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Senior Aviation Safety Officer Forum
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01 2023 EDITION

Spotlight

Delivering capability

Critically assessing compliance and conformance within Defence aviation standards

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FOREWORD

WELCOME TO *Spotlight* 01/2023. As the new Director of the Defence Flight Safety Bureau (DFSB), I would like to acknowledge and thank the previous Director, GPCAPT Dennis Tan, for his outstanding professionalism, dedication and overall contribution to Defence aviation safety. Throughout his tenure, he provided superior leadership of DFSB to investigate and report on challenging and complex aviation accidents such as the MH-60R Controlled Flight into Terrain and F/A-18F Super Hornet Double Ejection. Furthermore, it is also important to acknowledge numerous safety initiatives that he championed, such as the continued development of: Aviation Safety Officer education and training; publishing and multimedia support products; safety reporting; research projects; and human factors and Non-Technical Skills (NTS) awareness.

Since the previous edition of *Spotlight* 02/22, Defence Aviation unfortunately experienced a Class A event – the ditching of an MRH-90 Taipan that resulted from a catastrophic failure of the Number One engine. It is a testament to the MRH-90 Taipan crew's professional handling of the emergency that the aircraft was successfully ditched and the crew egressed safely.

Defence Aviation also experienced several near misses and events that progressed beyond all expected and remaining risk controls, and which demonstrated low situational awareness by the incident crews throughout the sequence of events. Although analysis of individual and team actions often highlight human error as the defining event, it is important to understand that sub-optimal conditions related to local factors, risk controls and organisational influences are nearly always significant contributing factors to the sequence of events and degradation of situational awareness.

DFSB Aviation Safety Investigation Reports continue to highlight two noteworthy systemic themes: insufficient application and knowledge of risk-management practices; and ineffective oversight of personnel to cater for inexperience, lack of currency and as part of an overloaded workforce. Furthermore, ever present organisational stressors – high workload and operational tempo; fatigue; complex and or inadequate orders, instructions and publications; and deficiencies in sustainment support – on Defence Aviation commanders, supervisors and managers continue to create tension and prioritisation issues for the delivery of capability while minimising risks to aviation safety.

I note the extremely positive culture of aviation safety reporting across Defence Aviation, which ultimately serves to capture and share lessons, findings and recommendations for the benefit of all organisations. Similarly, I am pleased to note increased awareness of the requirements for and benefits of integrating NTS education, training and skilled practice across all aspects of Defence Aviation operations. In particular, DFSB advocates that advancements in the practical application of NTS by operations personnel is likely to make significant contributions to Defence Aviation safety.

As you read this edition, I implore commanders, supervisors, managers and operations personnel to reflect upon organisational pressures to deliver capability, thence to question whether your organisation's risk management, supervision and authorisation policy, procedures and practices are robust and commensurate with the scale and complexity of aviation operations and activities being conducted.

Very respectfully and kind regards,

Group Captain David Smith
Director DFSB

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Complacency

an easy trap to fall into

By FLTLT Andy Bialek

"RUNWAY INCURSION AT BRAVO." I indicate to the tower controller. The fire vehicle had entered the runway after the passing of just one of the two F/A-18s in the formation. The tower controller immediately advises the second F/A-18, who is fortunately already travelling slow enough to avoid serious conflict. But how did we get here? The answer lies in a combination of distraction, knowledge, decision, and perception errors.

The situation was a relatively routine emergency; the lead of a pair of F/A-18s had suffered abnormal landing gear indications on arrival and had elected to hold as a formation for troubleshooting. This was common, and apart from a generally more compressed timeline to respond, was a standard activation of the aerodrome emergency plan.

The first slip was a simple one; conditional clearances to enter the runway (instructions to enter once a particular aircraft has passed) are not permitted when the condition is reference a formation. This is simply because it can be hard to tell on the ground which is the last aircraft in a formation.

Despite it being a formation, the surface movement controller issued a clearance to the fire vehicle to enter the runway behind the F/A-18 on final. At that time, the first F/A-18 had landed, and the second was moments from touchdown.

It is common practice for the fire controller to enter the runway immediately behind the emergency aircraft. As is standard, the fire controller had been informed that the first landing F/A-18 was the emergency

In my mind I did not have sufficient time to get the corrected message through the controller and I assessed that the likelihood of misunderstanding of the original instruction was low. Both were incorrect.

aircraft. It is also standard practice for the fire vehicle to be given clearance to enter the runway and follow behind the emergency aircraft.

I had found myself on the phone with the Squadron duty supervisor, who had taken an unusually high interest in this emergency. I was partially distracted but had maintained situational awareness. I heard the surface movement controller issue the incorrect entry clearance but elected not to correct it.

This was an error in my decision-making process. In my mind I did not have sufficient time to get the corrected message through the controller and I assessed that the likelihood of misunderstanding the original instruction was low. Both were incorrect. The final risk control of the fire vehicle look-out failed, they either perceived the aircraft but did not understand the significance or they failed to perceive the second F/A-18 and they entered the runway.

I was the Tower Supervisor at Williamtown for about three years in the lead up to this incident, and before that I had an additional three-and-a-half years of supervision experience at another location.

With hindsight I can say that I had built a healthy level of complacency based on a system that rarely fails. In a system heavily laden with risk controls my belief in the error tolerance of this system had expanded to such an extent that I did not believe it necessary to intervene even in the face of a clear-cut error.

This complacency could have resulted in a disastrous outcome and is an easy trap to fall into once an individual reaches a level of unconscious competence in their duties.

Focusing on what goes right, rather than just what goes wrong, in our safety system is a good step in combating this complacency.

When we are forced to confront the vast array of processes that must work to achieve safe operational outcomes, it is harder to take them for granted.

Reality not so clear-cut

By GPCAPT David Smith, Director DFSB

KEY POINTS

- Defence aviation safety investigations continue to highlight areas of weakness related to flying supervision, risk management and ineffective supervision of inexperienced personnel.
- Experience suggests squadron executives require a detailed understanding of operational and airworthiness regulation implementation.

DEFENCE HAS EMBARKED on significant changes to operational and airworthiness regulations, requiring flying squadron executives to manage flying supervision, flight authorisation and risk management, while also being educated and skilled in the interdependencies of Defence's airworthiness framework.

Squadrons continue to face challenges of high workload, operational tempo, fatigue, Orders, Instructions and Publications (OIP) and sustainment support. Similarly, Defence aviation safety investigations continue to highlight areas of weakness related to flying supervision and risk management, as well as ineffective supervision of inexperienced personnel.

This article shares the perspectives I gained in the early 2000s as a new executive officer (XO) regarding the organisational requirements of flying supervision and flight authorisation; and the need for executives to have a detailed understanding of operational and airworthiness regulation implementation.

In 2005, I was posted to the role of executive officer (XO) of a Lead-In-Fighter (LIF) training squadron from my previous role as an operational conversion unit, training flight commander. I assumed that transitioning to LIF aircraft, thence overseeing LIF training courses and development of LIF graduates in preparation for operational conversion courses would be relatively straightforward with my background and experience in managing operational conversion, instructor conversion and operational flying instructor courses. Both

flying-training institutions operated under the same force element group, and as such, I expected similar cultures of flying supervision and flight authorisation, and similarities with course design and instructional methods. Reality was not so clear-cut.

The LIF squadron I was posted to had a high training tempo and instructor workload, with exceedingly capable and professional instructors – all dedicated to graduating LIF aircrew and mentoring LIF graduates in preparation for front-line operational conversions. In hindsight, the squadron's executives and I were not always cognisant of shortcomings in the squadron's flying management system, application of organisational requirements for air operations nor awareness of airworthiness considerations when introducing new flying-training sequences.

My first challenge as I began ground school for the LIF aircraft was to learn aircraft systems and Normal and Emergency Checklist procedures. When provided with a Flight Manual and Pocket Checklist, I was advised that I would also need to delve into the Flying Order Book (FOB), in which a complete section was devoted to amendments to Emergency Checklist procedures.

I soon discovered that I was required to pen amend my Flight Manual and Pocket Checklist and insert photocopied pages of the FOB into the Emergency sections of both publications. Needless to say, I was not impressed and noted the requirement for a frank discussion with the wing standardisation officer (STANDO) as to why the original equipment manager (OEM) was not tasked to provide a revised edition of both the Flight Manual and Pocket Checklist, through what I expected would be a mature Orders, Instructions and Publications (OIP) review and amendment process.

After completing my LIF aircraft conversion, I felt relatively comfortable that I had sufficient training and experience to undertake tactical proficiency training, then instructor conversion and formal assessment and award of a LIF instructor category. As the XO, it was also imperative that I was sufficiently experienced and formally qualified to instruct, supervise and authorise both Training Flight activities and the wide variety of ADF support tasks being conducted by LIF graduates in the Operations Flight (OPSFLT).

For my first familiarisation flight as the now type-rated XO, it had not yet dawned on me that the squadron did not formally promulgate an authorising officer on the daily flying program. However, a duty pilot (instructor) was promulgated to oversee the many and varied changes to the daily program and to provide assistance to the operations officer. After asking several of the squadron executives, I was eventually provided an authorisation for my sortie by an executive who was otherwise tasked with administrative duties.

After the flight, I knew that it was time to have a difficult conversation with the unit executives as to how the promulgation and delegation of authorising officers was documented in squadron OIP and communicated to squadron pilots.

The squadron was fortunate to have a dedicated flying instruction standardisation officer (FISO), of whom I enquired about the squadron's plan for my tactical proficiency and instructor conversion training. According to the FISO, the generic plan for all new instructors

However, I remained ever curious as to how the squadron's approach to AIT had diverged from Defence aviation standards.

is to follow the progress of the LIF course by leading several LIF training missions and learning from the instructor of record as to how the applicable sortie was briefed, taught and debriefed.

Noting that I had arrived at the squadron mid-way through a critical tactical phase of the syllabus, it was clear that my arrival was out of cycle, which meant that foundational tactical proficiency could not potentially be achieved until the start of the next course in three-to-four months. My obvious question to the FISO was why the squadron did not have a dedicated instructor conversion course in preparation for my instructor category check.

After arranging for several tactical-proficiency missions related to the current phase of the LIF course, and arranging for dedicated instructor conversion and assessment missions, I gained an instructional category (despite there being no formal record of completing a recognised instructor conversion course).

As I embarked on teaching LIF students and delving into the *Instructor Air Training Guide* (IATG), it quickly became apparent that the method of airborne instructional technique (AIT) was not necessarily aligned to the Central Flying School's (CFS) endorsed AIT policy and standards. Many of the instructional events only contained an instructor demonstration followed by student practice; with no clarity as to whether the practice included instructor direction of attention or whether the practice was to be monitored by the instructor. This obviously created natural tension when assessing whether the student had met the required learning objectives to progress to the next syllabus event and or to be assessed as safe solo. Subsequent and frequent discussions with the FISO instigated a complete re-write of the IATG and associated syllabus to align with endorsed AIT policy and standards. However, I remained ever curious as to how the squadron's approach to AIT had diverged from Defence aviation standards.

