds. Lightning production was well underway. One was completed as the experimental XP-38A, to be evaluated under USAAC Secret Project MX-6 with a pressurised cockpit. A second cockpit was installed in the left boom, where the General Electric Model B-1 turbosupercharger was normally located.

LIGHTNINGS BY THE THOUSANDS

By the end of production in 1945, more than 10,000 Lightnings had been built. It was the only US combat aircraft in continuous production throughout the war and served in every war theatre. The program gave rise to numerous variants, including the F-4 and F-5 photographic reconnaissance versions and even two-seat modifications: the 'droop snoot' bombing pathfinder and the P-38M radar-equipped night fighter.

One-off spinoffs included the XP-49, fitted with Continental inverted V-12 'hyper engines' of 2,100-horsepower (1570kW) emergency rating, and the substantially larger, completely redesigned XP-58 Chain Lightning heavy fighter with Allison 24-cylinder engines, each essentially a mated pair of standard V-12s.

While Hibbard and Johnson were responsible for the design of many successful Lockheed-built aircraft, the P-38 was their first 'over-the-top' invention. It was that airplane that created America's still-highest-scoring fighter aces, and it helped in a big way to bring about the end of World War II.

RAAF LIGHTNINGS IN WORLD WAR II

The first Lightnings to enter wartime service were not fighters but the F-4 photo-reconnaissance (PR) version of the P-38E. In place of nose armament, they carried up to four large Fairchild K-17 aerial cameras, each with 200-negative film roll magazines in nine-inch square (23cm) format.

Arriving as shipboard cargo in Melbourne, the F-4s were assembled by the Commonwealth Aircraft Corporation and went into action in April 1942 with the US 8th Photo Reconnaissance Squadron, imaging Japanese positions on and around New Guinea. After six months, two of the aircraft were passed on to the RAAF, joining No.1 Photo Reconnaissance Unit (No.1 PRU) at Hughes Airfield near Darwin. There they supplemented the unit's obsolescent Buffaloes and Lancers, flying their first RAAF PR missions in November 1942. One was destroyed that month in a fatal crash attributed to engine failure. A replacement arrived in 1943 after No.1 PRU's relocation to Coomalie Creek Airfield near Darwin.

Serviceability problems continued to hamper the RAAF's Lightning operations. It was not until mid-1944 that Mosquitoes replaced the motley collection of PR aircraft with No.1 PRU (soon to become No.87 Squadron). By then the replacement Lightning, A55-3, had been written-off in a belly landing, and A55-1 crash landed later that year in September.

Another pair of F-4s had meanwhile joined the P-40 Kittyhawk fighters of No.75 Squadron RAAF at Milne Bay, Papua New Guinea, on loan. Their cameras gathered much valuable intelligence before they were returned to the USAAF in December 1943.

ABOVE F-4 Lightning A55-3 was camouflage painted in green and brown with grey undersides for its RAAF service. Photo: Australian War Memorial.

THE JOINT STRIKE FIGHTER PROJECT: X/F-35 LIGHTNING II

Four US Marine Corps F-35B aircraft lift vertically from a secluded base. Their mission: to attack heavily defended surface-to-air missile and radar facilities. Each is armed with two high-explosive, satellite-guided 250-pound (113 kg) small diameter bombs, carried internally in weapon bays. Some 16km from their respective targets, each pair releases their bombs and turns for home. Reconnaissance unmanned aerial vehicles loiter high overhead and transmit strike video in real time for bomb damage assessment. Even before the aircraft return, the result is in: all targets destroyed.

That was a combat scenario envisioned for the fifth-generation Lightning II – the most expensive military program in history – which is now in service with the armed forces of the US and several allied nations including Australia. The F-35B STOVL (short take-off and vertical landing) is one of three variants, the others being the conventional takeoff and landing (CTOL) F-35A and the larger-winged aircraft carrier variant (CV) F-35C.

GENESIS OF THE JSF

In the late 1980s, the US Defense Advanced Research Projects Agency sent out a request for proposal to US airframe and powerplant industries. It called for a joint advanced strike technology (JAST) fighter aircraft: a stealthy, supersonic, multi-role, multi-service fighter. JAST was soon superseded by the simpler term Joint Strike Fighter (JSF).

After a decade of design and development, including many flight test evaluations, the X-35 proposal from Lockheed Martin Corporation and the X-32 from Boeing Company were thoroughly examined by Pentagon officers and officials. Boeing Phantom Works' two JSF concept demonstration aircraft (CDA), designated X-32A and X-32B, were unveiled at Palmdale, California, in December 1999.

Both firms met all the JSF specifications and flight-test requirements. However, a major design difference was that the X-35 design featured cheek-type engine air inlets, while the X-32 featured a single large 'sugar scoop' type air inlet. That feature alone would make the X-32 detectable to enemy radar by exposing the face of the turbofan engine. Although a radar-scattering screen was devised for the X-32, the X-35's engine was more effectively cloaked within the airframe and it won the day.

On 26 October 2001, the US Department

of Defense announced that Lockheed Martin had been chosen to build the JSF and the F-35 was born. Initial customers would be the US Air Force, US Navy (USN) and US Marine Corps (USMC), the Royal Air Force (RAF) and the Royal Navy (RN).

Final assembly was to take place at the Lockheed Martin facility at Fort Worth, Texas, while major components would be supplied by Northrop Grumman and BAE Systems. That consortium would produce an initial batch of 24 F-35s (including 10 non-flyable platforms for static testing and radar signature evaluation), encompassing all three variants, in the US$25 billion System Development and Demonstration (SDD) phase of the JSF program.

At the time of the announcement, the first flight of the initial SDD airplane (an F-35A CTOL variant) was scheduled for late 2005, with a projected first delivery of an operational aircraft scheduled for 2008. Pratt & Whitney, meanwhile, was awarded a contract to produce three versions of its F135 engine, one for each F-35 variant. In the Alternative Engine Program, begun in 1997, General Electric would produce three versions of its F136 for later evaluation, but the F135 was chosen.

Three years into the SDD phase, Lockheed Martin and its team members were busy creating a common strike fighter for an ever-increasing number of land and sea-based air forces, which now include those of Australia, Canada, Denmark, Italy, The Netherlands, Norway, Israel, Japan and South Korea..

Designing a multi-mission, multi-service fighter with a similar airframe, powerplant and weapon system that would meet the

ABOVE X-35A full-scale engineering mock-up. Photo: LM Skunk Works.

CDA TEST AIRCRAFT	FIRST FLIGHT	NO. OF FLIGHTS
Boeing X-32A CTOL	Sep 2000	33
Lockheed Martin X-35A CTOL	Oct 2000	27
Boeing X-32A CV	Nov 2000	33
Lockheed Martin X-35C CV	Dec 2000	73
Boeing X-32B STOVL	Mar 2001	78
Lockheed Martin X-35B STOVL	Jun 2001	39

demands of all US land and sea-based air forces had been tried in the 1960s. Called the TFX (tactical fighter, experimental) multi-service program. That program resulted in the General Dynamics F-111A (for the USAF), Grumman F-111B (for the USN), and subsequent derivatives including the FB-111A and the RAAF's F-111C. The carrier-based naval F-111B, however, was cancelled. It was too heavy and lacked maneuverability, so in its place Grumman developed the highly successful F-14A Tomcat, which first flew in 1970.

The F-35, however, satisfied all parties, air force and navy, with the added advantage of 80 percent commonality of components across all variants. The USAF planned to procure 1,763 F-35As to supplement and ultimately replace its A-10A Thunderbolt II and F-16C Fighting Falcon. The USMC and USN planned on 480 F-35B and C variants, to replace the AV-8B Harrier II and F/A-18C Hornet. The RAF and RN would each require 60 to 80 F-35Bs to replace their GR7 and AF2 Harriers.

PROPULSIVE SYSTEM

The engine chosen was the Pratt & Whitney F135 turbofan engine of 43,000-pound-foot (191kN) thrust with afterburner. It is a close relative of the F119 used by the twin-engined Lockheed Martin F-22 Raptor, but specifically optimised for the F-35. It integrates the proven F119 core: a high-performance six-stage compressor and a single-stage turbine unit with a low-pressure spool. The first production F135 propulsive system for operational service was delivered in 2007.

The F135-PW-600 engine, used in the vertical-takeoff F-35B for the USMC, RAF and RN, features a Lockheed Martin/Rolls Royce shaft-driven counter-rotating lift fan assembly that produces cool-air lifting force during STOVL operations. The fan is actuated by a clutch that can be engaged at any power setting, and works in concert with an articulating rear duct and underwing lateral-control nozzles. Because the fan amplifies the engine's power, the engine is able to run cooler and with less strain, increasing reliability and extending service life. The lift fan provides the propulsive system with about 15,000 pounds (67kN) more thrust than the base F135 engine alone could generate.

PARTNERSHIP

Almost from the outset, Lockheed Martin partnered with Northrop Grumman Corporation and BAE Systems for mission

ABOVE Three-view of X-35B STOVL as it appeared immediately after its conversion from theCTOL X-35A. Artwork: Giuseppe De Chiara.

LEFT USAF CTOL X-35A.

BELOW LEFT The Pratt & Whitney/Rolls Royce propulsive system of the F-35B: vertical lift fan in foreground joined by a shaft to the afterburning turbofan with its rear vectoring nozzle rotated to the vertical. Photo: NASM.

BELOW The first of the five USAF SDD F-35A CTOL aircraft (AA-1) in three-view. Artwork: Giuseppe De Chiara.

equipment delivery and integration. Northrop Grumman's electronic systems division in Baltimore, USA, is responsible for the F-35's AN/APG-81 fire control radar. The radar features an active electronically scanned array that enables near-simultaneous performance of multiple radar functions. Because the radar scans electronically, it can find targets much more quickly than mechanically scanned radars.

Meanwhile, BAE Systems' Information and Electronic Warfare Systems division, headquartered in Nashua, New Hampshire, was responsible for F-35 electronic warfare system integration for the SDD and low-rate initial production phases of the JSF program.

INTO SERVICE

The stealthy F-35A, F-35B and F-35C Lightning II 'birds of a feather' are entering service in numerous armed forces, and are expected to remain in service into the 2040s and beyond. The multi-role tactical strike warfighters are supplementing and replacing a growing number of tried-and-true victors from the past.

The F-35A in USAF and RAAF service is capable of the high-g maneuvering qualities of the Block 50 and later versions of the USAF's F-16C Fighting Falcon, described by one high-ranking USAF pilot as a "hot rod from hell" (production of which was relocated from Fort Worth to South Carolina in 2017 due to F-35 production). The F-35A also complements the F-15C Eagle and F-22 Raptor.

F-35C onboard USS *Carl Vinson*, January 2022. Photo: US Navy.

The F-35B offers USMC, RAF and RN pilots something they never had with the AV-8B Harrier II: supersonic performance. And with the F-35C, USN pilots enjoy a carrier-based warfighter that is more capable than the F/A-18 Hornet.