Graduates of LIF training courses progressed to OPSFLT while waiting for the next available front-line operational conversion course. As the new XO, I was keen to participate in the broad range of ADF support tasks being conducted by OPSFLT, and the squadron in general. This included maritime strike training for the RAN, close air support training for ADF JTAC courses, 'red air adversary' support for the front line operational squadrons and tactical intercept training for the control and reporting units, as well as general tactical proficiency training in all aspects of LIF air-to-air and air-to-ground skills.

LIF instructors were often tasked on an ad hoc basis to fly with and supervise LIF graduates on ADF support missions. My first observation of the squadron conducting a four-aircraft maritime strike mission highlighted that the instructor leading the formation had been allocated minimal time to plan and brief the mission, which on balance was not overly complicated on a good weather day. However, the impact of inclement weather and the instructor's lack of recent experience with fleet-support missions resulted in numerous and lengthy discussions in the debrief as to elements of the mission that were executed poorly, including incursions into adjoining airspace with an active NOTAM for firing serials.

My subsequent discussion with the mission's authorising officer also highlighted that he had not participated in an ADF fleet-support mission for some time and was not informed of the requirement to authorise the mission until the promulgation of the flying program late the afternoon prior. Furthermore, there was no documented guidance as to the commanding officer's delegation of authorising officers for training versus OPSFLT missions, nor requirements for induction, training and assessment of new authorising officers.

Having instructed air-to-ground gunnery during the LIF syllabus, I developed a concept that LIF students should be taught the basics of air-to-air gunnery. After all, LIF graduates would progress to a front-line operational conversion course that included air-to-air gunnery in the syllabus.

Embarking on a plan to source air-to-air banners for the next six-monthly program, and tasking one of the squadron's senior instructors — who had conducted air-to-air gunnery in LIF programs overseas — to progress the concept, I assumed that development of lectures, mass briefs and OIP would be relatively straight forward.

Furthermore, the squadron planned to conduct an operational test and evaluation phase by senior instructors as the necessary step before introducing air-to-air gunnery to OPSFLT aircrew; and to LIF students in due course. However, I soon learnt that my plans for LIF air-to-air gunnery training was causing much angst at the wing headquarters. To the STANDO's credit, I was provided with a very succinct and detailed overview of the required airworthiness and risk management processes to embark on such a new activity.

First, air-to-air gunnery was not detailed in the LIF Statement of Operating Intent and Usage (SOIU), with changes to Configuration, Role and Environment (CRE) likely to increase the aircraft's fatigue-usage profile. Noting that LIF aircraft were accruing unexpectedly high fatigue in certain areas of the airframe, the STANDO was very clear that fatigue usage related to air-to-air gunnery was likely to be very high, requiring careful consideration of changes to the SOIU.

As Defence aviation embarked on a cultural-change program to ingrain Aviation Risk Management (AVRM), the STANDO quite rightly highlighted that the squadron must develop a detailed Mission Risk Profile (MRP) for air-to-air gunnery for review and approval by the wing headquarters.

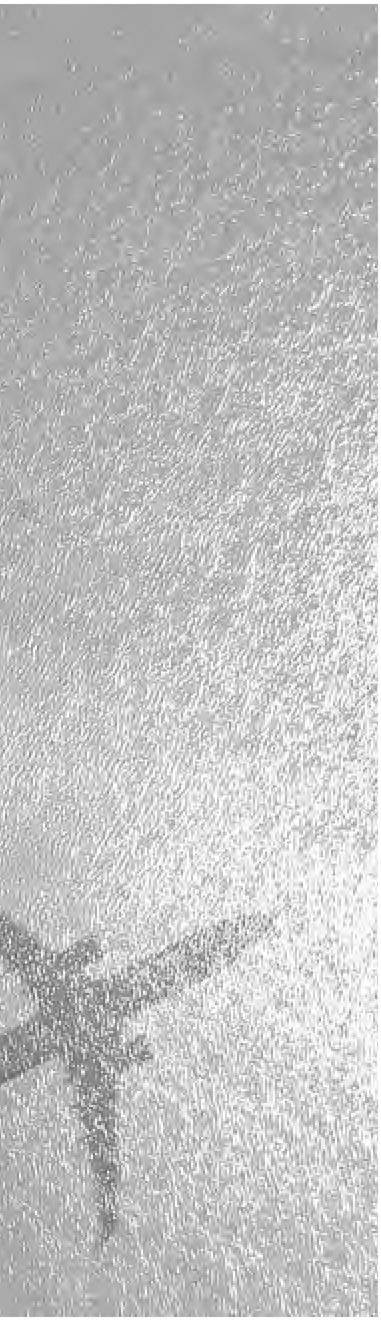
Ultimately, plans for air-to-air gunnery were shelved as neither an updated SOIU nor MRP justified the airworthiness and operational risks associated with the activity. Upon reflection, it was obvious that I had a limited understanding of Defence's airworthiness and aviation risk management frameworks; therefore, setting a poor example to squadron executives as to requirements contained in Defence operational and technical airworthiness regulations.

As a new flying squadron executive, how prepared are you and the squadron's executive to manage the squadron's Flying Management System, and when was the last time it was critically assessed for compliance and conformance with Defence aviation standards?

Battling your INNER DEMONS

KEY POINTS

- Mental illness is as real as a broken arm and deserves the same seriousness.
- The stigma surrounding mental illness impacts the way aviators and their managers deal with it.



By Adrian Park

AS PROFESSIONALS WE have plans and systems for pretty much everything, but what's your plan for the following scenario?

You're the captain of a long-haul transoceanic flight. You're a well-respected pilot — experienced, professional, capable and well-liked. Somewhere across the Pacific you're looking out at the vast expanse of ocean and you suddenly realise how massive it is, how small you are and how completely reliant you are on this machine you call an aeroplane.

You begin to feel a sense of unease. You try to ignore the unease but you can't shake it. You check your systems. Everything is green. You check them again. Nothing. The feeling grows, evolving quickly from disquiet to anxiety and then to dread. You try to fight it. You tell yourself everything is ok. You tell yourself you're a professional pilot and you've been doing this for decades—why the fear? You try to focus on your breathing. You take a deep breath in and slowly breathe out. But you suddenly notice your heart accelerating — in fact, you can feel it thumping in your chest.

'Not now!'

The words out of your mouth are surprising, as though from someone else. But you've felt this more times than you're prepared to acknowledge. It's been with you for the last 17 years of flying and you know what comes next. Sure enough, a rapid and overwhelming feeling you're dying, choking, 'losing control' and 'going mad'—all at once. You feel as though you can't breathe. You begin to sweat so much it's only a few moments before your entire shirt is soaked. Then comes the dizziness, light-headedness and then faintness.

Later, you'll describe it this way:

Halfway across the open sea, I was suddenly stricken. My head seemed to be getting heavy. Then suddenly, I had a horrible feeling that I did not know who I was or what I was doing. I knew that I was flying a plane and that I had to reach land which was out of sight, but who I was or why I was there, I didn't know. The attack lasted a minute or so. I was in a peculiar condition of half-consciousness, I think. Somehow, I still don't know how, the next minute I was suddenly diving at a steep angle toward the sea. In a sweat of apprehension, I gained control of myself. Was it sunstroke? I didn't know. Amid waves of nausea I recovered the aircraft…

This might seem extreme to the point of fiction but this is a factual account of a real pilot on a real flight. This really did happen and it happened to a world-renowned Australian pilot.

We'll get back to the identity of this pilot shortly, but for now let's circle back to the opening question: do you have a plan for this? To have a plan for 'this' means understanding what 'this' actually is. Some of you have probably already guessed. If you've seen one of the many Beyond Blue or Black Dog advertisements, then you already know these are the classic symptoms of severe panic disorder.

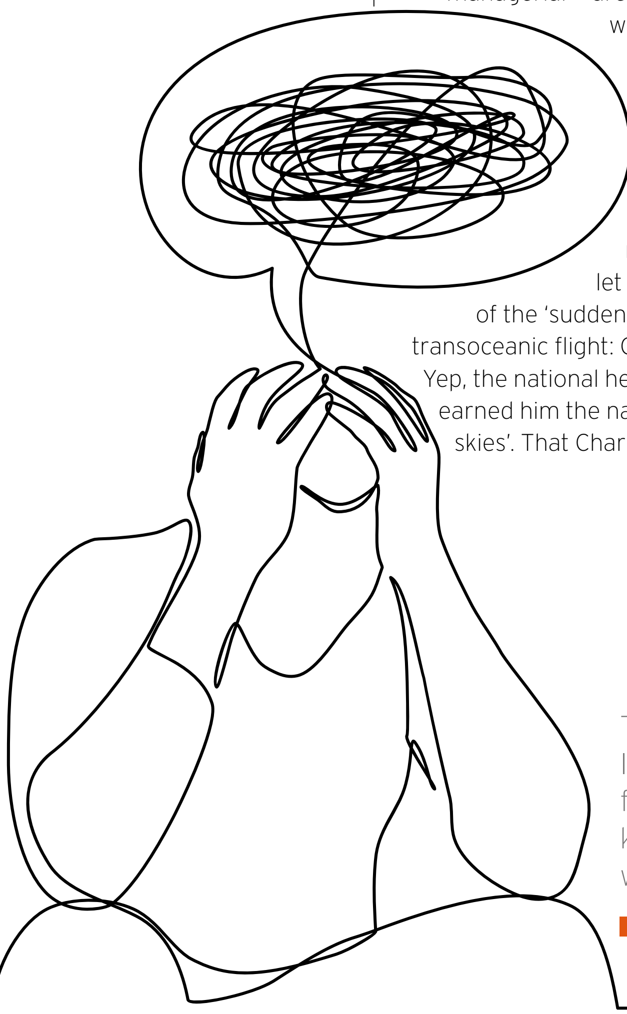
As aviators, we always have a plan; in fact, we normally have several, 'if this, then that' plans. So, what's your plan for this? Maybe your plan will be 'self-management'. Maybe your 'plan' will be to tell yourself you're working too hard and maybe it's just stress and you just need some leave. Then again, your plan might involve what psychologists call 'maladaptive strategies'. Maybe a couple of reds tonight will do the trick. And hey, if it ends up being a whole bottle like the previous few nights (and the few nights before), then that's ok as long as you can cop a break from these damn feelings and tightness in your chest. You could tell your DAME but hell, then CASA will be involved and who knows what happens next? Maybe you could bring this up with your manager but, since you Googled your symptoms and are pretty sure you've got severe panic disorder, what kind of manager is going to want a pilot with 'panic' as their middle name?

Speaking of managers: what's your management plan for this? You've got quite a challenge, haven't you? How do you manage something they're not telling you? And if they do tell you, what do you do now? You can't have pilots with severe panic disorder at the front of an aircraft, can you? Which means you're probably going to ground that pilot and when you do, why would anyone else suffering with the same symptoms ever fess up themselves?

Maybe the easiest thing is to not have a plan, after all, these are aviation professionals we're talking about. They of all people should be relatively free of mental health concerns, shouldn't they?

But then a quick search of 'aviation mental health' and statements such as '350 British pilots grounded in the past five years because of mental illness', 'Mental illness second to cardiovascular disease in reasons for losing an aviation license' and 'Fatigue, circadian dysrhythmia, work patterns and lack of social support increase pilots' psycho-social stress' give you pause. So does the ongoing scrutiny into the Germanwings accident with the apparent murder/suicide of the A320's crew and passengers by the co-pilot (who locked himself in the cockpit) and who had previously been treated for psychotic depressive episodes.

These thoughts – both piloting and managerial – are probably pretty typical when faced with aviation mental illness. But these thoughts can lead to what we could call 'mythologising' or 'pathologising' tendencies. What do I mean by that? To answer let me give you the identity of the 'suddenly stricken' pilot on that transoceanic flight: Charles Kingsford Smith. Yep, the national hero whose aviation exploits earned him the name the 'conqueror of the skies'. That Charles Kingsford Smith.



Then suddenly, I had a horrible feeling that I did not know who I was or what I was doing.

In her recent biography, *King of the Air: The turbulent life of Charles Kingsford Smith*, Ann Blainey does a great job of demonstrating how Smithy was suffering from severe panic disorder and had been since his time at war. Of course, in the 20s and 30s, no vocabulary existed for such things and Smithy would often express other causes such as sunstroke or carbon-monoxide poisoning. He would do this publicly, whereupon many in the general public thought he was either 'losing his nerve' or becoming an alcoholic, even though Smithy's prep for record-breaking flights was well known and involved, in his own words, 'early to bed, gym, exercises every morning, no beers and very few cigarettes'.

Nonetheless, someone sent him a white feather in the mail. The sender evidently thought Smithy's illness was just a myth and he needed to 'harden up'. What was happening here was a 'mythologising' of the illness, that is, understating or downplaying it, which then led to judgementalism around Smithy's character and motivations.

Just as bad is when we mythologise our own illness. Smithy knew something was wrong. So did his wife Mary and his mother Catherine. On the eve of what would be his final flight, they begged him to rest. They could see what he couldn't – the stress of those long flights, the constant pressure from the public and recent financial difficulties – required some fundamental changes.

He wouldn't listen and that final farewell was described as wretched. 'Oh, I do wish, if he comes back safely, that he will never do these long flights again,' his mother told a reporter in an unusual display of emotion.

No one can say with certainty what caused the disappearance of the Lady Southern Cross, not least because the aircraft has never been found. But we do know that every significant aviation accident has multiple causal factors, and Kingsford Smith's mental state appears to be just such a factor

In the terms of James Reason's accident causation model, Kingsford Smith had a large hole on one of his 'Swiss cheese' defence layers, when he set out from Croydon on that fateful trip.

We also know mental illness is as real as a broken arm and deserves the same seriousness – from ourselves and our managers.

If our mental health plan should account for our mythologising tendencies, then it should also account for our pathologising temptations. To 'pathologise' is to make the measure of the illness the measure of the person. This is where the illness – as a near horizon of its own limitations – obscures the potentiality of the person.

Again, Smithy shows this tendency. 'Am I a squib?', he would ask of himself. A squib was a colloquialism of the day and meant 'a worthless person'. Imagine that – the great conqueror of the skies, the guy on our old 20-dollar bill, the guy whose name is on one of our biggest airports and numerous streets around the country, seeing himself as worthless because of his own illness.

We can do the same thing if we look at ourselves or others suffering with mental illness and buy into the false truth this is all there is and all there will ever be.

Consider Smithy. At the same time as he struggled with anxiety and panic disorder, he was able to complete a 34-and-a-half-hour leg from Suva to Albert Park on his record-breaking trans-Pacific flight. This was while sitting on wicker chairs bought from Wian's furniture store in Glendale, with engine noise as loud as sledgehammers and wind through the cockpit so cold and biting a small silk Australian flag hung between the petrol gauges was ripped to shreds. Despite his illness, he accomplished great things. Despite our own struggles, so can we.

This leads us back to the original question and the conclusion: what's your plan?

Consider the figure of Smithy hunched over the controls of the Southern Cross. Would your plan restore, redeem, strengthen and enhance the essence of Smithy or would it ignore, trivialise, suppress and even quench that spirit? What will your plan do for (or to) the 'Smithys' in your world?

Again, Smithy shows this tendency. 'Am I a squib?', he would ask of himself. A squib was a colloquialism of the day and meant 'a worthless person'. Imagine that – the great conqueror of the skies ...

Resources for a mental health plan:

- Beyond Blue
- Black Dog Institute
- Mates4Mates
- Australian Federation of Air Pilots member assistance program
- HIMS Australia
- Australian and International Pilots Association welfare

This article was originally published in *Flight Safety Australia* magazine. Reprinted with permission from FSA and the author.

Senior aviation safety officers gather for education and engagement

THE SENIOR AVIATION Safety Officer (SASO) Forum, held in Canberra in April 2023, served as an important engagement activity by the Defence Flight Safety Bureau (DFSB) with Defence Aviation Commands and Defence Organisations responsible for aviation operations. The broad aims of the conference were to discuss DFSB's key safety initiatives, seek feedback on common issues and challenges for the conduct of Defence aviation safety management systems, and share observations and lessons from investigations.

The Director of DFSB, GPCAPT David Smith, opened the conference by highlighting that Defence had experienced numerous near misses in recent years that could have led to Class A events, especially noting that the sequence of events progressed beyond all remaining risk controls. He discussed that DFSB was developing a revised SENTINEL reporting framework that would be closely aligned to the Defence Aviation Safety Regulatory (DASR) framework, in order to clarify reporting of events for: Flight Operations (inclusive of UAS); Initial and Continuing Airworthiness; Air Navigation Services/ Air Traffic Management; Aerodromes Operations; Air Cargo Delivery; and Air Battle Management Systems. He also discussed that DFSB was undertaking a review of Defence's corporate approach to risk management for aviation operations in order to improve the usability of and access by operational personnel of risk management documentation.

GPCAPT Smith shared insights from the *FY21-22 Defence Aviation Safety Health Assessment* and associated *DFSB Annual Review of Safety Statistics*, which remain as ever-present organisational risks to aviation safety:

- Organisational influences and pressures related to workforce, operational tempo and fatigue, Orders, Instructions and Publications (OIP), and sustainment support continue to be experienced across all organisations.
- DFSB Aviation Safety Investigation Reports highlighted recurring systemic themes related to insufficient application of risk management practices and ineffective oversight of personnel to cater for inexperience and or lack of currency.

According to GPCAPT Smith DFSB perceived some complex Aviation Safety Reports (ASR) were classified before a detailed analysis of the breadth and depth of the investigation had been completed. He noted a tendency to under-classify ASRs, which could lead to not preserving key evidence should the event be re-classified to a higher level during the investigation process.

DFSB executives presented a range of topics and initiatives related to investigations, education and training, reporting, intelligence and research, and publications and multimedia:

- **INVESTIGATIONS.** CMDR Dom Cooper highlighted observations from the outcomes of investigations into recent Class A and Class B events. CMDR Cooper acknowledged the immediate response provided by qualified Aviation Safety Officers from Fleet Air Arm that assisted DFSB to preserve key evidence after the MRH-90 ditching in Jervis Bay.
- **EDUCATION AND TRAINING.** WGCDR Clare Fry discussed the DASA integrated project to revise DASR SMS and provide clarity of occurrence reporting policy, which would necessitate the withdrawal of the *Defence Aviation Safety Manual* (DASM) as the corporate solution to compliance with DASR SMS. Furthermore, WGCDR Fry highlighted that information contained in the DASM would be integrated within DASR SMS and supporting guidebooks and manuals such as an investigation and reporting manual. WGCDR Fry also stated that DFSB was critically reviewing training and education related to Aviation Risk Management, Aviation Safety Officer and Aviation Incident Investigation courses.
- **PUBLISHING AND MULTIMEDIA.** Mrs Rebecca Codey advised the conference how the DFSB Publishing and Multimedia section can support aviation commands to develop proactive safety products and campaigns. Mrs Codey also requested ongoing support from the aviation community to write articles for *Spotlight* magazine, which is an important and influential means of sharing lessons and promoting aviation safety.
- **REPORTING, INTELLIGENCE AND RESEARCH.** Mr Ryan Cooper provided updates on the promulgation of revised ASR Event Classification Factsheets for Flight Operations and Maintenance. Mr Cooper discussed proposed SENTINEL and SALUS upgrades, and the development of an ASR Classification Guidebook and tailored ASR Burst Reports. Mr Cooper also noted that advancements in the education and training of Non-Technical Skills (NTS) were a future focus of his section, with poor or inappropriate NTS being reported as a significant contributing factor during event investigations.
- The Fleet Air Arm, Army Aviation Command and Headquarters Air Command SASOs provided updates on respective challenges for the management of aviation safety. Broadly, the SASOs highlighted ongoing organisational challenges and pressures related to: high operational tempos; the introduction-to-service of new platforms and capabilities and associated preparedness requirements; reductions in flying rates of effort and associated aircrew experience levels; and reduced ability to grow supervisors with appropriate background and experience to authorise complex and demanding missions. Discussions related to SENTINEL reporting of fatigue and crew duty variations highlighted that supervisors required greater visibility of the submissions of these reports and that there was a general lack of reporting of fatigue as a contributing factor in ASRs.

GPCAPT Smith closed the conference by reiterating DFSB's key initiatives to assist SASOs to manage command-led aviation safety management systems. Of particular note, GPCAPT Smith stressed that advancements in risk management and NTS education and training are vital to improving the safety performance of Defence aviation.

SASO presentations are available on the DFSB SASO Website and a second conference is being planned for October/November 2023.

MILITARY PILOT SELECTION

THE FIRST DECADES

By the late Stan Bongers

In 1914, very little, if anything, was known regarding the qualifications of an aviator, aside from the fact that it was assumed that he must possess an unusual amount of dare-devil spirit.

F. Dockeray and S. Isaacs, 1921

Introduction

MILITARY PILOT TRAINING is a lengthy process and the average cost of failure, even during initial training to 'wings' standard, is very high. After graduating with their 'wings', military pilots proceed to operational training in military aircraft that are expensive to acquire, maintain and operate. As training progresses, and costs escalate, the price of failure becomes incalculably high.

Since the early days of the First World War, when both general and military aviation were in their infancy, military organisations have developed pilot-selection processes. These processes attempt to achieve manning requirements while screening out applicants with an unacceptably low probability of meeting the basic standards.

These standards are discriminating because flying military aircraft can be demanding and dangerous, particularly in time of war and when training for war.

Although selection processes differ across nations and services, nowadays they generally involve pre-screening by educational requirements, medical standards, a battery of selection tests, and a series of interviews to assess an applicant against well-developed selection criteria. Increasingly, flight-screening programs have been used to supplement the preliminary screening process.

Candidates who demonstrate satisfactory abilities and performance proceed to a selection panel. Like the selection process itself, the composition of pilot selection boards varies, but usually includes a senior officer and a current military pilot. In Australia, pilot selection boards also include a psychologist. Of course, such sophisticated selection procedures were not always the case. This article overviews the progressive development in pilot selection methods during the first three decades of military aviation. Interestingly, several problems encountered in the earliest days of aviation selection remain with us today.

Selecting pilots in World War I

At the declaration of war with Germany in August 1914, Britain had 48 military aircraft whereas Germany had 180. By the end of the war in November 1918, the Royal Air Force had 22,647 aircraft and 103 airships – making it the world's largest air force.