When the P-38 Lightning first flew in 1939, it was faster than any production fighter in the world. In service it also proved agile, it packed a punch with a range of internal and external armament, possessed a good combat range, and was liked by its pilots. Other than speed, those attributes apply equally to the F-35 Lightning II 60 years later, preserving the legacy of the ingenuity and vision of the Skunk Works founders. W

Edited excerpts and images are used (with permission) from The Projects of Skunk Works *by Steve Pace (Voyageur Press).*

F-35A SPECIFICATIONS

MISSION: CTOL multi-role stealth fighter

LENGTH: 15.6m

WINGSPAN: 10.7m

WING AREA: 42.7sqm

EMPTY WEIGHT: 13,290kg

GROSS WEIGHT: 31,750kg

POWERPLANT: One Pratt & Whitney F135-PW-100 turbofan of 28,800lb (128kN) dry thrust (43,000lb/191kN with afterburner)

MAX SPEED: Mach 1.6 (1,7000kph)

MAXIMUM RANGE: 2,220km with 8,280kg internal fuel

CEILING: 50,000ft

ARMAMENT: One 25mm GAU-22/A cannon AIM-120C air-to-air missiles AIM-9X Sidewinder short-range air-to-air missiles GBU-31 Joint Direct Attack Munitions (JDAM) guided bombs, GBU-39 small diameter bombs, laser-guided bombs

F-35B SPECIFICATIONS*

MISSION: STOVL multi-role stealth fighter

EMPTY WEIGHT: 14,700kg

POWERPLANT One Pratt & Whitney F135-PW-600

VERTICAL ENGINE THRUST: 177kN

MAXIMUM RANGE: 1,670km with 6,100kg internal fuel

ARMAMENT: As for F-35A but 25mm cannon mounted in external stealth pod

**Specifications shown only where different from F-35A.*

F-35C SPECIFICATIONS*

MISSION: Aircraft carrier-based multi-role stealth fighter

EMPTY WEIGHT: 15,700kg

WINGSPAN: 13.1m

WING AREA: 62.1sqm

POWERPLANT: One Pratt & Whitney F135-PW-400

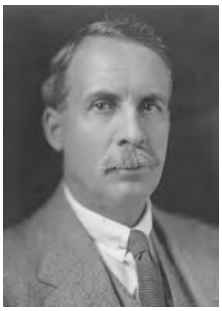
MAXIMUM RANGE: 2,200km with 8,960kg internal fuel

ARMAMENT: As for F-35A

**Specifications shown only where different from F-35B.*

WINGS OUT WEST

ESTABLISHED TO DEFEND AUSTRALIA'S WEST COAST, RAAF BASE PEARCE IS NOW A MAJOR PILOT TRAINING BASE AND TYPICALLY SEES MORE DAILY AIRCRAFT MOVEMENTS THAN ANY OTHER BASE.



WHEN DEFENCE MINISTER Senator George Pearce of Western Australia approved the formation of the Australian Flying Corps in 1912, he could scarcely have imagined the modern Air Force it would eventually spawn.

During the first two decades of Australian military aviation, there was little financial commitment to the development of an effective air defence network for Australia, despite the lessons learnt from the use of air power in World War I.

The deficiencies were pointed out in 1928 by RAF Air Marshal Sir John Salmond, who was loaned to the RAAF to inspect Australia's air defence preparedness, or lack thereof. Among his recommendations to the government was a proposal that a RAAF station for a Citizen Air Force bomber squadron should be established near Perth, WA. The squadron's role would be twofold: to co-operate with WA-based army units on exercises, and to defend against any seaborne attack on the state (considered at the time to present a far greater threat than air attack).

It was not until the Air Force expansion program of 1934 that the idea was progressed, and a 260-hectare plot of land at Bullsbrook, 44km north-east of Perth, was purchased for £3234. The station's first commander, WGCDR Ray Brownell, was appointed in 1936 but construction work lagged behind. The base did not have a name until late 1937 when Pearce was chosen, in honour of Sir George Pearce who had been Australia's longest-serving Minister for Defence.

ABOVE Classic Hornets at RAAF Base Pearce being prepared by No.75 Squadron Maintenance for Exercise Phoenix Black/Nigrum Pugio 2020. Photo: Department of Defence/ LAC Brandon Murray.

ABOVE LEFT Sir George Pearce, Minister for Defence, 1910-21 and 1932-34. Photo: Department of Defence.

RIGHT Hudson bomber engine maintenance at RAAF Pearce, November 1940. Photo: Australian War Memorial.

CITY OF PERTH SQUADRON

In early March 1938, No.23 Squadron (Citizen Air Force) arrived over Perth with six Demon biplanes and several Anson bombers. The aircraft had just completed the laudable achievement of crossing the continent from Victoria. The rest of the squadron personnel took the transcontinental train and proudly marched through the streets of Perth beneath the formation of aircraft.

Although the men found RAAF Station Pearce far from ready for habitation, the situation soon improved. WGCDR Brownell found that the station's isolation from the eastern states gave him a high degree of freedom to operate what some considered to be, in effect, a separate West Australian Air Force.

On the first day of 1939, 23SQN became No.25 (General Purpose) Squadron, named the City of Perth Squadron, and a station headquarters was soon formed. No.14 Squadron joined it, taking on 25SQN's Anson bombers under the command of (coincidentally) FLTLT Charles Pearce.

In the early days of World War II, 25SQN flew Wirraways and Buffaloes, uncomfortably obsolete aircraft for the air defence of Perth. The Japanese attack on Broome in March 1942 made a future attack on Perth seem more realistic and the aircraft were replaced by more modern Vengeance dive-bombers. But with the threat of attack diminished by 1945, the squadron moved to nearby Cunderdin Airfield to re-equip with Liberator heavy bombers. From there, via northern WA airfields, they flew attacks and patrols in the Netherlands East Indies area.

No.14 Squadron, meanwhile, flew new Hudson bombers on anti-submarine and convoy patrols. Other fighter and transport squadrons transitioned through, while No.5 Initial Training School gave new recruits their first taste of RAAF life. From May 1945, the Spitfires of No.85 Squadron were also stationed at Pearce, albeit in a training capacity, and at war's end they joined a victory formation flypast over Perth.

Hawker Demons on exercise from Bullsbrook (Pearce) in April 1939. Piloting the middle aircraft is FLTLT Brian 'Blackjack' Walker. Photo: Australian War Memorial.

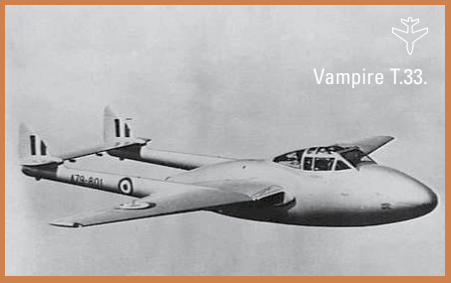
DE HAVILLAND VAMPIRE

The wood-and-metal Vampire was Britain's second jet fighter, following the Meteor, and Australia's first. After three British-built fighter variants were delivered to the RAAF during 1947-49, another 190 Vampires were built by de Havilland Australia in Bankstown, NSW. Eighty were single-seaters (F.30 fighters and FB.31 fighter-bombers), while 110 were dual-seat trainers (T.33, T.34 and T.35 variants for Air Force and Navy).

In 1958, RAAF's school for advanced pilot training, No.1 Applied Flying Training School (AFTS) relocated from Point Cook to Pearce to re-equip with Vampire trainers, as Pearce's runways were longer and more suitable for jets. Other training units equipped with Vampires included Central Flying School and Nos 2 and 5 Operational Training Units.

In the early 1950s, both single and dual-seat variants equipped the Citizen Air Force squadrons (Nos 21, 22, 23 and 25). In addition, No.78 Wing (Nos 75 and 76 Squadrons) served in Malta on air defence duty, flying RAF Vampire FB.9s.

The Vampire fighter was replaced by the Sabre in 1954, and the trainer variants by the Aermacchi MB-326H in 1971.



Vampire T.33.

TECHNICAL DATA (VAMPIRE T.35)

Description: Two-seat advanced trainer

Power plant: One de Havilland Goblin 35 turbojet of 1858kg thrust

Loaded weight: 5058kg

Dimensions: Wingspan 11.58m, Length 10.53m

Maximum speed: 866kph

Rate of climb: 4500ft/min

Service ceiling: 40,000ft

Range: 1352km

Armament: Two 20mm Hispano cannon, eight 11kg rockets or practice bombs

POST-WAR

Through the 1950s 25SQN, again a Citizen Air Force squadron, flew Mustangs and Vampire jets from RAAF Base Pearce (Station having been replaced with Base from 1952), and then served as a ground unit for three decades. The 1950s also saw the Lincoln and Neptune maritime reconnaissance bombers of No.11 Squadron stationed there, prior to the formation of Base Squadron Pearce and Headquarters RAAF Pearce.

A generation of RAAF pilots trained on the Vampire, their syllabus including 110 hours of Vampire flying time (following 120 hours on the Winjeel basic trainer).

Replacing the Vampire from May 1968, the Italian Aermacchi MB-326H jet was chosen as the first trainer to encompass 'all-through' (elementary to advanced) training. Peace was chosen over Point Cook and East Sale in Victoria and Edinburgh, South Australia as the site for all-though training due to its good weather, cost-effectiveness and, as the sky above Pearce became busier, the availability of land for a satellite airfield, Gin Gin, which was established to its north-west.

No.70 Pilots Course in 1968 was the first to complete all pilot training on the one type at the one base, each student completing 200 flying hours in 59 weeks on the Macchi. It was soon found, however, that basic training and a grading test on piston-engined Winjeels at Point Cook were needed prior to a trainee pilot's posting to Pearce. That weeded out those unsuited to pilot training, and reduced the density of air traffic over Pearce and Gin Gin to safer levels.

In 1969, a decade after No.1 AFTS transferred to Pearce from Point Cook, AFTS became the current No.2 Flying Training School (No.2 FTS).

In 1989, No.25 Squadron resumed flying duties with Macchi trainers, and only two years later, the jet was replaced in No.2 FTS by the Pilatus PC-9 turboprop trainer. More recently that has made way for the PC-21, acclaimed as the world's most advanced pilot training aircraft. Both RAAF and Royal Australian Navy pilots are trained by No.2 FTS.

In 1993, the Republic of Singapore Air Force's (RSAF) No.130 Squadron began using Pearce for training its pilots in Marchetti jet trainers, preferring the less crowded skies and predictable weather of the Perth region to those over Singapore.

In 2014, the RAAF Pearce supported the search effort for missing Malaysian Airlines Flight MH370. Aircraft from the US, New Zealand, Japan, Korea and China joined in the search.

ABOVE LEFT Photographic trainees of No.14 Squadron being instructed in the use of a camera gun at Pearce, 1940/41. Photo: Australian War Memorial.

de Havilland Vampire jets of 25SQN taxi out at Pearce for Operation Oxcart, July 1957. Photo: Australian War Memorial.

AERMACCHI MB-326H (CAC CA-30)

By 1965, the RAAF's ageing Vampires were in need of replacement. A RAAF evaluation team selected the relatively inexpensive Italian Aermacchi as the RAAF's new jet trainer. License-built in Melbourne by the Commonwealth Aircraft Corporation (CAC), the 'Macchi' began equipping No.1 AFTS in 1968 as the unit was superseded by No.2 FTS. The last of 87 RAAF and 10 Navy examples were delivered in 1972.

The RAAF's plan to use the Macchi for basic as well as advanced training only lasted for two courses before the basic training role was returned to piston-engined aircraft. From 1989, the Pilatus PC-9 took the Macchi's place as the RAAF's advanced trainer, and the remaining jets became lead-in-fighter trainers. They served in that role with Nos 25 and 79 Squadrons at Pearce, and with 76SQN at RAAF Base Williamtown, until replaced by the Hawk 127 in 2000.

Additionally, the Macchi flew from Williamtown with 77SQN, No.2 Operational Conversion Unit and No.5 Operational Training Unit, and from East Sale with Central Flying School. To the public, the Macchi is best known for its service with the RAAF's aerobatic team, the Roulettes, through the 1970s and 1980s.

TECHNICAL DATA

Description: Two-seat basic and advanced trainer

Power plant: One Rolls-Royce Viper turbojet of 1,134kg thrust

Loaded weight: 4,300kg

Dimensions: Wing span 10.57m, Length 10.67m

Maximum speed: 806kph

Service ceiling: 44,000ft

Range: 1,512km

Armament: Two M134 minigun pods and eight 12kg practise bombs

ABOVE Aerial view of Pearce in 1940. Photo: Australian War Memorial.