Britain responded very effectively to the expansion need; however, there are few surviving records that describe the pilot selection and classification process used by either the Royal Naval Air Service or the Royal Flying Corps during World War I.

One exception is a review by Dockeray and Isaacs (1921) of early physiological and psycho-physiological studies aimed at improving the process of selecting military pilots. Most of the research involved physiological studies, although some psychological experiments were carried out including "the MacDougall dotting test (used to measure the improvement gained by administering oxygen to pilots who had flown at altitude without oxygen), studies of tremor and giddiness, and a study of temperament and service flying" (p. 128).

Military flight training: The first approach – sink or swim

The world's first military aircraft was a Wright Flyer. After trial flights in July 1909, the aircraft was formally accepted on 2nd August of that year and designated Signal Corps Airplane No. 1. Two US Army officers, Lieutenants Frank Lahm and Frederick Humphreys began receiving flying lessons from Wilbur Wright in October 1909 with both officers soloing after two weeks. However, both officers returned to duty at their units, leaving the Aeronautical Division without a pilot for its only aircraft.

Fortunately, a third officer, LT Foulois had flown as a passenger on several occasions. Based on this experience, he was ordered to take the aircraft to Fort Sam Houston and teach himself to fly. He had never made either a take-off or landing. Foulois made his first flight on 2nd March 1910. By September of the same year, he had piloted the aircraft on 61 flights. While Foulois was teaching himself to fly, the Wright Brothers mailed flying instructions in response to his requests for advice.

Studies of tremor required the subject to close his eyes, protrude his tongue, and stretch out his arms in front with fingers separated and semi-flexed. Apparently, the degree of tremor revealed by this exercise was highly correlated with poor flying ability. It was concluded that "Tremor is absent or slight in the good pilot" (p. 131).

The British laid great stress on simple motor co-ordination tests such as walking a line heel to toe, turning on one foot and standing on one leg with the eyes closed. One of the tests required the candidate to balance a rod on a flat board. This test was recommended as being "a useful method for testing states of exhaustion, flying stress, insomnia, and other neuropathic and psychopathic conditions in the early stages of development" (p. 129-130).

Emotional control

An early focus of pilot selection was on measuring emotional control under stress. Hilton and Dolgin (1991) suggested this approach was

KEY POINTS

- Military pilot training is a lengthy process and the average cost of failure, even during initial training to 'wings' standard, is very high.
- Pilot selection evolved greatly in its first 30 years to resemble, to a significant extent, what it is today.

About the author

The late Dr Stan Bongers joined the RAAF Psychology Services in 1971 and worked with the Service for 28 years, the last 14 years as the Services' Director. His research was instrumental in refining the ADF approach to pilot selection, developing the earliest RAAF organisational climate survey, and shaping collaborative programs in psychometric test development with our allies.

Dr Bongers' broad and unstinting professional work, both inside and outside Defence, which continued long into his retirement, was recognised by the rare distinction of being elected as both a Fellow and a Life Member of the Australian Psychological Society and being awarded the George Kearney Medal for lifetime achievements in military psychology.

This article was drawn from his PhD thesis: *'An investigation of individual differences in performance on complex psychomotor tasks: The role of cognitive abilities and previous flying experience.'*

COL Peter Murphy

due to the mechanical unreliability and high susceptibility to combat damage of aircraft of that era. Pilots who panicked in such situations were liable to lose their aircraft and possibly forfeit their lives.

One could add to this proposition that military pilots in World War I had to contend with many challenges engendered by rapid changes in aerial warfare. Pilots had to adapt. It is not surprising that research in physiology and psychophysiology remain as important today as it was during World War I.

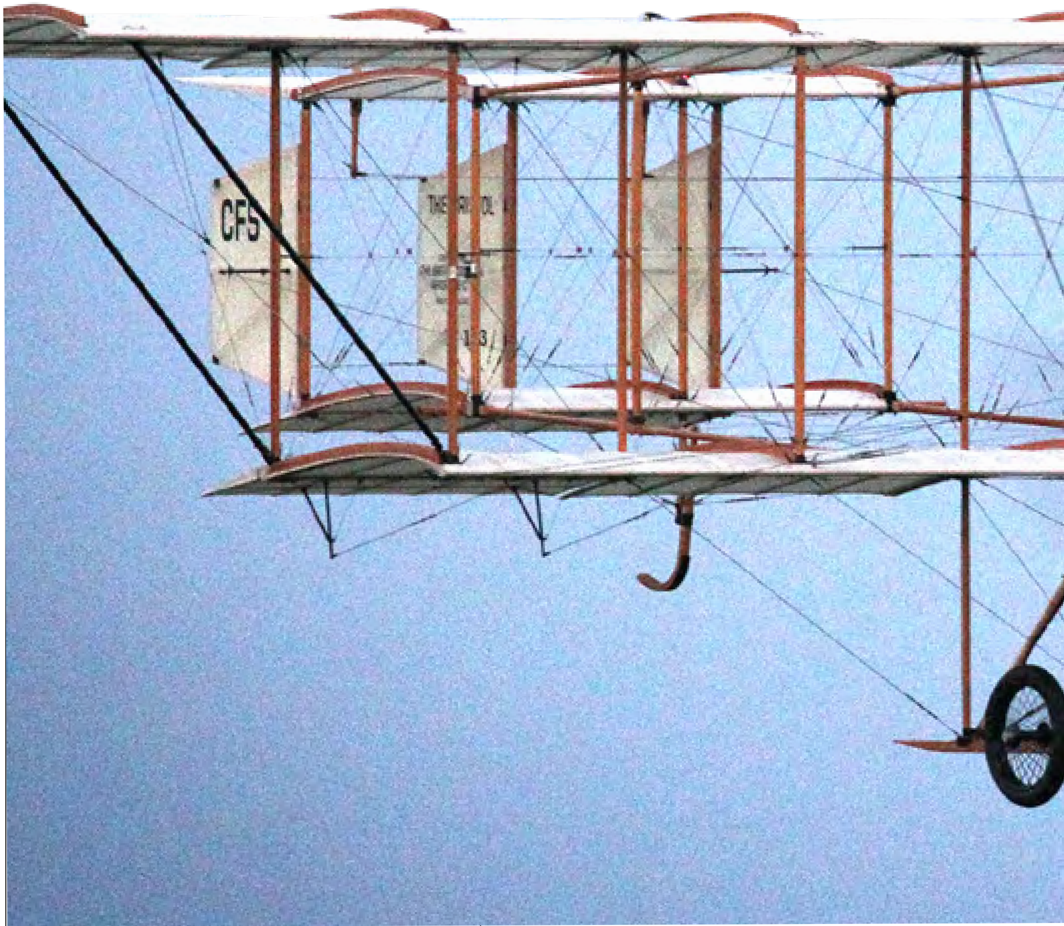
Personality

"We were instructed to select men of good education and high character, men who were in every way qualified and fitted to become officers of the U.S. Army — a rather intangible set of specifications. We were constantly enjoined to remember that the flying officer was not to be an aerial chauffeur, but a twentieth century cavalry officer mounted on Pegasus".

Henmon, 1919, p. 103

Dockeray and Isaacs (1921, p. 147) wrote, "As to the personality of the aviator, it seems that no general rule can be laid down. Quiet, methodical men were among the best flyers. What seems most needed by the aviator is intelligence, that is, the power of quick adjustment to a new situation and good judgment."

He need not be so quick in motor adjustments, provided he thinks clearly or makes quick mental adjustments. The nervous, high-strung individuals, or those bordering on the temperamental, are the least reliable, for though they often become good flyers, they are the most liable to become psychotic under stress." This study may have been the first serious attempt to analyse and describe the military pilot's job and identify some of its requirements.



Testing the 'emotional apparatus'

Bachman (1918), a United States Navy (USN) surgeon, designed an extensive selection procedure for navy applicants for flying training. The procedure was also designed to test the applicant's 'emotional apparatus'.

Bachman believed that tests should be made to "determine judgment and emotional control in the applicant" (p. 38). He did not suggest any particular test but did point out that "a medical officer's supervision is always at hand at every flying camp, and he could be utilised to assist the instructor in making observations". Interestingly, he added: "

At present, the method employed of producing a sudden shock, such as shooting a pistol or creating another loud noise suddenly behind the unexpecting candidate does not meet the requirement".

Bachman focused on cognitive judgment, in particular the applicant's ability to make normal estimates of distance, speed, and time because these "enter considerably into flying in all its phases" (p. 38). He described simple performance tasks that could be used in the assessment process, including one to gauge "arrangement judgment" which involved measuring the time taken to arrange seven pieces of sawn timber into an eight-inch perfect square. Bachman argued that the data supported the conclusion that tests of judgment were possible.

The search for aptitude

In the US during World War I, high physical standards for aviators resulted in a high rejection rate. In addition, many who did meet the physical standards failed pilot training due to

'lack of flying ability'. The problem of how to identify those applicants who would successfully complete their flying training and become operational pilots demanded a solution.

Very little, if anything, was known about aptitude for flying in 1914. And by 1917 very few, if any, real gains had been made in this area of knowledge. Dare-devil spirit, perhaps better expressed as courage, determination, and resourcefulness, was certainly important then, and remains so today. All the same, many people believed there were other attributes to be discovered and applied in pilot selection.

The first criterion-referenced[1] study of pilot aptitude occurred in 1918. The study used 10 tests on 74 student pilots after their initial flying training (Parsons, 1918). Flying instructors provided assessments of flying ability, with ratings of excellent, average, or poor. Against these criteria, the experimental data indicated one test, a measure of emotional composure, was the most valuable because it would have 'rejected' 90 per cent of the 11 students who had been assessed as poor, 17 per cent of the 40 students assessed as average, and none of the 23 students assessed as excellent.

Parsons (1918, p.172) concluded that the study had provided "valuable clues to work on", adding that tests of proven value should be standardised and used to supplement physical examinations. It was an understated but important acknowledgment that there was potential value in psychological research aimed at improving the pilot selection.

An early validation study

Another study conducted in 1918 administered a battery of 10 pilot aptitude tests to 50 cadets whose flying ability was unknown. None had more than three hours of dual flying instruction and some had no flying experience at all. Using test performance alone, it was predicted that five of the participants would either be discharged or would have great difficulty learning to fly, and that two others would show special aptitude.

Of the five predicted failures, three were discharged after (respectively) completing 4, 20, and 22 hours of instruction. One of those three completely wrecked two aircraft. The fourth was suspended and then given another chance. He was commissioned after 85 hours instruction, the class median being 60 hours. The fifth was commissioned after being instructed for 93 hours.

With regard to the fourth and fifth students, the assessment made by the officer in charge was that they did "fair" work. In contrast, the two men predicted to show special aptitude were commissioned as pursuit pilots with assessments of having shown "very good" work. One of those men, who had barely met the educational standards, was commissioned after 43 hours of instruction when the median for his class was 70 hours (see Henmon, 1919).

Based on the successful differentiation and the correspondence between predictions and performance outcomes, the tests were brought into the pilot-selection process.

Between World War I and II

In 1926, a research project was started at the School of Aviation Medicine, Brooks Field, Texas. The aim was to develop tests that helped identify suitable and unsuitable applicants for military flying training. Participants in the study were either second lieutenants or flying cadets, selected on their educational achievements and physical standards.

Two studies testing over 1000 student pilots showed that reaction time test scores distinguished successful from unsuccessful pilots. For example, in one study 71 per cent of those in the fastest reaction time group graduated, whereas the graduation rate for the students in the slowest reaction time group was 39 per cent.

Interestingly, Mashburn (1934) did not support introducing the tests into the selection process at that time, but he did recommend continuing the experiments. He commented that, for practical purposes, "performance tests have value only in a negative sense" (p. 151).

Explaining this, Mashburn reasoned that, "A good score on a test is not a positive indication of aeronautical ability, nor does it convey positive assurance that, if selected, the applicant will be successful in training". In contrast, a poor score "does convey very definite and valuable information. It indicates the applicant to be deficient in certain abilities which are involved in making a creditable performance on the test, as well as normal progress in a military flying school."

World War II – RAF aircrew selection procedures

Parry (1947) reported that the RAF aircrew selection process in 1939 consisted of medical examinations and two interviews, the first interview being conducted by an officer at a Combined Recruiting Centre and the second by members of an Aviation Candidate Selection Board.

By the middle of 1940, three parallel forms of a 20-item General Intelligence Test were used. Although advice was provided identifying scores below which selection for pilot, navigator, wireless operator, or air gunner were considered problematic, the Selection Board members were free to disregard the scores at their discretion.

In addition to the General Intelligence Test, two other tests were introduced.

One was a 15-minute test of elementary mathematical knowledge, the other a written test involving two 50-word essays that would provide some indication of the applicant's knowledge of current affairs and his powers of expression. Because of the perceived risk of subjectivity in marking essays, the officers were encouraged to place 'only a very slight reliance' on this third test (p. 69).

These three tests were used in the aircrew selection process for more than three years. At the beginning of 1942, this three-test battery was enlarged by the addition of an apparatus test which provided measures of psychomotor ability, and three tests designed to identify applicants who were unsuitable for wireless operator training.

RAF high failure rates continue

During 1941, a high percentage of student pilots were suspended before completing their flying training. This caused serious concern because Britain was at war and the large number of training failures appreciably slowed the process of gaining needed pilots. Professor Myers was given the task of reducing the attrition rate. His analyses of the data revealed that 22 per cent of his sample of several hundred cadets failed during the stage of elementary flying training.

A second study of the records for 2292 cadets who had entered Elementary Flying Training School during the summer of 1941 showed that 24 per cent had been suspended before flying solo. Examining the records for the remaining 76 per cent revealed individual differences in time to solo which ranged from less than nine hours to more than 14 hours.

The data for hours to solo were grouped to form four categories, which were named: Very Fast (less than 9 hours), Fast (9 to 10 hours), Medium (11 to 14 hours), and Slow (more than 14 hours). The respective percentages were 8 per cent, 27 per cent, 35 per cent, and 6 per cent. Samples of 150 were drawn from each of the four groups and compared with assessments of flying ability at the Elementary Flying Training School, the Service Flying Training School, and with pilot assessments at the Operational Training Units. Pilots who soloed in less than nine hours had better results than did members who required nine to 10 hours. Likewise, those who soloed in nine to 10 hours showed more superior results across the criteria than did those who required 11 to 14 hours, and those who soloed in 11 to 14 hours performed better than those in the group requiring more than 14 hours to solo. As Parry (1947) explained the findings, "in brief, speed of learning was shown to correlate with quality of performance at all stages of training" (p. 160).

Flight grading

Those data led to a decision to provide 12 hours of flying instruction in the three-week period between finishing Initial Ground Training and leaving for flying training overseas. Under this plan, flight tests were to be given at prescribed intervals during the 12 hours of flying training. The estimates suggested that, for the plan to be successful, it would be necessary to select not more than the top 50 per cent of those who entered a Flight Grading School.

To obtain the extra numbers needed to make this 'top-down' selection plan work, changes were made at the level of the Aviation Candidate Selection Board. Rather than select for a single category (either pilot or navigator or air bomber), all applicants assessed as being suitable for an aircrew category were to be given the opportunity to enter Flight Grading School. This increased the size of the pilot selection pool because about 90 per cent of aircrew applicants wanted to become a pilot.

The term flight grading was applied because the role of the instructional staff was to grade the applicants on each course in order of their piloting skills. The decision whether to accept any applicant for entry to the military pilot training program was made by members of a centralised selection board based on that applicant's flight training score cards. Given that there were differences between schools in the severity of markings, school conversion tables were used as a means of overcoming this difficulty (Parry, 1947).

At a flight grading school, every applicant received instruction from at least two, but no

As Parry (1947) explained the findings, "in brief, speed of learning was shown to correlate with quality of performance at all stages of training"

more than three, flying instructors; and no applicant was assessed twice by the same flying instructor. At the start of the flight grading program, students were assessed after seven hours of training, and again after 11 hours of training; each assessment receiving equal weighting.

Flight grading outcomes

"The main effect of grading has clearly been to prevent those with a basic lack of skill from going into pilot training, but it has incidentally reduced the number of failures due to such causes as airsickness and temperamental instability. There is also evidence that those in the higher deciles have from a third to a half of the accident rate found among those in the lower ranges, while those in the two higher deciles appear to contain a higher proportion of commissionable material. In short, no criterion at all relevant to pilot success has been found which does not show some association with grading results."

Parry, 1947, pp. 162-163

This changed; however, when research showed that the second assessment was more predictive, and that the combined scores were better predictors than either used on its own. This finding led to a revision of the program that provided for three assessments being made — the first after 5.5 hours, the second after 7.5 hours, and the third after 11.5 hours. Equal weighting of the assessments was dropped in favour of a 1:1:2 differential weighting system.

The success of the flight grading program is reflected by the change in the overall attrition rates that followed its introduction. Early in 1942, the gross attrition rate had been approximately 48 per cent of student pilots. This rate was reduced to 25 per cent following the introduction of flight grading. Different percentages were associated with each stage of pilot training, with the biggest difference being an important reduction from 30 per cent to 14 per cent at the stage of elementary flying training. The percentages were calculated from large samples comprising 27,000 and 23,000 members trained in six different theatres.

Enduring selection challenges

Inadequate resources

Henmon's (1919) early validation study was successful in that the results gained the authorisation needed to introduce some tests into the pilot-selection process. Even so, Henmon reported that neither the time nor the human resources needed had been available for the task of calculating the appropriate statistics (what would take seconds today via computer would have been done manually then and could have taken weeks). Henmon asserted that the tests should have been given "a practical tryout" (p. 109) with a view to validating and improving them but the armistice brought the pilot-selection process to a stop before the tests were formally adopted.

Funds are rarely easy to obtain, but a strong argument to support an ongoing research, development and validation program may be found in the high cost of aircrew training failures. The average cost of a suspension for reason of poor flying ability is a useful statistic when accompanied by data showing the utility of pilot selection tests. Usually, such data are readily understood by senior management when presented as an odds-ratio expectancy table showing pilot aptitude stanines cross-tabulated with cumulative course results.

The problem of the criterion (outcome or performance measure)

In 1946, Melton argued that selection tests should yield reliable scores that validly predicted future performance, or some component of that performance. Even in the early decades of military aviation, the USAAF criterion of success in pilot training was simply graduation from elementary, basic, and/or advanced flying training.

For the purpose of evaluating pilot selection tests, the greatest weight was given to the elementary training stage because it was during this phase that the largest proportion of trainees were suspended for deficient flying performance. Such gross outcome measures remain the main criteria for validating pilot selection. Efforts to develop more discriminating predictors of performance outcomes continue to this day.

Intelligence — an unreliable predictor?

The best single predictor of military performance is known to be general ability (often referred to as the Intelligence Quotient or IQ). However, in aviation, general ability as a predictor of pilot performance has been inconsistent. For example, Hilton and Dolgin (1991) believed that "there is little doubt that above average intelligence is necessary to master military pilot training" (p.94) while Hunter (1989) remarked that "there seems to be little relationship between general intelligence and pilot performance" (p. 134).

Part of this confusion may stem from the assumption that there should be a linear relationship between IQ and flight training success, which simply may not exist. Alternatively, it may be that certain aspects of general cognitive ability, such as working memory capacity under stress, are more important to military flying. Wittmann and Süβ (1999) argued that general ability tests, by definition, provide a broad measure of ability, and therefore are unlikely to provide the acuity needed to tease out ability-performance relationships.

Measures of skilled performance are usually quite precise, so that the breadth or 'bandwidth' of a general intelligence predictor is unlikely to match that of the skilled performance criterion. This may explain why most pilot-selection approaches incorporate a battery of subtests or subscales (such as working memory, division of attention and visuo-spatial agility) to tap into specific pilot abilities.

Nevertheless, when a pilot is challenged by a novel and demanding problem-solving situation in the air, most people would hope that his or her responses will be guided by a strong intellect.

More recent research lends a degree of resolve to this debate. Duke and Ree (1996) investigated the value of ability testing in reducing the costs associated with military pilot training in a sample of 1082 USAF officers who had graduated from pilot training.

The results showed that those who had scored in the upper two quintiles (percentile score ✣ 61) of a general ability measure had not required extra hours flying time in order to graduate. In contrast, the 456 pilots who scored in the lower three quintiles had flown extra hours. For this sample alone, and using costs relevant to the time, it was estimated that the USAF would have saved over US$1.1 million had only those in the upper two quintiles had been accepted for training.

Selection is a complex but cost — effective tool

Pilot selection evolved greatly in its first 30 years to resemble, to a significant extent, what it is today. From an approach without selection criteria, other than perhaps "an unusual amount of dare-devil spirit", a range of at times naïve, sometimes sophisticated techniques and measures were developed. These spanned psychomotor tests such as simple reaction time tasks through personality characteristics to measures of cognitive capacity.

Early apparatus with rudimentary flight controls were early prototypes for today's advanced simulators. The concept of multi-aptitude assessment batteries quickly gained favour, perhaps a reflection of the complex array of skills needed for successful combat flying. Flight grading, where previous or initial flying experience is adopted as a predictor of the successful completion of flying training, was introduced. As noted earlier, the RAF Flight Grading Program reduced the overall pilot training attrition rate from 48 percent to 25 per cent.

Validation studies began to appear after the First World War and quickly proved that the use of selection measures could dramatically increase the completion rates of trainee pilots by weeding out those who lacked 'the right stuff'. Research has shown a relationship between hours to solo and flying performance at all stages of training suggesting speed of learning is strongly predictive of quality of performance.

A consistent finding of pilot training during the interwar years was that most suspensions occurred in the elementary stage of flying training. Recognition that predicting failure was a complex matter began to grow. For example, Flanagan (1942) noted that individuals differ in many dimensions, and that it would be overly simplistic to categorise people in terms of their being intelligent or not intelligent; or having fast or slow reaction times.

He also recognised that pilots must not only be selected; they must also be classified regarding the specialist category they will enter — a task that required evaluating the abilities, aptitudes, and characteristics needed for specialist categories.

Today's aviation selection processes benefit from a legacy nearly as old as powered aviation itself. Assessment batteries, simulator performance, and flight-screening results are used in conjunction with competency-based assessments of oral communication, teamwork, influence, problem solving, confidence and psychological resilience and ability domains such as verbal reasoning, numerical reasoning, spatial ability, attentional capacity, work rate, and psychomotor skills.