ABOVE LEFT WAAAFs refuelling a Wirraway at Pearce, March 1943. Photo: Australian War Memorial.

PEARCE TODAY

In addition to No.2 FTS and 130SQN RSAF, Pearce is also home to No.79 Squadron, which operates the Hawk 127 lead-in fighter for pilots destined to fly F/A-18 Super Hornets. Pilots complete a 14-week Introductory Fighter Course which includes general, instrument, formation, and night flying, including navigation. Graduates progress to a 20-week course at RAAF Base Williamtown, NSW for weapons training on the Hawk prior to F/A-18 conversion. Pearce typically sees more daily aircraft movements than any other RAAF base.

Also planned for basing at Pearce will be a fourth flight of the Australian Air Force Cadets (AAFC) Elementary Flying Training School (EFTS), instructing cadets to fly the Diamond DA40 NG. Ground units currently based there include:

- 453SQN (Pearce flight) air traffic control
- No.3 Security Forces Squadron Detachment Pearce
- No.1 Expeditionary Health Squadron Detachment Pearce.

Although its primary role is pilot training, Pearce, as the only permanent RAAF Base on the west coast, also has a significant logistics role.

PILATUS PC.21

In 2017, as part of the AIR 5428 Pilot Training System project, the PC-21 began replacing the PC-9A at Pearce and East Sale as the RAAF's all-through training aircraft. The system aims to train more pilots faster and to a higher standard, preparing them for transition to more advanced aircraft.

The PC-21's cockpit is pressurised and air-conditioned and has on-board oxygen generation. Hydraulically assisted control surfaces facilitate fighter-like manoeuvrability, while a digital power management system and automatic yaw compensation make control easier.

The aircraft can be used from day one of training, eliminating the need for an elementary flying training fleet while also bridging the performance gap between traditional turboprop trainers and the lead-in fighter, the Hawk 127.

Currently, student pilots undergo five months of training at East Sale, including 40 flying hours on the PC-21, before being posted to Pearce for further training.

TECHNICAL DATA

Description: Two-seat trainer

Power plant: Pratt and Whitney PT6A-68B turboprop (1600 shaft horsepower)

Loaded weight: 4250kg

Dimensions: Wing span 9.1m, Length 11.2m

Maximum speed: 685kph

Service ceiling: 25,000ft

Range: 1333km

Armament: Nil

LEFT A RSAF PC-21 with a RAAF PC-9 over RAAF Base Pearce, 2008. Chief of Air Force AIRMSHL Mark Binskin is in the PC-21 and MAJGEN Ng Chee Khern, Chief of the RSAF, is in the in the PC-9 . Photo: Department of Defence/FLTLT Ray Hurley.

ABOVE RIGHT Graduates of No.254 Advanced Pilot Course receive their wings at RAAF Pearce, 2019.

RIGHT A PC-21 diamond formation overflies the graduation ceremony of No.262 PC-21 ADF Pilots' Course with No.2 FTS at Pearce, August 2021. Photos: Department of Defence/ Chris Kershaw.

Scan the QR code to see a two-minute Air Force 100 video overview of RAAF Base Pearce

Scan the QR code to see a four-minute in-cockpit video, showing a recent No.2 FTS course flight from Pearce in a PC-21.

WAR + PEACE

SHOWCASING AIRCRAFT OF

WORDS Aimee O'Hare

OWNED AND OPERATED BY THE RAAF ASSOCIATION WESTERN AUSTRALIA, PERTH'S AVIATION HERITAGE MUSEUM DISPLAYS ONE OF THE NATION'S LARGEST COLLECTIONS OF AIRCRAFT.

NESTLED BEHIND THE GATE to the picturesque parklands of the Air Force Memorial Estate for retirees, in the Perth suburb of Bull Creek, the Aviation Heritage Museum is Western Australia's only aviation museum. It displays one of the largest collections of aircraft in Australia along with a fascinating array of aviation memorabilia. The museum is owned and operated by RAAF Association WA and supported by a team of dedicated volunteers.

MUSEUM BEGINNINGS

Over many years, Association members and aviation enthusiasts collected and restored aircraft and artefacts. Their aim was to preserve the history of the RAAF and of aviation in Australia, with a particular focus on WA. In 1971, they formed the Aviation Historical Group and began to plan a museum to house the collection of aircraft and components, aero engines, books, photographs and artefacts.

That same year, RAAFA WA began developing its Air Force Memorial Estate on an allocated block of land in Bull Creek. Eight years later, a state

government grant of $100,000 enabled the construction of the museum's south wing adjacent to the estate. The museum was declared open on 17 November 1979.

The south wing was too small for aircraft such as the Lancaster bomber and Douglas Dakota, each with wingspans of about 30m. Further government funding enabled the construction of the north wing, which opened four years later. New facilities have been added to the museum over the years, including a walkway in the north wing, a library, offices, workshop and new displays.

From the Spitfire to the imposing Lancaster, the museum showcases significant aircraft in war and peace as well as engines, communication devices, tools, support vehicles and training equipment. All demonstrate the skills and services that have worked together in conquering the skies.

The collection continues to grow, with a focus on preserving aviation history and sparking curiosity in young people, to encourage them to dream and perhaps to build the aircraft of the future for defence, travel or exploration.

LANCASTER BOMBER

The showpiece is the Avro Lancaster Mk VII four-engined bomber. Acquired in 1962, it serves as a reminder of the service and sacrifice of RAAF aircrew who flew over Europe in World War II. It arrived in spectacular fashion, flying over the Perry Lakes stadium as part of the finale of the Commonwealth Games held in Perth that year.

The task of restoring it to original appearance was undertaken by volunteers from No.25 (City of Perth) Squadron, Citizens' Air Force. Its white French Aéronavale paint scheme was replaced with the camouflage colours of RAF Bomber Command, and the identification code WU16 was replaced by its 1945 British serial, NX622.

On 18 August 1979, the Lancaster was moved in pieces from the airport to its new, permanent home at the museum – an operation in itself. The rear fuselage was loaded by crane onto a specially prepared dolly, which was then attached to the turntable of a prime mover. Semi-trailers were loaded with the engines, wings and tail sections before the convoy, escorted by a radio liaison van from the Department of Civil Aviation, made its way to the museum along Leach Highway.

The bomber was again repainted in 1994 by reservists from No.25 Squadron, this time to represent a Lancaster of No.463 Squadron RAAF. The particular aircraft chosen was coded JO-D (D for Digger), a veteran of 93 raids over enemy territory and crewed by several Western Australians.

ABOVE Bristol Tourer (G-AUDK) cutaway.

FAR LEFT Spitfire replica gate guard.

BELOW Macchi VR experience and Canberra bomber.

The Lancaster is the focal point of the museum and faces visitors as they enter the north wing. It also creates a spectacular function venue, with events held under its wings.

Visitors can elevate their experience by booking a personalised external and internal tour of the bomber. Guests traverse its huge wingspan and then climb inside to sit in the wireless operator's seat and at the navigator's table. The tour provides an in-depth insight into the workings and crew positions of this special aircraft, and is a unique experience.

VIRTUAL EXPERIENCES

The museum offers a specially developed Bomber Command virtual reality experience. It is based on a real-life sound recording of crew conversations during a night-time bombing mission flown from an airfield in Nottinghamshire, England to the heart of Europe. Through the sights and sounds of the raid, visitors gain a greater understanding of the commitment and bravery of those who served in Bomber Command.

A second virtual reality experience enables visitors to sit in the pilot's seat of a Macchi advanced jet trainer. Participants can use the actual controls, taking charge of the throttle to fly over Rottnest Island and Perth City, with a flight instructor in the rear seat. Virtual pilots can try aerobatics over the skies of Perth and experience the rush of being a jet pilot, including a simulated 'black out' in the virtual-reality goggles.

MUSEUM ACTIVITIES

The museum undertakes a number of other activities and projects. It has a well-stocked gift shop which sells some unique items, and volunteers run a library of books and photographs. A model aeroplane group and a cadets group meet at the museum, offering opportunities for aviation enthusiasts of all ages to share their passion.

Recognising the importance of STEM subjects (science, technology, engineering and mathematics), a Young Aviators' Area was developed in 2021. The special section for children includes simulator and virtual-reality experiences, jet and piston engine displays, and a cinema. New elements are added regularly.

TOP De Havilland Vampire.

ABOVE The Lancaster's cavernous bomb bay.

ABOVE LEFT A luncheon function in the North Wing.

LEFT Bell UH-1H Iroquois.

ABOVE CAC Wirraway. In the background the 'black swan' tail fin of a WA-based 25SQN Liberator Bomber.

Volunteers are the lifeblood of the museum. They carry out the museum's restorations, maintenance, retail, modelling, display creation and cleaning, along with tour-guide duties and running the simulators. New volunteers are always welcome, with plenty of flexible opportunities.

The Aviation Heritage Museum appeals to visitors of all ages and interests, including those without a passion for aviation. It is open daily from 10am to 4pm (except New Year's Day, Good Friday, Christmas and Boxing Day).

• See aviationmuseumwa.org.au for more information.

OTHER AIRCRAFT

The impressive aircraft collection is maintained and preserved by a dedicated volunteer team and is a source of great pride.

- **Consolidated PBY Catalina,** which presents an imposing first impression upon entry to the museum. Visitors are always interested to learn about the Catalina's ability to land on the water, and its rich local history when it was based just across the river in Crawley during World War II.
- **Douglas C-47B Dakota** (RAAF serial A65-124), another of the museum's larger aircraft open for tours. It holds the distinction of having been the last Dakota received by the RAAF in 1945. It served in Papua New Guinea, Korea, Malaysia and Australia, including a five-year stint patrolling the northwest coast of WA. The museum took delivery in 1981.
- **Supermarine Spitfire Mk 22** (RAF serial PK481) is displayed in the north wing. It began service with the RAF in September 1945, serving with several squadrons before being retired in 1953. In addition, a replica Spitfire stands gate guard mounted on a pole outside the museum.
- **Avro Anson** (RAF serial W2121), which flew with No.4 Service Flying Training School RAAF at Geraldton, WA.
- **CAC CA-6 Wackett trainer** (RAAF serial A3-31), the personal aircraft of WA aviation pioneer Horrie Miller. Based in Broome, it was transferred to the museum in 2002.
- **CAC CA-5 Wirraway Mk III trainer** (RAAF serial A20-688), which flew with RAAF units in the eastern states before transferring to RAAF Base Pearce in Perth in 1956.
- **De Havilland Tiger Moth trainer** (RAAF serial A17-161), flown by No.9 Elementary Flying Training School at Cunderdin, WA.
- **Bell UH-1H Iroquois (Huey) helicopter** (RAAF serial A2-296). Following its varied and busy service life with the RAAF (1973-1990) and subsequently with Army Aviation, the 'Huey' was allocated to the museum in 2012 and displayed in the south wing in 2014. Its cockpit is opened on special days for visitors to experience life as a helicopter pilot.
- **Canberra jet bomber Mk 20** (RAAF serial A84-230), which saw active service in Malaya and in Vietnam during 1967-71 with No.2 Squadron, prior to its final service in a photo-reconnaissance role. It was donated to the museum in 1983.
- **De Havilland Vampire T35A jet trainer** (RAAF serial A79-821), donated to the museum in 1970.

Detailed aircraft histories can be found at **aviationmuseumwa.org.au/aircraft-collection.**

THEN. NOW. ALWAYS.

AIR FORCE 2021 COMMEMORATIONS CONCLUDED WITH THE DEDICATION OF A NEW MEMORIAL.