Even in the technologically sophisticated world of military aviation, the more things change, the more they stay the same — at least when it comes to selecting the human operator.

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Endnote

1. Criterion-referenced tests report how well students are doing relative to a pre-determined performance level on a specified set of educational or performance goals/ outcomes — not how they compare to others.

THE RED BARON LEARNS TO FLY

After 25 training flights, on his first solo flight, Richthofen crashed while trying to land, destroying his plane. The renowned ace of the First World War had an ignominious start to his piloting career.

Manfred von Richthofen was commissioned in the 1st Regiment of Uhlans Kaiser Alexander III in April 1911. Following the outbreak of World War One, Richthofen served briefly in the trenches. He applied for a transfer to the flying corps and began flying school in June 1915.

Worried that the war would end before he had a chance to see action in the air, he decided to train as an observer. Pilots normally were required to undergo three months of training, whereas observers were ready for the field in four weeks. Three months later in October 1915, after combat experience in a bombing squadron, Richthofen transferred to pilot training.

Pilot training was difficult for Richthofen because he lacked a natural affinity for the mechanics of flying. It was reported that he was an adequate, but not outstanding trainee pilot. It is not known what selection process, if any, Richthofen went through. In those early days, the training itself was probably a selection tool.

The following excerpts from Richthofen's personal journal (*The Red Battle Flyer*, first published in Germany in 1917) begin with his pilot training:

My whole aim and ambition became now concentrated upon learning how to manipulate the sticks myself. Hitherto I had been nothing but an observer. Happily I soon found an opportunity to learn piloting on an old machine in the Champagne. I threw myself into the work with body and soul and after twenty-five training flights I stood before the examination in flying alone.

One fine evening my teacher, Zeumer, told me: "Now go and fly by yourself." I must say I felt like replying "I am afraid." But this is a word which should never be used by a man who defends his country. Therefore, whether I liked it or not, I had to make the best of it and get into my machine.

Zeumer explained to me once more every movement in theory. I scarcely listened to his explanations for I was firmly convinced that I should forget half of what he was telling me.

There are some moments in one's life which tickle one's nerves particularly and the first solo-flight is among them...

I started the machine. The aeroplane went at the prescribed speed and I could not help noticing that I was actually flying. After all I did not feel timorous but rather elated. I did not care for anything. I should not have been frightened no matter what happened. With contempt of death I made a large curve to the left, stopped the machine near a tree, exactly where I had been ordered to, and looked forward to see what would happen.

Now came the most difficult thing, the landing. I remembered exactly what movements I had to make. I acted mechanically and the machine moved quite differently from what I had expected. I lost my balance, made some wrong movements, stood on my head and I succeeded in converting my aeroplane into a battered school 'bus.

I was very sad, looked at the damage that I had done to the machine, which after all was not very great, and had to suffer from other people's jokes. Two days later I went with passion at the flying and suddenly I could handle the apparatus.

Two weeks later Richthofen took his field examination which cleared him to go to a special flying school at Doberitz. There he went through a rigorous program and passed his final examination on 25 December. He joined his first unit as a pilot in March 1916.

Identifying the gaps

By FLTLT Stephanie Redman

IN 2022, No.2 Operational Conversion Unit (2OCU) spent large portions of the year working remotely due work being carried out on the RAAF Base Williamtown runway. This coincided with 2OCU operating alongside 77 Squadron in preparation for Exercise Pitch Black, while executing the first AWIC on the F-35 Platform. The unit was achieving large sortie rates to meet both squadrons' mission objectives, which in turn required a solid maintenance effort to produce the requisite serviceability rate.

This period of time raised a lot of ambers in the maintenance workforce, namely: fatigue working away from home and on a surge period; NT weather systems; different maintenance facilities (Darwin's Ordnance Loading Areas (OLA) and bunkers); variable physical environments (OLAs curved hangar vs home lines); operating alongside another squadron; and pressures to sustain aircraft serviceability commensurate with the rate of effort.

A number of these factors did lead to safety incidents and maintenance-induced damage. I was intimately involved with one incident in particular – an approximately 50 kg component was dropped from height onto the wing of an aircraft while undergoing a removal and install. Fortunately nobody was injured; however, the damage and repair was extensive, requiring specialist team support, large amounts of surface damage testing and for the F-35 program to develop a new repair procedure.

Upon investigating the incident, it was noticed that the members involved were exposed to many influencing factors leading up to the event. They were fatigued from the unit tempo, some members were unfamiliar with the task (although all were experienced techos), weary due to the heat and challenged by their physical facilities/environment.

This led to inadequate planning, missing key hazards and a failure to re-plan once the hazard was realised. Additionally the Ground Support Equipment (GSE) operator was found to have made an error in judgement due to the pressure of the situation, resulting in a procedural violation (outside the bounds of technical publications and missing warning labels).

This instance showed that while the team was experienced, the change in conditions negatively influenced team members' performance and planning. The risk controls were abundant (warnings in tech pubs and stickers on the GSE); however, the context was misunderstood. Further, the operator felt cornered and violated JTD – they did not understand the consequence or failure mode of incorrect use. Overall the team was heavily impacted by what had occurred, experiencing shock, and team members took on a level of personal liability, impeding their confidence.

As the investigator of this incident, I was required to remove myself from the situation and work quickly to identify the gaps to understand what had occurred. The interviews were sensitive in nature and challenging so as not to further impact the members' mental state or allow them to perceive questions as further blame.

As an ASO of sort, I learnt that it's important to reinforce that aviation safety reports are not punitive and they are not to seek blame, but to identify gaps and prevent recurrences. The event led to some key outcomes, findings and actions that were immediately implemented. The same task was conducted twice more in the next month, and thanks in large part to the changes implemented the incident did not reoccur.

By WOFF Jon Durrant

Lessons learnt, traditions shared

DFSB team's trip to Philippines

ALMOST 60 AVIATION professionals from the Philippines became students, immersed in the world of Aviation Non-Technical Skills (NTS), for a week of education run by a Mobile Training Team from Defence Flight Safety Bureau (DFSB).

The DFSB team travelled to Manila in support of the Joint Australian Training Team – Philippines, to provide NTS training to members of the Philippines Armed Forces (PAF), including the Philippines Air Force, Army, Navy and Coast Guard and the Philippines National Police (PNP).

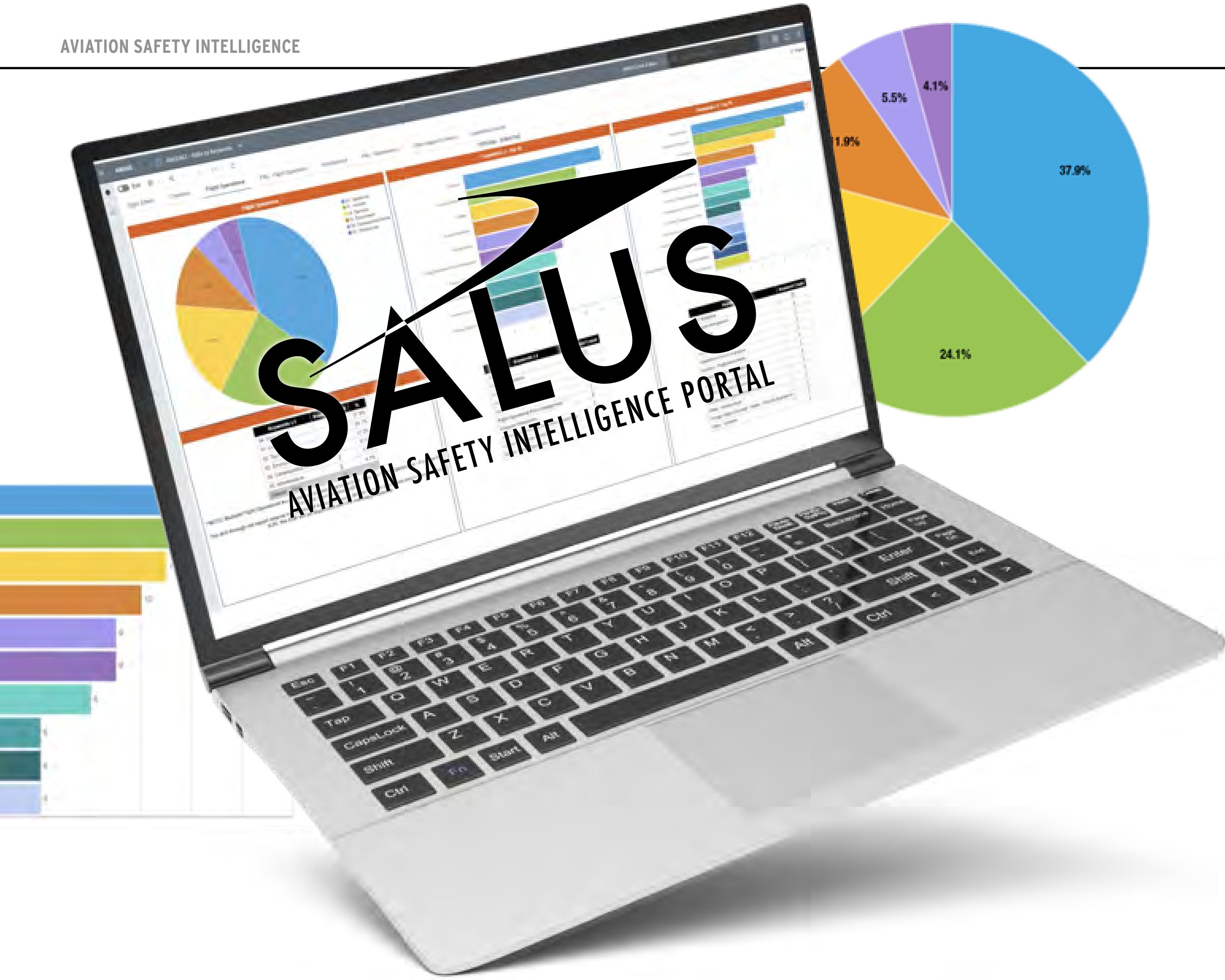
Based on the NTS foundation training provided to Australian Defence aviation personnel, subjects included: Decision-making, Error and Violation, Managing Stress and Fatigue, Teamwork, Human Performance, Leading and Working in Teams and Situational Awareness. The training culminated in a scenario exercise that consolidated NTS skills learned during the week.

Led by WGCDR Clare Fry, Deputy Director Education and Training, the MTT consisted of members of the DFSB Training and Human Factors teams. "The training provided an excellent opportunity for us to share lessons learned in our aviation operations with the Filipino Armed Forces and Police, and for us to learn more about their aviation safety experiences," says WGCDR Fry.

Throughout the week the interaction between Australian and Filipino Defence and Police personnel was positive. Stories, experiences and lessons learnt were exchanged and customs, traditions and heritage were shared. At the conclusion of the week friendships had been forged and each party came away with a much broader understanding of the other's organisational and social cultures.

In closing out the week the Defence Attaché to the Philippines ADF Colonel Paul Barta accompanied by PAF Colonel Arnold P Tapia, Deputy Chief of Air Staff for Training, addressed the group and presented certificates of completion to all participants. Colonel Barta acknowledged all who were involved with the planning and execution of the training, particularly thanking the PAF and PNF for their active participation.

DFSB returned to the Philippines in May 2023, and provided Aviation Safety Officer Training to the PAF and PNF, further strengthening the relationship between our two countries' safety professionals.



De-mystifying SALUS

KEY POINTS

- Web-based application Salus provides the Defence Aviation Community with an enhanced safety-intelligence capability.
- Users can expect improved presentation of data though interactive charts/graphs that allow for drill through to deeper and more detailed levels of data in the future.

By WOFF Brendan Church

SALUS CONTINUES TO provide the Defence Aviation Community with an enhanced safety-intelligence capability. The web-based application was introduced in 2018 to deliver a centralised accident and incident database and to facilitate the sharing, exchange and analysis of safety data within and between Defence Aviation Safety Authority (DASA) and the Defence Aviation Community (DAC), with the goal of enhancing aviation safety.

Why do we need Salus?

Salus is capable of bringing together, accessing, processing and visualising a variety of different high-value safety data sets. Its organisational use has expanded over the last five years – originally established as a reporting and analysis tool for a single data source (ASR Sentinel), Salus now incorporates multiple different data sources and is anticipated to include additional data sources in the future.

In 2022, DASA determined a requirement for a DASA Safety Intelligence System (SIS), where

Salus was identified as a key component for centralised data warehousing and reporting. Salus, as part of the DASA-SIS solution, provides DASA with a centralised repository of safety data supported by a customised interface and functionality to meet the internal needs and objectives of DASA Directorates.

Who is responsible for Salus?

The day-to-day operation of Salus is managed and supported by DASA-DFSB Reporting, Intelligence and Research (DFSB-RIR) sub-directorate. Salus support services provided by DFSB-RIR include:

- user interface portal design
- development and maintenance of Salus reports and dashboards, provision of related data analysis advice
- provision of service desk support functions including the processing of user access requests, service requests, change requests and first-level problem management.

CIOG-Systems Monitoring and Reporting Directorate (SMRD) provides second-level support and maintenance such as software updates, technical troubleshooting and overall management of the data warehouse, test and production environments. DFSB-RIR, through engagement of a specialist contractor, augment CIOG-SMRD in the delivery of second-level support functions.

What has been done to improve Salus?

As is the case with any system within a dynamic environment, there are always opportunities for improvement. In 2021 a number of inherent and emerging issues were identified with Salus. These included current and future sustainment arrangements, product quality and consistency, organisational use consistency, configuration control and future growth capacity. As a result, a number of reform initiatives were identified and subsequently implemented over the course of 2022 and early 2023.

These initiatives sought to improve:

- Salus system management through enhanced governance
- system reliability though expanded sustainment arrangements
- Salus user experience through standardising and simplifying access to and presentation of aviation safety data provided via Salus
- sharing and exchange of aviation safety data internally within DASA and externally within the DAC.
- overall organisational uptake of Salus use.

Some of the key improvements implemented are:

- an effective configuration management (change) process
- a task-management process
- configuration record keeping standard
- an appropriate user interaction/ support standard
- an improved Salus user interface
- a report presentation/format standard
- a Salus report configuration baseline
- corporate report solutions that can be applied broadly at different levels within the DAC
- an ongoing contractor and third-party support mechanism.

What is the future of Salus?

Users can expect enhanced presentation of data though improved visual, (charts/graphs) that are interactive and allow for drill through to deeper and more detailed levels of data.

There will be further consolidation of the report configuration suite to condense like-for-like report data and report functions and exploration in the use and supportability of other data warehousing and analysis tools that may provide an improved experience.

How can I learn more about Salus?

Instructional video clips on the use of Salus are available inside the Salus Portal via the Additional Salus Support button. Salus-specific training is also provided during the Initial and Advanced versions of the Aviation Safety Officer (ASO) Course. Additionally, members of the Salus team can provide training for new users and groups on request.

Please contact the Salus Service Desk for all Salus-related matters, including access requests, enquiries and support via email to salus.servicedesk@defence.gov.au. The Salus Service Desk operates Monday to Friday during normal business hours. For more information, visit the DASA-DFSB Home page and select the grey Salus tile.

"While some believe Salus to be an acronym, like Safety Analysis Look Up System, according to *Encyclopaedia Britannica* it is actually the Roman goddess of safety and welfare."

(https://www.britannica.com/topic/Salus)


WHO
WHEN
WHAT
HOW
WHERE
WHY

Reconcile your existing prejudices, biases and preconceptions

By CAPT Zachariah Emms

WHEN was the last time you came to a conclusion or made a decision and considered not only the facts, not only the logic, not just your intuition; but you interrogated the decision maker – yourself – as to what shaped your assemblage of facts to that conclusion?

Chapter 3 of the *Defence Aviation Safety Manual* (DASM) directs us that: Findings, actions and recommendations resulting from the investigation of an aviation safety event should be based upon the best judgement of the investigating team, carrying out an impartial and objective analysis of available evidence.

How will you as an ASO or investigator ensure your investigation, particularly toward human factors, is impartial? How do you recognise and reconcile your existing prejudices, biases and preconceptions to generate the most constructive outcomes?

There are currently 11, multiple hundred-page document tabs open at the top of my iPad document reader application. All of which I am expected to maintain an intimate understanding and recollection of for the safe, day-to-day operation of an aircraft.

Not just expected, I am, in fact obliged — this over-dependence on individual knowledge is a risk control after all. Above all this information though there are three key adages guiding me since the beginning of my aviation journey: fly like everything and everyone around you is trying to kill you; fly every sortie as though it will be presented in court, finally; aviation eats its own.

I want to focus on point three as it may seem cynical and pessimistic, yet forms the essence of my argument. Any post-incident crew room discussion or group-chat will show you it's true; aviators are occupation cannibals and we feed on the individual actions of other aircrew. It's not wrong to do so, it's human.

People, especially in aviation, tend to be comparative, competitive, and in being analytical apply their experience, knowledge and perceptions to the actions of others. Philosopher MJ Blehart reminds us that you have a unique experience and perception of life, the universe, and everything. The places you have been and lived, the environments, communities, education, upbringing, relationships, associations, and everything else that has been experienced by you influences and impacts your view. Please remember: your reality is exclusive to you.

With unconcealable pretentiousness I will quote Immanuel Kant from his work *The Critique of Pure Reason:* 'ALL our knowledge begins with the senses, proceeds thence to the understanding, and ends with reason. There is nothing higher than reason.' In the context of an investigation, we can't shape our senses (the facts) but we can influence what our mind does with them or at least be cognisant of when our intuition is attempting to override analytical reasoning.

In February 2018 I was involved in a relatively benign incident with the following deliberately vague details. Myself, a very junior pilot joining a highly experienced QFI on a run-of-the-mill instrument sortie were rudely interrupted by an obviously spurious FUEL LEVEL LOW caution followed by a blatant but (I thought) understandable violation of checklist actions. It would prove to be the QFI's final flight.

The actions, the outcome and the discussions that took place have frustrated me ever since. I needed to find the tools to make sure I didn't fall as easily to cannibalistic judgement as others had. I found it in the 2019 article *Gravity's Judgement* by PhD researcher Adrian Park, quite ironically an article involving rather factual FUEL LEVEL LOW cautions. Park offers a series of 'what if' questions to ask yourself to avoid being, as he has coined, a judgementalist:

- What if the pilot was cognitively compromised through fatigue, startle or some other psycho-social duress?
- What if the accident pilot is actually a way better pilot than me?
- What if it were me in that situation?

Objective understanding enables sound reasoning and impartial analysis. Used in conjunction with the 5-Whys methodology when viewing aviation incidents this additional rigour provides a gateway to enhancing our understanding of an incident; free, or at least aware of our prejudice and preconceptions.

Impartial analysis and reasoning facilitates comprehensive discovery of contributing and non-contributing factors involved and, to cautiously expand on Park's terminology, transcend ourselves from that of an ignorant judgementalist to that of the consciously informed judgementalist.

Reframed thinking

By LEUT Kiara Penman

ONE TOPIC OF contentious discussion within the Fleet Air Arm (FAA) is the manipulation of circuit breakers on the MH-60 Romeo by aircrew.

Last year, during an Aviation System Safety Committee (ASSC), an Aviation Safety Report (ASR) trend was identified where aircrew missed resetting circuit breakers in their pre-start checklists and developed behaviour to manipulate them in-flight without the correct analysis before resetting the circuit breaker.

This led to several ASRs where critical systems were not engaged in flight (that is, fire extinguisher bottles) or being reset inappropriately. Through discussion in a working group, two key issues were identified:

1. Aircrews were missing the circuit breakers during their pre-start checklists.
2. Aircrew members are constantly manipulating circuit breakers and they are not applying the correct analysis before resetting circuit breakers either in-flight or on the ground.

Issue one

The explanation from aircrew members as to why they were missing circuit breakers was that the ergonomics of their gear and being "strapped in" while conducting these checks made it difficult to check and reset all circuit breakers. This led to a common practice of conducting the step "reset all circuit breakers and switches" IAW their pocket handbook during the pre-flight instead of pre-start.

Issue two

The working group discussed that the Romeo was unique in that aircrew members, at aircraft acceptance, are presented with several circuit breakers "out" or pulled. Other platforms, including in some cases of the US operating the Romeo, presented the aircraft with circuit breakers pushed in/reset. The industry approach to circuit breakers was that they would only reset them if the system was considered essential for safe flight.

The practice identified in the FAA was that circuit breakers were being reset to troubleshoot system failures. A potential correlation was identified that since Australian aircrew were presented with several circuit breakers pulled and were then required to reset them prior to flight, a mental model of manipulating circuit breakers was now considered "normal" practice.

Solutions

Two solutions were discussed in the working group to change this mental model. The first is the education and training of circuit breakers, their purpose and why it is required to conduct a thorough analysis prior to resetting. The second was to establish an additional inspection to alleviate both issues and provide another barrier prior to the pilot conducting the pre-start checklist missing the circuit breakers occurring. It was determined that this additional inspection would include resetting the circuit breakers prior to the aircrew conducting their pre-flight checks, to change their mental model of frequent circuit breaker manipulation. This, of course, stirred a controversial topic of introducing a "maintenance control" to fix an "aircrew problem".

Culture

When I heard the sentiment surrounding "maintenance fixing aircrew problems", I was immediately concerned. I have recently been posted as Deputy AEO/MASO at my unit. I knew this culture was prevalent within the aviation workforce, but I did not realise the extent of it and how it impacted the mere discussion of a potential control that would mitigate the risk to aircrew.

Several other factors must be considered before implementing such a control, such as: what this inspection would look like, where in the aircraft

release process it would occur that does not pose an additional risk to maintenance personnel during ground evolutions (refuelling, towing, stores loading), and where it would be documented. However, when trying to prompt discussion on these issues, it quickly turned into "this isn't our problem; this is an aircrew issue". It can be easy to get into their mindset, especially when historical examples of such issues caused additional work or administrative burdens to maintainers. Some even to a point where problems and blame have now shifted from aircrew to maintenance (that is, circuit breakers can still be missed, but now maintainers are missing them as well).