THE RAAF CENTENARY PROGRAM concluded with a commemorative dedication of a new memorial at RAAF Base Point Cook, Victoria, to honour the 350,000 Australians who have served in Air Force in its first century, including the 11,191 Australians who died serving their nation.

The memorial, constructed at the birthplace of the RAAF, provides a place to pause and reflect on the contributions of Air Force personnel since 1921, in times of conflict and in peace. A spotlight points to the sky honouring the 3,143 Air Force personnel who have no known grave.

Chief of Air Force, Air Marshal Mel Hupfeld AO DSC and a number of retired Air Force chiefs attended the dedication ceremony on Wednesday 30 March which featured flypasts by the Roulettes and a No.100 Squadron Mustang.

"This memorial will stand here – at a place with such rich Air Force heritage – for another century and longer, as a reflection of all that our people have achieved in the first hundred years in times of conflict and peace, and what future generations of Air Force people will achieve," AIRMSHL Hupfeld said.

"The memorial has been designed to be inclusive so every Air Force member, our veterans and their families, can connect with it. The memorial includes officer and enlisted rank insignia and is representative of all employment groups within Air Force throughout the ages. The centenary theme 'Then. Now. Always.' is immortalised for future generations of aviators on the upper base of the memorial.

"As we conclude the centenary period, I am very proud of our program which appropriately honoured those who have served before us, demonstrated today's highly capable force and inspired the next generation to consider a career in Air Force, or aviation more broadly."

Air Force Centenary (AF2021) initiatives spanned Australia and the world. Her Majesty the Queen, HRH Prince William the Duke of Cambridge, Governor-General the Honourable David Hurley AC, state governors, federal and state ministers, Australian ambassadors and high commissioners, foreign military representatives, local government dignitaries and the Australian public joined current serving members, veterans and the Australian Air Force Cadets in marking the milestone.

The centenary also featured live national television broadcasts, community engagement events, special commemorative issues from the Royal Australian Mint and Australia Post and the distinctive and dynamic centenary branding was incorporated into a variety of retail products marketed by licenced partners. Royalties from those sales supported the restoration of a former RAAF search and rescue boat.

The AF2021 team worked closely with the Department of Veterans' Affairs to recognise Air Force veterans who turned 100 during the centenary period: 1 January 2021 to 31 March 2022. Those veterans received a special framed certificate, co-signed by the Chief of Air Force and the Warrant Officer of the Air Force.

Director General, Air Force 2021, Air Commodore Andrew Elfverson paid tribute to the centenary team "whose passion and commitment over a period of years was truly inspirational".

"The team faced many challenges, notably COVID-19, but continued to push forward, innovate and succeed," AIRCDRE Elfverson said. "COVID-19 was particularly frustrating for our base liaison officers and the regional engagement team who had developed a comprehensive community outreach program that we were not able to implement."

WGCDR Andy Anderson

Air Force Principal Air Chaplain Mark Willis addresses the audience during the Air Force centenary memorial dedication. Photo: Corporal Kieren Whiteley.

FLOATING HISTORY

THE LAST SURVIVING RAAF WWII SEARCH AND RESCUE BOAT HAS BEEN RETURNED TO THE AIR FORCE.

ABOVE Previous owners of RAAF search and rescue boat 02-06, Harry Bowman and Karen Letch in front of the boat. Photo: FLTLT Christopher Moon.

AIR FORCE HAS BEEN GIFTED the only remaining World War II RAAF rescue launch, 02-06, and the craft will be added to the Air Force Heritage Collection. Senior Air Force Curator, History and Heritage – Air Force, David Gardner, accepted the donation from its owner, Howard "Harry" Bowman, on behalf of Air Force.

Air Force operated boats from 1921 to 1993, and the fleet of various classes of boat peaked at 1,300 during WWII, with 600 powered and 700 unpowered craft.

Rescue launch 02-06 was one of 15 02-class vessels constructed for the RAAF in 1941 at Fishermans Bend in Melbourne by Thornycroft/Halversen and served as a search and rescue (SAR) boat during WWII. At different stages, it operated at the Gippsland Lakes, East Sale and Point Cook.

After the war, the RAAF commenced disposing of its unwanted boats. A revision of its Small Marine Craft Program led to the retention of only 107 boats to provide support in the areas of supply, torpedo recovery, air-sea rescue and flying boat service at eight RAAF bases. The need for those services gradually diminished until only three marine sections remained for search and rescue duties. Those three sections, Townsville, Williamtown and Point Cook, remained operational until 31 January 1993.

RAAF disposed of 02-06 in 1954 and it was subsequently operated on Melbourne's Maribyrnong River, changing hands twice before being purchased by Harry Bowman in 1986, for use as a pleasure craft. When Harry realised he had acquired a piece of RAAF wartime history, he motored the boat across Port Phillip Bay to Mordialloc Creek, loaded it on a boat trailer and transported it to Sale.

For the next 36 years, it was a regular sight on the waterways between Sale and Lakes Entrance and generated a great deal of interest from locals and holidaymakers. Harry maintained the boat's original features as much as possible, converting it internally into a comfortable family cruiser without detracting from its unique military past. He had always wished, when he decided to take life easier, to donate the boat to an appropriate organisation that would restore it to its former glory and display it for future generations.

In February this year, the boat was transported by road from Lakes Entrance to the History and Heritage facility at Spotswood in Melbourne.

History and Heritage Branch will restore the boat to its WWII livery before putting it on permanent display at the RAAF Museum at Point Cook.

The restoration of boat 02-06 will be supported by royalties totalling more than $136,000.00 from Air Force Centenary licenced merchandise sales.

Courtesy No.464 Squadron History and Heritage Branch.

WHAT CHINA LEARNT FROM MELBOURNE

THE STORY OF CHINA'S AIRCRAFT CARRIER PROGRAM.

THE CHINESE JUST LIKE THEIR SOVIET COUNTERPARTS maintained they wouldn't be building aircraft carriers for the naval arm of the People's Liberation Army (PLA). However, a changing geo-political scenario and the rise of carrier-centric fleets forced China to review its policies and adopt an aircraft carrier naval force element. In this article, we explore the evolution of China's carrier ambition as it grew from no go to full speed ahead.

The communist parties in China and the Soviet Union followed different ideals which led to the Soviet-Sino split in the early 1960s, and the USSR became the primary adversary for the Chinese. Fearing a massive land invasion led by the Soviet army and supported by the Soviet air force, the PLA's early focus was on its the land and air branches. The navy's role was simply to secure the Chinese coastline.

In the mid-1980s, the USSR showed signs of impending collapse and German reunification left those cracks open for everyone to see. Thus, the Soviet threat diminished and the PLA Navy (PLAN) started attracting attention in terms of resources and funds. Those events coincided with the rise of Admiral Liu Huaqing, the father of China's modern navy.

He promoted a major shift in the PLAN strategy from "coastal defence" to "offshore defence" (as directly translated from Chinese sources). PLAN was now expected to operate independently, far from China's coasts – in short, be able to conduct blue water operations.

Naval power projection in blue water operations requires a Carrier Battle Group (CBG) style posture and that entails a composite fleet comprising nuclear submarines for sea denial and carrier protection, multiple surface escorts for carrier protection and an impressive fleet of replenishment vessels to sustain those assets while deployed. Thus, the new offshore-defence strategy approved in 1986 required the development and operation of indigenous aircraft carriers, nuclear powered submarines, escorts, replenishment vessels etc.

Developing all of those assets at once is nearly impossible. The Chinese first concentrated on the peripheral assets and started looking to procure a carrier directly. They managed to acquire four vessels, HMAS *Melbourne*, *Kiev*, *Minsk* and *Varyag* (second Admiral Kuznetsov class vessel), which satisfied different roles for the Chinese.

BELOW Decommisioned HMAS-*Melbourne.*

BELOW HMAS *Melbourne* R21 during her days of glory.

Liaoning during her commissioning ceremony.

HMAS MELBOURNE

Melbourne was a Majestic-class catapult-assisted take-off but arrested recovery (CATOBAR) carrier operated by the Royal Australian Navy (RAN). Decommissioned in 1982, *Melbourne* spent three years in 'mothballs' before being sold to the Chinese for conversion to scrap. The Australians had removed all sensitive technical equipment except for the catapult, arresting gear and the mirror landing system – a visual approach slope guide to aid the pilot onto the carrier flight deck. All modern carriers have advanced derivatives of the original landing system developed by the British.

Reportedly, PLAN officials knew nothing about *Melbourne* until it had arrived in China. Disassembly was expected to begin immediately, but it didn't eventuate. From 1985 to 1994, the carrier lay undisturbed except for occasional visits by PLAN officers and engineers, who reportedly studied her thoroughly.

After in-situ analysis, the catapult, arresting gear and mirror landing system were removed and installed at a base in Dalian on a replica flight deck. Interestingly, a J-8 (modified MIG-21) was reportedly modified and used for flight tests from the facility.

Conversion to scrap began in 1994 and took several years to complete. If online sources are to be trusted, the break down ended in 2002. It took eight years to reduce the 15,740 ton (not loaded) vessel to scrap, obviously every part that came off the carrier was extensively studied before recycling.

The World War II-era designed *Melbourne* thus gave the Chinese carrier program a shot in the arm and helped them develop some of the much-needed equipment and procedures for carrier ops before a Chinese carrier could be fielded.

THE DECEPTION

The Chinese procured three carriers after *Melbourne*: *Kiev*, *Minsk* and *Varyag*. *Minsk* was acquired from Russia in 1995 for conversion to a tourist attraction, followed by Varyag from Ukraine, also supposed to be a tourist attraction. *Kiev* was acquired in 1996 for conversion into a theme park. According to *Deciphering Chinese Strategic Deception* by the Naval Postgraduate School, the acquisitions were a deception. The Chinese wanted their carrier ambitions to be discrete as it would have strained relations with the West. Carriers *Kiev* and *Minsk* were purchased to strengthen the cover story.

Varyag ended up in a dry dock in Dalian and was quietly refurbished, painted and modified to ensure it worked well with PLAN assets. It emerged as *Liaoning*, China's first combat-ready aircraft carrier commissioned on 25 September 2012.

ABOVE R21 being helped out of Sydney and on the long tow to China.

BELOW Dalian mock-up, you can see the jet on the deck and the encircled gaps for deck edge elevators.

Liaoning.

While the work on *Liaoning* was going on, the Chinese built a full-scale system's mock-up in Dalian to study various sensor configurations and finalise what would be installed on *Liaoning*. Mock-ups of jets and helicopters were also spotted on the replica flight deck.

THE AIRCRAFT

The Chinese had been looking for carrier-borne aircraft for some time. They started negotiation with Russia to procure the Su-33 – arguably the best fourth-generation naval fighter design in service today. Its Su-27 Flanker lineage offers superb agility, payload and range capability even while operating from a ski-jump. Thus, the Naval Flanker offered by Russia was arguably the best possible choice for the Chinese. Disputes stopped the sale of off-the-shelf aircraft and the Chinese had to make a suitable replacement domestically.

Features necessary for safe and sustained carrier ops were added to the J-11, a Chinese derivative of the Su-27, thus giving rise to the J-15. The prototype flew for the first time in August 2009 and bore close resemblance to the Su-33. It sported similar folding wings and tail surfaces along with canards and a twin wheel nose landing gear. Interestingly, commissioning ceremony photos revealed a picture of the deck with tyre scuff marks indicating some ops had been done.

The inhouse development of J-15 was a boon for the Chinese. They now know how to design carrier-borne aircraft with no external assistance. They can easily modify the fighters they have built to future proof them as they age without going through the tedious task of doing it via Sukhoi. Another point worth noting is that follow-on carriers could be CATOBAR. The J-15 was designed for launch from a ski-jump and hence lacked a catapult launch bar on the nose landing gear assembly. However, a J-15 has been observed with such a link hinting at a CATOBAR variant. That along with the presence of an electromagnetic aircraft launch system (EMALS) and steam catapult testing site has confirmed that the Chinese are deeply interested in CATOBAR carriers, and we might see such vessels serving with the PLAN in the near future.

The EMALS, developed by General Atomics for the US Navy, employs a linear induction motor rather than a conventional steam piston to thrust an aircraft to flying speed. It was first installed on the aircraft carrier, USS *Gerald R. Ford*. Its main advantage is that it accelerates aircraft more smoothly, putting less stress on the airframe. Compared to steam catapults, the EMALS also weighs less and is expected to cost less. It requires less maintenance and can launch both heavier and lighter aircraft than a steam piston-driven system. EMALS also reduces the carrier's requirement for fresh water, thus reducing the demand for energy-intensive desalination. China is reportedly developing a similar system which is expected to be used on China's Type 003 aircraft carriers.

Chinese J-15 fighter in tests aboard *Liaoning*. Photo: PLAN.

LEFT Viewed from the front, the islands of *Shandong*, right, and *Liaoning* are quite different.

AN INDIGENOUS CARRIER

The obvious step after commissioning a refurbished carrier is to build one from scratch using all the knowledge gained over the years. The Chinese had reportedly obtained all the blueprints used to build *Varyag* from Ukraine, and those designs would play a monumental role in designing and building the nation's first indigenous carrier, *Shandong*.

RIGHT A model of Chinese aircraft carrier Type 003.

CARRIER DESIGNATIONS

The Chinese designate important naval projects using the type designation, for example Type 052D destroyer. The aircraft carriers were designated:

Type 001: *Liaoning*
Type 002: *Shandong*, based on *Liaoning*'s design
Type 003: CATOBAR carriers of higher displacement with conventional propulsion and equipped with EMALS. Expected launch date mid-2022.
Type 004: Already on the drawing board for a nuclear powered CATOBAR Carrier equipped with EMALS.

Rumours were afloat in 2013 that work on a carrier had begun in the Dalian shipyard. By the first quarter of 2015, the keel of an unknown vessel had been laid down in the same drydock *Liaoning* had occupied. As time progressed and more modules were assembled, carrier-like features were observed. The vessel had a definitive hangar which according to some was the hold of a bulk freighter.

Additional modules with the space for deck edge elevators confirmed that the vessel was a carrier. Its dimensions matched those of *Liaoning* too. Then in September 2016, the ski-jump was placed which confirmed the vessel was an aircraft carrier not some ordinary freighter. The island came on in September and the vessel, *Shandong*, was launched in April 2017.

Shandong features a lot of changes over *Liaoning* and the baseline Kuznetsov design. The island is shorter allowing one to two more J-15s to be parked on the deck. The flight deck has been extended on sponsons in the aft-starboard quarter allowing a further two J-15s to be parked there, increasing the complement of aircraft carried from 58 on *Liaoning* to 62 on *Shandong*. The redesigned island sports Type 346A radar arrays placed at an angle instead of the Type 346 on *Liaoning* which are arranged differently.

Shandong left on her maiden sea trials on 13 May 2018 and spent about five days at sea. After the trials, she was put up in the dry-dock for post-trial modifications or repairs. Unlike *Liaoning*, it seems no J-15 ops were conducted as tyre scuff marks were absent. Interestingly, *Liaoning* arrived at the Dalian yard alongside for first pictures showcasing both carriers.

Once the Chinese have perfected all factors of carrier ops (if they haven't already), they will have two potent aircraft carriers in service. *Liaoning* and *Shandong* will have an impressive fleet of escorts keeping them safe. Escorts would include the under-construction Type 055, in service 052D, 052C destroyers and 054A frigates. First Type 901 replenishment vessel had also started its sea trials when this article was being written in 2017 and is specifically designed for sustained blue water ops.

In early May 2022, The Associated Press reported that China's *Liaoning* aircraft carrier group had embarked on a "realistic combat" training mission in the Western Pacific. According to a posting on its social media site, the PLAN said the mission was "routine, adhered to all international laws and practices and was not directed at any third parties".

The carrier fleet will allow the Chinese to buttress their territorial claims and deter other navies from operating in close proximity.

An edited version of an article first published on Battle Machines website in June 2017. Copy courtesy Paul Shiels, Editor Slipstream, the quarterly magazine of the Fleet Air Arm Association of Australia.

AN EXCLUSIVE CLUB

WORDS
Ken Wright

THE NECESSITIES OF WAR TRANSFORMED THE PARACHUTE FROM A STUNTMAN'S PROP TO A LIFESAVER AND GAVE RISE TO SOME SPECIAL GROUPS, INCLUDING AUSTRALIA'S LITTLE-KNOWN ROO CLUB.

ABOVE 82nd Airborne Division and British paratroopers participate in a jump during 40th anniversary of D-Day commemorations.

PRIOR TO WORLD WAR I, the use of parachutes was something foolhardy, undertaken only by showmen and women to thrill crowds of voyeuristic spectators. However, the war of 1914-18 transformed the parachute from a curiosity to a life-saving device.

With the employment of massed artillery and the ability of aircraft to fly high enough to observe and report on the layout of an unfolding battle, aerial observation became an essential tactic of modern warfare. Observation of the enemy position and the ability to accurately direct artillery from a stable platform was initially achieved using tethered balloons carrying observers in wicker baskets. However, the stability and static nature of the balloons made them a tempting target for enemy aircraft and the evasive action of winching a balloon down by its ground crew was not always fast enough to avoid a devastating attack. In most cases, the observation balloon was defended by anti-aircraft guns but to secure the safety of the observers, parachutes were introduced.

Parachutes were stowed in containers attached externally to the basket frame and attached to observers by static lines. In theory, all an observer had to do was jump out; their falling weight would snatch the parachute from its container and it would hopefully open.

Between 1915 and 1917, the idea of issuing parachutes to pilots was not considered appropriate for aviators and crews of fixed-wing aircraft, mainly because it may undermine a pilot's aggressive fighting spirit. It was argued that having a parachute would soften their moral fibre to get in close and engage the enemy.

Due to that rigid, obsolete view of warfare, men continued to die unnecessarily. It is true aviators on both sides took pride in their ability to nurse a damaged aircraft back to base or at least land safely if the option was available.

However, as the loss of valuable pilots mounted, parachutes gained

recognition, at least by the Germans. By early 1918, the German Air Force had begun making parachutes available to their pilots.

It is interesting to note that the initial reaction of the German and Austro-Hungarian pilots when issued with a parachute was to treat it with a degree of contempt. The first successful parachute jump by a German was 27 June 1918, when Leutnant Helmut Steinbrecher was shot down by a British aircraft and parachuted to safety.

In 1919, American Leslie Leroy Irvin designed a parachute with a silk canopy 32 feet in diameter with 24 silk rigging lines, each 16 feet long. The canopy had a small vent at the top to allow a certain amount of air spill to control oscillation. The chute was packed in a canvas container, carefully folded and secured by heavy elastic bands with two metal pins attached by cable to a handle, an arrangement that became known as a ripcord. When the ripcord was pulled, the pack opened and exposed a small pilot chute to the free stream which extracted the main chute and reduced the rate of descent to approximately 20 feet per second, as opposed to 175 feet per second without a parachute.

After a few modifications, trials proved so successful that the American Army Air Corps adopted the design and made wearing a parachute standard for aircrew.

ABOVE Observers in the basket of a kite balloon, France, 1914. Photo: National Library of Scotland.

BELOW Observers fixing tackle connected with parachutes, 1914.

ABOVE The seat-pack parachute (right) and a lap-pack type chute (left) used by Observers, 1923.

LEFT Leslie Irvin.

ABOVE German paratroopers landing in Crete, May 1941.
Caterpillar Club membership card.

WWII Allied aircrew had two types of parachutes available. The seat chute which was always worn and doubled as a cushion and the chest type which was stowed in a convenient place and in an emergency was clipped to a harness worn by the aircrew. At the height of the war, production at the Irvin Air Chute Co. in Letchworth, England reached a peak of nearly 1,550 parachutes a week.

CATERPILLAR CLUB

Some of Irvin's friends suggested he start a club as there would be many in the future using the chute. The idea was discussed, and it was decided that because silk was used in the canopy and rigging lines, and because the silkworm or caterpillar let itself down to the ground by a silken thread, it was to be called the Caterpillar Club with the slogan, 'Life depends on a silken thread'.

From a membership of two in 1922, the Caterpillar Club has become the most exclusive aviation club in the world with a past and present membership in the tens of thousands worldwide. It's a club without joining fees, committee meetings, offices or staff, and is open to all nationalities irrespective of race, religion, gender or political affiliation. There is only one condition for membership. The applicant must have saved their life in a genuine emergency descent using an Irvin-type parachute.

Once accepted, the member received a certificate and a small gold caterpillar pin with the member's name and rank, if applicable, engraved on the back. During WWII, real gold was substituted with gilt gold due to economics. A large percentage of applications were from prisoners of war. None of the Luftwaffe aircrew applied to join during the war, although they were technically eligible as they were using the Irvin chute made at a factory bought by the Nazi government in 1936. Some did apply after the war and were accepted.

ABOVE Paratroopers learn to land correctly using a special harness at RAF Ringway, 1942.

BELOW 1st Polish Independent Parachute Brigade receiving instruction in landing at the Polish Parachute Training Centre at Largo House, Fifeshire, UK, 1942. Photo: Imperial War Museums.

RAAF PARACHUTES

From 1925, the RAAF purchased its first parachutes from the United Kingdom and continued to do so until 1937 when Light Aircraft Pty Ltd in Sydney bought the manufacturing rights from both the Irvin Air Chute Company and the GQ Parachute Company, both of which supplied the Royal Air Force.

When the manufacture of Dominion parachutes in Australia commenced, the Light Aircraft's policy was to endeavour to have, as far as possible, everything made in Australia. The parent companies in England kept Light Aircraft informed of the latest parachute developments anywhere in the world throughout WWII. Samples, drawings and material were constantly arriving in Australia, and the information was supplied to the government. Light Aircraft responded

A LIFE SAVER

In the forward to a booklet illustrating the production of Dominion parachutes by Light Aircraft Pty Ltd, RAAF Air Vice Marshal R. Williams CB, DSO, OBE wrote: *It would be a bold man who attempted to assess the value of a life saved, but at least it is sufficiently great to allow it to be said that if a Dominion parachute produced by Light Aircraft Company saves the life of one young man of this country, all those who have been responsible for establishing the industry and producing the finished parachute will be well repaid. I would like to congratulate the prime mover in establishing the industry and all those associated with the work of producing an article to which any airman in dire need can trust.*

ABOVE Dominion parachute pack. Photo: Australian War Museum.

in kind. A small royalty was paid to the parent companies, but it was suggested the money be used to buy Australian War Bonds instead. That gesture was an indication of the excellent relationship between the companies.

George Mills, an Air Force reservist and WWI pilot, was the managing director of Light Aircraft's parachute division assisted by his secretary, Miss Storey, a RAAF Flight Lieutenant, and Wally Shiers, one of the team that had made the first England-to-Australia flight in a Vickers-Vimy in December 1919.

The factory and office were in Sydney, on the seventh floor of Grace Brothers on Broadway near the University of Sydney. As there were no trained workers in the specialist field in Australia, staff were recruited from vocations such as dressmaking, coat, vest, trouser, bag making, georgette and silk fabrication. One employee, Lorna Walker, stated that one of the benefits of working with the 65 feet of silk it took to make a parachute was the availability of offcuts which factory workers were able to turn into useful items of clothing, especially underwear.

THE ROO CLUB

Inspired by Irvin's Caterpillar Club, Mills instigated a parachute club for Australians whose lives were saved using the Dominion parachute. Little known and arguably more exclusive than the Caterpillar Club, it was dubbed the Roo Club. Qualifying members were presented with a plaque and a gilded gold tiepin in the shape of a kangaroo.

The first three Roo club members were RAAF Leading Aircraftsmen Ian Sinclair, John 'Jack' Hewson and Hugh Fraser. On 29 September 1940, two Avro Ansons were on a training flight from No.2 Service Flying Training School at Wagga, NSW. At 10:45am, the two aircraft collided at about 3,000 feet and became locked together facing the same direction. They continued flying but slowly began to lose altitude. In the upper Anson, trainee pilot LAC Leonard Fuller remained at the controls while his navigator, LAC Sinclair, bailed out.

As soon as the initial contact had taken place, the pilot of the lower Anson, Hewson, had increased his engines to full power and locked the controls enabling Fuller to continue flying and not spiral out of control. As Hewson had not been wearing his parachute, Fraser, his navigator, handed it to him before parachuting to safety.

Hewson donned his chute sitting on the cockpit floor then climbed out through the broken cockpit Perspex, crawled onto the starboard wing and slid off at about 900 feet. When he opened his parachute, it became tangled and he was turned upside down as it hadn't been clipped on correctly. The parachute fully opened at approximately 100 feet, and Hewson slammed into the ground injuring his spine.

Meanwhile, Fuller managed to fly both aircraft about eight miles before bellylanding both safely in a field five miles south-west of Brocklesby. Hewson was the only one injured in the incident and made a full recovery after a few months in hospital.

The last member to join the club, pilot James [Paddy] Nolan, was formally presented with his club badge and presentation plaque in 1945 before the assembled employees of the Light Aircraft's Dominion parachute division.

Nolan's Boomerang aircraft was hit by Japanese small arms fire causing his engine to seize. He turned his aircraft upside down and bailed out over the Solomon Sea at about 400mph under the height of 1,000 feet with the chute opening less than 100 feet from the water. The deceleration was so great that it pulled his flying boots and socks off and he hit the water so hard it split the soles of his feet. Nolan managed to inflate his rubber dingy and was later rescued.

The Roo Club has only 122 and a half members. The 'half' member bailed out at 150 feet with a parachute which was half Dominion and half Irvin.

Sadly, more detailed information about the club is virtually non-existent. When the parachute side of Light Aircraft Pty Ltd closed its operations in the 1970s, the membership details and records were lost to history in an office cleanout. A tragic loss to a part of Australian aviation history.

TOKENS OF APPRECIATION

On 13 September 1940, Luftwaffe bombers targeted Buckingham Palace. The private chapel built for Queen Victoria was hit and destroyed. RAF fighter pilot, Flight Lieutenant James 'Ginger' Lacey DFM shot down one of the German bombers. The Light Aircraft Company had a Dominion parachute and a silk scarf autographed by all the staff sent to England and presented to Lacey as token of their appreciation of his downing of the enemy aircraft. FLT Lacey had already made nine parachute escapes during combat and had accounted for 23 enemy aircraft. The famous 'legless airman' Squadron Leader Douglas Bader was also presented with a silk scarf autographed by the Dominion parachute staff in appreciation of his service to his country.

BALANCING A TEAM

ACCORDING TO **RECRUITMENT EXPERT LOU ADLER,** THERE ARE ONLY FOUR WORK TYPES: THINKERS, BUILDERS, IMPROVERS AND PRODUCERS, AND EACH HAS ITS PLACE IN GROWING AN ORGANISATION.

THE FOLLOWING IS A story relating to many businesses that I have worked with, and to me it is thought provoking.

The story starts with a Thinker who saw a need and espoused an idea for a new venture. The idea was then shared and some Builders started to convert the idea into reality. As a few years went by, Improvers made the reality better and the business began to grow. Then Producers worked out ways to provide the business services over and over again, delivering quality in a repeatable manner.

Then the process began again with new ideas and new ways of doing business being developed as the old ideas became stale.

As the organisation grew and reached maturity, more of the work was done by the Producers and Improvers. However, without a culture of consistent improvement, the Producers soon took over and implementing change became slower and slower until it stopped.

By that time, the Thinkers and Builders had left because they had become bored. The Improvers soon followed.

Over time, the old Producers, who could not continually evolve by learning new skills and processes, were left behind to fend for themselves and the organisation.

Maintaining balance across all four "work types" is a constant, but necessary struggle for an organisation to continue to grow, adapt and survive. Every workplace needs a mix of all four work types, dependent on the actual work involved, the scope and scale of the roles required, and the organisation's growth rate. To ensure balance and flexibility, all four work types should be considered when preparing for any new employees or developing any new strategy.

Since people tend to start out using their skills in Producer jobs, that is the logical start point to this discussion.

Producers execute or maintain a repeatable process. The process can range from a simple function, such as handling a transactional process, to the more complex, such as the performance of multi-dimensional systems.

Improvers upgrade, change or make a repeatable process better. Managers are generally required to continually monitor and improve a process under their charter. Building, training and developing the team to implement a process is part of an Improver's role. Improvers can be individual contributors or managers of

teams and projects: their key is to focus on improving the existing process.

Builders take an idea from scratch and convert it into something tangible and functional. That could be creating a new business model or a complex new product, closing a big deal, or developing a new process.

Thinkers are the visionaries, strategists, intellects and creators of the world, and every big idea starts with them. Their work covers new products, new business ideas and different ways of doing everyday things.

Every person is comprised of a mix of each work type, with one or two attributes dominant. Likewise for every job. As you select people for new roles, it's important to get the work type blend within the team right. That starts by understanding the full requirements of each position, the strengths and weaknesses of others on the team, and the primary objective of the organisation.

In the rush to get new work done, it's easy to lose sight of that perspective, emphasising skills and experience over performance and fit. That is how Builders get hired instead of Improvers, and Thinkers get hired when Producers are required. While there are only four work types, hiring the wrong one is often why the wrong work is delivered.

The model works extremely well when you define the job first and then break it into the four work types. It's less meaningful when you use it to broadly classify a person. In that case, the model only implies interests and preferences, not competencies. For example, just because an individual possesses Improver attributes, doesn't mean they're good at it, and even if they are good at it, their competency may only be in a specific niche application.

While the four work types are useful for defining the work required in any job, on a broader scale the concept can also be used to better understand how companies and people grow, develop and interact. Interestingly, people grow by first becoming technically proficient at something, the Producer role, they then evolve into one or more of the other work types. That is an inside-out progression. Companies, on the other hand, grow outside-in, starting with an idea, building it, improving it and then producing the business output in a repeatable manner.

Unfortunately, as companies grow, change becomes more and more difficult. That type of stagnation can be minimised by looking at every job as a mix of all four work types, balancing the needs of the company with the people currently on the team, and the capability of the new hire. Maybe using the work-type model to achieve a team balance is where the concept has the most value. That alone has the potential to open up the talent pool to a whole new group of Thinkers, Builders, Improvers and Producers, never before considered.

When interviewing people for a position, it is important to understand the work type most applicable to that position.

> **Real knowledge is to know the extent of one's ignorance.** CONFUCIUS

Lou Adler suggests that you ask of a candidate the following question. "What single project or task would you consider the most significant accomplishment in your career so far?"

To see why that simple question is so powerful, imagine you're the candidate and I've just asked you that question. What accomplishment would you select? Then imagine over the course of the next 15-20 minutes I dug deeper and asked you about the ins and outs of your accomplishment.

If the accomplishment was comparable to a real job requirement, and if the answer was detailed enough to take 15-20 minutes to complete, consider how much an interviewer would know about your ability to handle the job on offer. The insight gained from that type of question would be remarkable. But the real issue is not the question, that is just an opening. The details and explanation underlying the accomplishment are what's most important.

Where are your strengths in this model? Thinker. Builder. Improver. Producer. Even if you are retired, such observations are relevant to your life.

Peter Ring, inspired by Lou Adler, CEO, Performance-based Hiring Learning Systems and author of **Hire with Your Head** *and* **The Essential Guide for Hiring.**

TO GOOD TO BE TRUE

HEARD THE SAYING ABOUT A FOOL AND HIS MONEY BEING SOON PARTED? THAT'S WHAT SOME ORGANISERS OF FREE WEALTH CREATION SEMINARS ARE BANKING ON.

HAVE YOU EVER BEEN INVITED to attend a free wealth creation seminar? There is no shortage of them, especially those promising to disclose the secrets of success in the Australian property market. Typically, the seminars feature compelling motivational spruikers who claim to have made personal fortunes out of property investing and are now willing to freely offer you, a complete stranger, the strategies and techniques that have made them rich.

Common messages from the spruikers are that property investments (at least the ones they support) are pretty much risk free, are sure to make you a millionaire in a few short years and will achieve above average returns.

So why would anyone offer these services for nothing? Could it really be out of the goodness of their heart? That's always a possibility, but it's unlikely. What's more likely is that the motivational rhetoric is a softening-up process. After that, serious money can be made out of selling (sometimes) over-priced properties on behalf of developers that are commercially connected to the spruikers, arranging mortgages for potential buyers, and marketing expensive so-called "property education" programs to seminar attendees.

In order to sweeten the deals, the properties mentioned at the seminars will often include "rental guarantees" and apparently generous discounts for buying "off-the-plan" during the seminar program. For example, if a rental guarantee of five years is offered, ask yourself who is paying for the guarantee. It's unlikely the seller will be paying. Could it be that the buyer is actually paying for the guarantee through an excessive price on the property? The same point applies in the case of discounts for buying off- the-plan. It's most unlikely that the discounts will be generous and may not even be genuine discounts at all.

KEY MESSAGES

1. Never make a significant financial decision in the heat of the moment, especially at a seminar where the atmosphere is designed to be exciting and motivating, and does not encourage rational thinking.

2. Before making a commitment from which you can't extract yourself, ask for a detailed written outline of the deal that's being proposed, especially its income and expenses, both now and down the track for, say, at least five years (or the term of your loan, whichever is the greater). That should include all commissions and incentives to the promoter.

3. Seek a second opinion, preferably from an independent, licensed financial adviser who only charges clients on a genuine fee-for-service basis (hourly rate, flat or fixed fees). It will cost you money, but it's likely to give you some assurance that you're on the right (or wrong) track with your investment.

4. Check the on-line reviews of other consumers. It is by no means a definitive basis on which to form an opinion, but it can be a factor in your due diligence of the deal.

5. Check whether the promoter's name (or a company associated with the promoter) appears in:
   - the Australian Securities and Investments Commission's

Connect professional registers (under "banned and disqualified")
- the Australian Competition and Consumer Commission's undertakings register
- the website of your state or territory's consumer affairs and protection agency.

6. Remember the golden rule of investing: if something looks too good to be true, it probably is. Be sceptical. Do not be hurried into making a decision that you may live to regret. If they pressure you, walk away. Do not be a victim of fomo (fear of missing out). One thing that can be absolutely guaranteed is that there will always be another property available (many others, in fact) when you're ready to make a commitment.

It's also worth noting that in addition to the Australia-wide network of commission-based local real estate agents, there are many "boutique" specialist property consultants and mortgage brokers who don't offer seminar programs, but nevertheless promote the merits of buying and financing property through them. We're certainly not suggesting those consultants are unethical or dishonest, however, potential clients should understand how their consultants are remunerated and how that might impact on the advice that is being offered.

So, for example, where a "boutique" property specialist is paid a commission by a property developer (and not a genuine fee for service by the client), it could reasonably be concluded that the objectivity of the advice may be impacted by a conflict of interest. That does not mean the advice is necessarily wrong or inappropriate, however, when assessing the merits of the advice being offered, potential clients should always assess whether it is genuinely offered in their best interests.

Air Commodore Robert M. C. Brown AM FCA (ret'd), ADF Financial Services Consumer Centre

WORDS Flight Lieutenant (AAFC) Paul A Rosenzweig OAM

AVIATION OPERATIONS ONLINE

OVER THE PAST TWO YEARS there have been some big changes in the way the Australian Air Force Cadets (AAFC) conducts its aviation activities, and those changes have been reflected in improvements to the AAFC website.

The new aviation pages at airforcecadets.gov.au inform Cadets of the programs available for an introduction to aviation, provide more details about powered flying and gliding training, and promote opportunities for pilots, aviation instructors and staff.

The AAFC aviation program enables Cadets to have a safe, positive and educational aviation experience, and the webpages open with an introduction to aviation and Aviation Operations Wing. The website also includes the new aviation brochures for powered flying and gliding, and for staff opportunities.

Pilots, aviation instructors and staff members play a vital role in the provision of the AAFC flying training program. The aim is to give Cadets exposure to, and inspire their interest in, the aerospace industry through education in theoretical and practical skills of aircraft handling, aircraft engineering and flight operations.

If you are interested in helping develop future leaders within your community, have a look at the brochure for pilots, aviation instructors and staff at airforcecadets.gov.au/volunteers/instruct-aviation.

CADET PILOT Q + A

CADET SERGEANT JESSE ISAAC

JESSE ISAAC is a member of No.604 Squadron (Hampstead Barracks, SA). Recently promoted to Cadet Sergeant, he holds the Bronze Award of the Duke of Edinburgh's International Awards and is a current Silver Award participant.

HAVE YOU FLOWN A GLIDER PILOT EXPERIENCE (PEX) FLIGHT?

When I got the opportunity to fly a glider with Cadets, I couldn't say no! We were using a winch launch and were told it would be quite an experience. When I sat in the glider with an instructor, all my fear disappeared. I and the other Cadets will never forget that feeling of getting pushed back into your seat when you launch.

We found a good thermal and were able to climb quite high. After about 10 minutes, the instructor explained the controls to me, and then I took the controls. That really helped me put the theory I had learnt at my home squadron into practice.

The activity really helped light the blazing passion of flying that I now hold. I truly believe PEX flights hold life-changing possibilities.

WHAT WAS YOUR EXPERIENCE OF POWERED FLYING?

After I flew in a glider, I knew flying would become a massive part in my life. I began flight training with a private flight school hoping to be able to obtain my Recreational Pilot Licence (RPL) when I turned 16. All my theory training from my home squadron became very relevant. Powered flying felt quite a bit different and it was exciting to be able to explore while up in the air, while having an engine and not having to worry about finding thermals.

WHAT WAS YOUR EXPERIENCE OF FLYING SOLO?

On 16 April 2021, I first went up with my instructor and did three circuits to ensure conditions were safe and I was ready.

I will never forget the moment of getting

LEFT Jesse Isaac after completing his first solo powered flight in a Cessna 172S.

taxi clearance from Air Traffic Control and taxiing the aircraft all alone. I was so nervous, but as soon as I was given clearance for take-off, my nerves settled and my training kicked in.

I still always get a thrill when I advance the throttles and move down the runway, but I will never forget that moment on my first solo.

HAVE YOU DONE MORE FLYING?

In December, I did my RPL flight test and I was examined on several manoeuvres as well as more complex procedures. After my hard work, I'm now able to take passengers into the sky and allow them to have a feeling for aviation, and hopefully inspire people to start the same journey I started on my first PEX flight with cadets.

WHAT WOULD YOU SAY TO A NEW CADET?

Joining cadets is without a doubt one of the best things I've ever done. From flying a glider with cadets, to obtaining my pilot licence, the AAFC has supported me every step of the way and is one of the most valuable life experiences I'll have.

LEADING CADET JAYDN MERESZKO

DURING A GLIDING COURSE conducted by Warwick Glider Training Flight last year, Leading Cadet Jaydn Mereszko from No.222 Squadron (Upper Coomera, Gold Coast, Qld) flew his first solo flight in the DG1000S glider.

WHAT WAS YOUR EXPERIENCE OF FLYING A GLIDER?

Flying a glider is easy and extremely fun. You have freedom and the only thing you hear is the sound of the air rushing in through the vents. Although it is easy, it can also be quite challenging at times, but to me that's just part of the fun and the path to becoming a better pilot.

WHAT WAS YOUR EXPERIENCE OF FLYING SOLO?

Before take-off on my first solo, I was very nervous, but as soon as I started rolling for take-off, I knew I had it in the bag. You will never forget your first solo, and the smile on your face after you touchdown will be long remembered by you and many others.

As I am still learning how to become a better and safer pilot, I look back to when I first started, so I can feel proud of myself for how far I have come in under a year. I believe we can achieve anything if we put the effort in at the very beginning.

WHAT HAS THE AAFC TAUGHT YOU MOST?

The AAFC has taught me how to become a more respectful person, a more loyal person and I have learnt that you only get out what you put in. And that there are countless people just like you – you will meet them eventually – and they could be some of your closest friends for life.

WHAT WOULD YOU TELL A NEW RECRUIT JOINING TODAY?

Put in the effort to do what you want in this organisation, only then will you accomplish things you thought you couldn't, only then will you start seeing results.

HOW WOULD YOU SUMMARISE THE EXCITEMENT OF GLIDER FLYING?

The excitement of flying a glider is endless, no flight is the same as another. You will always enjoy yourself up in the sky, towering over everything in your way, peacefully gliding silently after you have released from the tug. I am lost for words when it comes to describing gliding and my general experience, it is just truly amazing.

BELOW LCDT Jaydn Mereszko preparing for his first solo flight at Warwick Airport.

GLIDING OPERATIONS

LAST YEAR, Bathurst Glider Training Flight had to cancel a proposed Gliding Course due to COVID restrictions, so the keen staff ran an online gliding course for their aviation trainees. Then early this year, Bathurst Flight started preparing to run Pilot Experience (PEX) flights, to give Cadets in No.3 Wing (NSW) the feel of flying a DG1000S glider.

They began the year running staff currency and recertification training. Squadron-Leader (AAFC) Bill Gleeson-Barker said: "Some great flights were achieved in spite of some bad weather and all the COVID safety measures".

That preparation was followed by a successful COVID-Safe PEX activity on the first weekend of February, with more than 50 cadets and staff in attendance.

The AAFC's Gliding Training School comprises three glider training flights at Balaklava, Bathurst and Warwick. It aims to provide every cadet with an immersive aviation experience in a DG1000S two-seater, fully dual-controlled glider – at no cost. For more information, see *airforcecadets.gov.au/what-we-do/training/aviation-experiences/gliding*.

ABOVE The flight line for Bathurst Glider Training Flight's first weekend PEX activity for 2022.

Erika Armstrong joined the Women in Aviation event online. Photo: Chancey Bush, Evergreen Newspapers.

WOMEN IN AVIATION 2022

AUSTRALIAN AIR LEAGUE Forest Lake Squadron hosted its annual Women in Aviation – Evening in the Hangar at Flight Standards (Archerfield) to celebrate International Women's Day 2022.

Each year the squadron is privileged to be visited by extraordinary women from the aviation industry, and this year was no exception. The first guest speaker was Erika Armstrong, pilot and author of *A Chick in the Cockpit*. Based in Denver, Colorado, Erika joined in virtually with a presentation to share her experiences as a pilot, providing cadets with an insight into the aviation industry, along with advice on career pathways and how to achieve their goals creatively.

She also answered questions from cadets about her experiences in such varied roles as international corporate pilot, airline captain, Red Cross and air ambulance pilot, and even flying elite sports teams around the United States.

The cadets were then joined by FLTLT Nelle who is an F/A-18F Super Hornet Weapons System Officer and Flight Test Systems Specialist at RAAF Base Amberley.

FLTLT Nelle shared her story from her inspiration as a five-year-old seeing the jets flying at a family day at Amberley, joining the RAAF as an Officer Cadet through the Australian Defence Force Academy and on to fast-jet training, through to the importance of understanding the fundamentals of flight and navigation.

The Women in Aviation evening was a great success with several visitors also coming to learn about the Air League and the many career paths available in aviation in Australia.

ABOVE RIGHT RAAF FLTLT Nelle (centre) spoke to the cadets about her career as an F/A-18F Super Hornet Weapons System Officer.

THE AUSTRALIAN AIR LEAGUE

The Australian Air League is for girls and boys aged eight years and older who have an interest in aviation as a career or as a hobby. In the Air League they learn about aviation in all its forms through classes in theory of flight, navigation, aircraft engines and a variety of subjects.

PHONE 1800 502 175
EMAIL info@airleague.com.au
WEBSITE airleague.com.au;

FLYING OFFICER KEITH RAYMOND MEGGS OAM, DFM, AAM (US)

7 January 1928 - 13 March 2022

KEITH MEGGS ENTERED the Australian aviation industry in 1943, aged 15, commencing work with Commonwealth Aircraft Corporation (CAC) when the company was producing Boomerang and Wirraway aircraft. He began flying, in gliders, at the end of 1945.

On 5 February 1948, he joined No.1 Flying Training School at Point Cook on No.2 Pilots' Course. On graduation from Point Cook, Keith was posted to RAAF Fairbairn, Canberra, and served with No.3 Squadron. The squadron's role was tactical reconnaissance and it was equipped with Mustangs, Wirraways and Auster aircraft. Keith then served in Nos 75 and 76 Squadrons at Williamtown until the end of 1950.

He was posted to No.77 Squadron in Korea on 14 December 1950 and flew Mustangs and Meteors in the Korean War, earning a Distinguished Flying Medal (DFM) and a US Aerial Achievement Medal (AAM). He completed his Korean tour on 7 February 1952.

Short postings over the next six months included Laverton, No.78 Wing HQ and No.2 Operational Training Unit.

In 1952-53, he saw service in the Mediterranean at Malta with No.75 Squadron flying Vampires as a part of No.78 Wing. Later he flew Vampires with No.75 Squadron in Australia until he was discharged from the Air Force in July 1956.

Keith rejoined CAC in 1957, working for several years on Sabre aircraft and the Ceres agricultural aircraft which was developed from the Wirraway.

He then worked at the Department of Civil Aviation as an Air Traffic Controller before taking up freelance charter flying. His log books have a total of some 19,500 hours on 109 types of aircraft.

In 1959 Keith became a foundation member of the Aviation Historical Society of Australia (AHSA). He served as AHSA President from 1988 to 2013, before becoming a Patron of the Society.

Over the past 50 years, Keith compiled a four-volume comprehensive history of 100 years of Australian aircraft building activity, *Australian-Built Aircraft and the Industry*. He leaves an indelible mark on Australian aviation history. It is no longer possible to gather the amount of detailed information that he compiled over such a long time.

Keith leaves behind a former wife, a daughter and three sons.

SQUADRON LEADER WAYNE NIGEL HIGGINBOTHAM

24 May 1946 - 23 February 2022

WAYNE HIGGINBOTHAM ENLISTED in the Air Force on 6 January 1971. Completing No.80 Pilots' Course, he was posted to No.2 (Fighter) Operational Conversion Unit at RAAF Williamtown on 10 April 1972 and qualified as a Mirage pilot. A posting to No.76 Squadron at RAAF Williamtown followed and when the government disbanded the squadron in October 1973, he was posted to No.77 Squadron

Wayne, or Higgy as he was universally known, was posted to No.3 Squadron RAAF Butterworth on 21 January 1975, the first of two postings to the tropics. He returned to Australia and back to No.77 Squadron in 1977.

Remaining at Williamtown for the next four years, Higgy spent time in No.3 Squadron, and again in No.77 Squadron before returning to Butterworth in December 1981, to No.75 Squadron, marking service in all four fighter squadrons operated by the RAAF.

On return to Australia two years later, he had a series of flying postings to No.77 Squadron and staff appointments at Headquarters Williamtown over the next five years.

The system eventually caught up with him and he was posted to Canberra for a two-and-a-half-year stint in a staff appointment.

Fortune smiled on Higgy and he returned to Williamtown and No.2 Operational Conversion Unit to complete an F/A-18 Hornet conversion course. Posted to No.3 Squadron as a Flight Commander on Hornets, Higgy subsequently served tours at Headquarters Williamtown and No.77 Squadron.

He retired from the RAAF on 5 April 1993 after 22 years of service. During that time, he flew Winjeel, Macchi, Sabre, Mirage and F/A-18 Classic Hornet and completed two tours of duty in RAAF

Butterworth. Higgy was one of the few pilots to accrue more than 3,000 hours flying the Mirage. He was the first non-Sabre qualified OCU graduate to fly the RAAF's heritage Sabre A94-983.

After leaving the Air Force, Higgy spent over 20 years flying Learjet and Westwind aircraft from Naval Air Station Nowra in support of ADF operational training and exercises throughout Australia and many overseas locations.

RIGHT Squadron Leader Wayne Nigel Higginbotham.

AIR COMMODORE JOHN BURROUGHS MACNAUGHTAN AM, CSC

5 April 1940 – 24 April 2022

BORN IN 1940, the son of a 100SQN Beaufort pilot, John Macnaughtan joined the RAAF via the Undergraduate Scheme and was commissioned as a flying officer after completing his aeronautical engineering degree at Sydney University in 1961. His subsequent postings followed a broad career path which would see him play key roles in leading the significant changes required to meet the challenges confronting RAAF Engineering during the last four decades of the 20th century.

John's first posting was to Williamtown, but soon afterward he found himself in Paris as part of the team preparing for our new-age Mirage IIIO fighter aircraft. Returning to Canberra, he filled a newly created appointment where, in collaboration with Australia's Aeronautical Research Laboratories, he was challenged with finding solutions to managing the mounting problems of metal fatigue in the RAAF's fleet of aircraft. He thus became our first 'fatigue expert', and his performance in that role earned him a place at the Cranfield College of Aeronautics in UK completing a Master of Science.

John's broad career then included senior field appointments at the maintenance squadrons of both Richmond and Williamtown, membership of the P3C acquisition team in Canberra, command appointments at No.481 Squadron and RAAF Base Wagga, and senior appointments at GPCAPT and AIRCDRE rank in both engineering and project management in Melbourne and Canberra. His notable successes included leadership of the engineering team that would determine the vexing cause of the Mirage undercarriage problem that had caused the loss of several aircraft, and as head of a team which received a Defence commendation for negotiating the contact to purchase the RAAF's C130J fleet.

John's most important achievement was as leader of a team that developed Blueprint 2020 – a plan which transformed RAAF engineering from a traditional 'stovepipe' organisation to a dispersed, well-regulated system that continues to underpin airworthiness assurance of all ADF aircraft today. A key feature of that system was the creation of the ADF Airworthiness Board, of which John was the first technical member.

Throughout his long career, John was renowned for his conscientious and dogged determination to get to the bottom of each and every issue. He was a modest, quiet achiever, but to those who knew him he will always be remembered as the perfect gentleman.

LEFT John presenting his father's medals to daughter Lisa to wear for a Sydney Anzac Day march.

MOIRA FULTON NEE BYRNES

17 August 1922 - 8 February 2022

MOIRA BYRNES WAS born on 17 August 1922 in Wagga Wagga. Losing both parents before she was 18, life in the pleasant country town was not without it challenges. Ironically, she was born during the Spanish Flu epidemic and passed away during the current COVID epidemic.

Moira enlisted in the Women's Auxiliary Australia Air Force (WAAAF) on 3 February 1944 at No.2 Recruit Centre, Woolloomooloo, as an Aircraftwoman. She resisted attempts to employ her in general musterings, wanting instead to work on aircraft. Her efforts were rewarded and she was selected to train as a flight rigger.

Posted to No.5 WAAAF Depot at Bradfield Park, Sydney for a month to undergo initial training , Moira was then posted to No.4 School of Technical Training in Adelaide on 17 March 1944. Established in 1940, the school trained airmen and airwomen to be riggers, armourers, fitter IIA (flight riggers) and a variety of other trades.

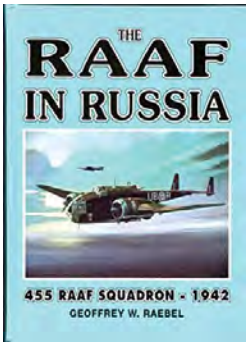
Three months later, on 10 June 1944, Moira was posted to No.1 Engineering School, Melbourne, were trainees learned their trade on Wirraway aircraft. Courses at the school graduated flight mechanics, electricians, instrument fitters and makers and fabric workers. The first WAAAF flight mechanics graduated in April 1944.

Returning to Wagga on 8 September 1944, Moira was posted to No.5 Aircraft Depot, responsible for major maintenance work on Bristol Beauforts and Beaufighters, Lockheed Venturas and B-25 Mitchell aircraft. The depot shared the base with No.2 Service Training School where she met Alan Fulton, a trainee at the school. He successfully completed pilot training and subsequently served with No.149 Squadron, RAF Bomber Command, flying Lancaster aircraft. Moira served at Forrest Hill until the end of the war.

Moira and Alan were married when Alan returned home and they had five children.

She discharged from the Air Force on 19 December 1945 and was a staunch member of the WAAAF Association for over 75 years. She marched every year on Anzac Day, until last year when she made it in a wheelchair.

ABOVE Moira Byrnes in the WAAAF.



REVIEW BY Bob Treloar

THE RAAF IN RUSSIA: 455 RAAF Squadron – 1942

By **GEOFFREY W. RAEBEL**
Australian Military History Publication. RRP $58

NO.455 SQUADRON was formed in May 1941 at RAAF Williamtown, NSW and transferred to England where it equipped with Handley Page Hampdens. Not so well known, the Hampden, along with Wellington and Whitley aircraft, formed the mainstay of the Royal Air Force (RAF) heavy bomber fleet in the early part of the war.

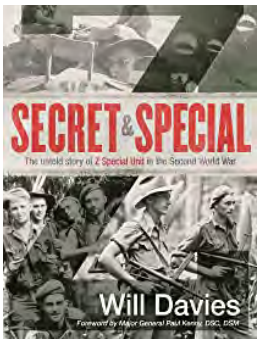
After a short period in RAF Bomber Command, the squadron was transferred to RAF Coastal Command in April 1942. No.455 Squadron and No.144 Squadron (RAF) were subsequently ordered to Russia. Their task was to attack the battleship *Tirpitz* and accompanying heavy cruisers should they sortie to attack convoy PQ18 while on transit to Archangel, Russia. Previous convoys had suffered devastating losses.

The transit flight of the squadron to Russia was about 30 minutes beyond the theoretical maximum range of the Hampden and aircraft losses were expected to be 30 percent. But it was successfully completed with fewer losses than anticipated.

In Russia, the squadron was scrambled only once to attack the *Tirpitz* when it was discovered it had left port. However, no contact with the warship was made. During the mission, the aircraft ventured to 73° north, believed to be the furthest north for an RAAF operation during the war.

The author deftly captures the hardships and isolation that squadron personnel endured in northern Russia, but also the lasting affection they developed for the Russian people and an admiration for their fighting spirit and skills. It is easy to read, despite the significant detail provided, and will capture the attention of the reader.

The RAAF in Russia contains some excellent photographs and provides a wonderful glimpse into a little-known part of the Air Force's history.



REVIEW BY Bob Treloar

SECRET & SPECIAL: The Untold Story of Z Special Unit in the Second World

By **WILL DAVIES**
Penguin Random House. RRP $27.75

***SECRET & SPECIAL* RECOUNTS** the operational history of the Inter-Allied Services Department. It was formed at the request of General Blamey in April 1942, four months after the Japanese attack on Pearl Harbour and the invasion of Malaya. Styled on its British counterpart, the Special Operations Executive was renamed Special Reconnaissance Department (SRD) in 1943.

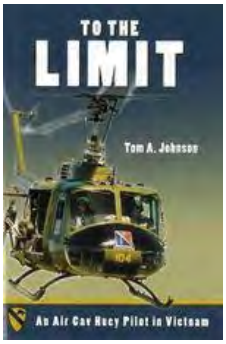
Its first operation was Operation Jaywick in September 1943, a covert attack on shipping in Singapore Harbour by Z Special Unit, formed within the SRD. Jaywick was undertaken by a mixed force of Army and Navy personnel, with the majority drawn from the Navy.

The unit was tasked to "obtain and report information of the enemy... weaken the enemy by sabotage and destruction of morale and to lend aid and assistance to local efforts to the same end in enemy occupied territories".

In all, Z Special Unit undertook intelligence gathering and raiding missions throughout Southeast Asia including New Guinea, Singapore, Timor, Malaya, Borneo, Vietnam and the Dutch East Indies. Important to its operations were the vessels manned by Navy personnel. While many of the operations were successful, SRD also suffered some significant disasters.

Will Davies has captured the essence of those operations and provided the human touch to a band of men who for many years went without due recognition of their feats.

Secret & Special is easy to read and is well researched. It provides the reader with an informative picture of the war conducted in the jungle and the islands on Australia's doorstep while detailing the hardships, heroism and resilience of the men of Z Special Unit. It will appeal to readers with even only a passing interest in the military history of Australia's near north.



REVIEW BY Bob Treloar

TO THE LIMIT: An Air Cav Huey Pilot in Vietnam

By **TOM A. JOHNSON**
Potomac Books. RRP $49.25

THE AUTHOR, Tom Johnson, flew Iroquois helicopters (Hueys) in 1967 and 1968 with the 229th Assault Helicopter Battalion, First Air Cavalry Division, US Army in II Corps, Vietnam. He survived medevac and rescue missions, significant key battles, including Hue and Khe Sanh, and major operations in the A Shau and Song Re valleys.

To the Limit is a first-person journey into the grim reality and chaos of the helicopter war in Vietnam. It is told simply and with a style that takes you into the cockpit of the Huey, capturing the emotions and challenges of operations, grizzly and heartbreaking medevacs, and an overriding sense of fear that accompanied most operations.

From a force of some 40,000 pilots, more than 2,000 helicopter pilots were killed or listed as missing in action during the Vietnam War. Tom was one of the fortunate ones. From the routine boredom of life between operations to the tension of quiet preparation and waiting for an impending operation that could escalate into a battle, he vividly describes the personal emotions of the moment. The swiftness of combat is well described with the loss of five helicopters in less than 10 seconds to radar-guided anti-aircraft fire when entering the A Shau Valley. Each aircraft was carrying nine people.

While a personal account, *To the Limit* provides an excellent description of helicopter warfare in Vietnam and an extraordinary insight of the challenges for the men who flew them. From the dangers of flying over inhospitable jungle to the savagery of war, Johnson's attention to detail is faultless. It is a compelling read for those with an interest in how helicopter warfare was waged in Vietnam.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UPLIFTING OPPORTUNITY

Powering up
from the beginning

We are immensely proud to have powered the Royal Australian Air Force throughout its illustrious history. Our long relationship remains strong to this day, and we will continue to support the air men and women into the future. We have shared a century of innovation, partnering to break new ground in the field of aviation, and we are committed to continuing that pioneering spirit to enable future generations to reach for the skies.