One way I look at this problem is through a risk-management perspective. In the situation where the circuit breaker is missed, the only current preventative control between a missed circuit breaker is the pre-start/pre-flight inspection conducted by the aircrew.

Adding the step where all circuit breakers are reset by maintenance prior to the pre-flight inspection not only adds the additional preventative control of missing the circuit breaker but now changes the mental model of the aircrew that it is abnormal to see circuit breakers out and manipulate them.

This change in the aircrew's mental model regarding circuit breakers is an excellent approach that considers the human factors of the problem. By changing the method by which circuit breakers are reset, we are providing an environment for aircrew that makes them less likely to make an error or follow on errors because of the failed control.

This divide between aircrew and maintenance is one that has been deeply ingrained within the Navy aviation community.

Encouraging people to reframe their thinking when it comes to delivering a capability is difficult, and I believe it will be an ongoing problem I will face in the role.

Approaching the problem with a risk-based approach is a good starting point. It also helps to remind people that we are contributing to the same goal: safe and effective capability. Where problems arise, we need to look at the issue holistically, from maintenance to operations, and see where we can apply the appropriate barriers to ensure we achieve our goal.

If you can't handle the HEAT

Temperature extremes impact cognitive performance

By Dr Peter Murphy, School of Aviation, UNSW, and Ryan Cooper, DFSB

THROUGHOUT MILITARY HISTORY, operations have been disrupted by extreme weather conditions. Exposure to extreme climates generates physiological and psychological stress that can significantly impact the operational performance and motivation of military personnel. In modern operations, the requirement for body armour and chemical-protective ensembles can create a thermal burden that can jeopardise even single-mission completion.

ADF personnel have built up significant corporate knowledge about operating in challenging local weather conditions (for example, overseas in Somalia, Cambodia, the Solomons, East Timor, Iraq, Afghanistan and the UAE, and at almost any of our mainland bases during summer). Nevertheless, heat stress is a significant challenge for ADF aircraft and maintenance crews, particularly in the absence of air conditioning and personal cooling systems, and when faced with limited flexibility in scheduling. Heat – and cold – can interfere with comfort and performance during work and with comfort and sleep when off-duty.

Generally, humans are at ease in a narrow range of environmental conditions. Our comfort is determined by a number of factors: ambient

KEY POINTS

- Exposure to extreme climates impacts the operational performance and motivation of military personnel.
- Acclimation is more effective when physical exercise is part of the process.

temperature of the surrounding medium (air/water), wind levels, humidity, oxygen availability in the air, and thermal radiation. We have all experienced the physical discomfort of hot (sweating) and cold (shivering) environments.

However, few people have a nuanced understanding of other aspects of thermal strain, such as impairments to cognitive function and physical performance, and changes to emotional and motivational states. For example, deficits in our ability to think can precede the onset of noticeable physiological changes in hot conditions. A rise in core body temperature of as little as 1°C can reduce vigilance in pilots so that safety may be compromised (Faerevik & Reinertsen, 2003).

To date, attempts to manage the risks associated with heat stress have largely focused on negating the occurrence of adverse physiological reactions. This article has as its focus the cognitive impacts of thermal stress – both cold and heat, but with an emphasis on the latter. Cognitive performance refers to the quality of information processing, as measured by speed, accuracy, attentional resources expended, and frequency and types of errors.

Initially, we examine some related issues.

Climate trends

"In summer we now see a greater frequency of very hot days compared to earlier decades. In terms of nationally averaged maximum daily temperatures, there were 33 days that exceeded 39 °C in 2019, more than the number observed from 1960 to 2018 combined, which totalled 24 days."

Australian Government Bureau of Meteorology, *State of the Climate 2020*

There is scientific consensus that the weather will increasingly impact those who work outdoors in Australia.

The *Australian Climate Commission Report* of 2013 confidently predicted that our already sunburnt country will be subjected to higher temperatures more often, and to more frequent extreme weather events such as bushfires.

The Bureau of Meteorology's latest *State of the Climate* report (published 2022) confirmed these predictions. It noted that Australia's weather and climate are changing in response to a warming global climate. Australia has warmed on average by 1.44 ± 0.24 °C since national records began in 1910, with most warming occurring since 1950 and every decade since then being warmer than the ones before.

Australia's warmest year on record was 2019, and the seven years from 2013 to 2019 all rank in the nine warmest years. This long-term warming trend means that most years are now warmer than almost any observed during the last century.

Warming has been observed across Australia in all months with both day and night-time temperatures increasing. This shift is accompanied by more extreme nationally averaged daily heat events across all months. For example, 2019 experienced 43 extremely warm days, more than triple the number in any of the years prior to 2000. (An extremely warm day is defined as a day where Australia's mean temperature was in the warmest 1 per cent of records (since 1910) for that month.) This increasing trend is observed at locations across Australia (*State of the Climate 2020*).

Given the trends noted above, understanding the performance impacts of operating in hot environs is more vital than ever. Added to this imperative is the fact that many components of the ADF aviation capability are activated in response to extreme environmental events – recall the 'Black Summer' of 2019/2020.

Gone mad with the heat

We had orders to head out west to a spot in the desert. My God it was horrible country. Featureless virtually. To look for three South African Blenheims that were down in the desert. They'd got themselves lost on a navigational exercise.

On the way down on this particular trip the pilot said, "I'm going to take this aeroplane up to see just how high it can fly." Which he did. And he took it up to about 18,000 feet indicated so that'd be probably more than 18,000 feet. And we were gasping on board. And he was a big healthy fellow. He was standing up to it all right. I remember the wireless operator was wrapped up in a blanket and he was turning blue in the face. And I must've been turning blue too.

The next day we were in Wadi Halfa. Went for a quick walk around the local streets and it was very, very hot down there on the border of the Anglo-Egyptian Sudan. And I just spun in. Boomph like that in the street. And they carted me off to hospital. I spent a day and a half there. Obviously heat exhaustion. Probably the combination of the day before, flying at 18,000 feet. They just cooled me down and poured some water into me and I was up and about.

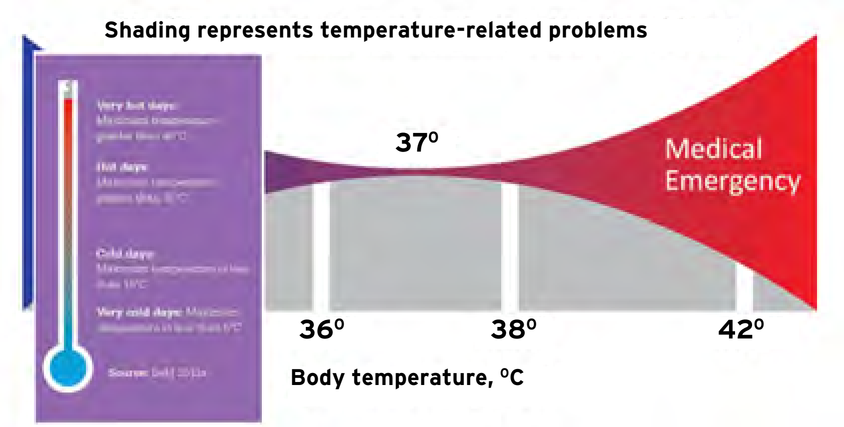
We went off on our search again. We couldn't find these guys for about another day. And by that time, a Wellington from another squadron came down, they found them and they were all dead. They'd landed successfully but they'd all shot themselves. Gone mad with the heat. That was a terrible episode that.

Milton (Milt) Cottee, 77 Squadron, Korea, Australians at War Film Archive

Heat stress

It is widely accepted that average core body temperature in adults is 37.0 °C. The typical oral (under the tongue) measurement is slightly less, at 36.8° ± 0.4°C. It should be noted that these figures are averages – there are variations in individual differences in body temperature (just as there is in other physiological measures such as resting heart rate and blood pressure). Heat stress occurs when heat is gained faster than the body can dissipate it. If core body temperature is raised by just 1°C above normal for several hours, reduced mental and physical capacity will likely result. Debilitation of this sort is often referred to as *heat exhaustion*.

Sustained increases in core body temperature of 2-3°C are likely to result in damage to body tissue, particularly the brain. Serious heatstroke and even death can occur after a relatively short time if core body temperature increases by 5°C or more (that is, above 42°C in most people).



In response to lessons from training exercises and operations, the ADF has rigorously addressed the risks of heat stress during the past two decades. This effort is demonstrated by Health Directives to manage and treat heat casualties, the Heat Injury Remediation project, the distribution of heat-stress monitors throughout Defence, mandatory heat-stress awareness training, research by DST to integrate thermal comfort into the design and testing of new clothing and equipment, and the introduction and revision of heat-stress policies and guidance in the *Defence Safety Manual* (SafetyMan) and various single service publications.

Defence Flight Safety Bureau (DFSB) policy on the management of heat stress aims to ensure all personnel from commanders down involved in at-risk activities are aware of their responsibilities, the hazards associated with environmental heat, and the various risk management strategies and hazard control methodologies.

Measuring heat risk

To assess the potential for thermal stress, special indices have been developed that take into account a number of physical factors beyond the standard thermometer measurement of dry-air temperature.

One of these measures is Effective Temperature, which is based on the standard dry-bulb temperature, humidity, and air velocity. Effective Temperature normally is high in humid tropical environments and low in windy Antarctic environments where wind-chill is taken into account.

Another widely used thermal index is Wet Bulb Globe Temperature (WBGT). It is drawn from three measures: a dry bulb thermometer, a wet bulb thermometer sensitive to evaporation graphics, and a globe thermometer sensitive to radiant heat.

These indices can be rather difficult to calculate and are somewhat approximate, but they provide a good indication of the likely level of thermal discomfort.

Thermoregulation

Numerous factors influence thermal load/strain or discomfort. These include 1.) the environmental factors such as dry bulb temperature, water vapour pressure (closely linked to relative humidity), air velocity, and radiant temperature, 2.) individual factors such as metabolic rate, physical work rate, and degree of acclimatisation, and 3.) organisational factors such as issued clothing and equipment, and guidance regarding length of environmental exposure.

The body has quite simple, automatic mechanisms to regulate internal temperature. When we are cold, we begin to shiver to

Heat exhaustion

Heat exhaustion is the body's response to an excessive loss of water and salt contained in sweat. People working or exercising in a hot environment are at high risk of developing heat exhaustion. If heat exhaustion is not treated, it can turn into heat stroke.

Signs and symptoms of heat exhaustion:

- heavy sweating (cool and moist skin)
- pale skin
- fast and weak pulse rate
- breathing fast and shallow
- muscle weakness
- cramps
- tiredness
- dizziness
- headache
- nausea or vomiting
- fainting.

First aid for heat exhaustion:

- rest in a cool place
- cool down by removing excess clothing, having a cool bath or shower, and placing cool packs under the armpits, groin and/or neck
- rehydrate by drinking cool water or oral rehydration drink

Seek urgent medical attention or call an ambulance if necessary if symptoms worsen or if there is no improvement.

Heat stroke

Heat stroke occurs when body temperature rises above 40.5 degrees Celsius. Heat stroke is a life-threatening emergency. Immediate first aid is very important to lower body temperature as quickly as possible.

Signs and symptoms of heat stroke:

- a sudden rise in body temperature
- red, hot, and dry skin (sweating has stopped)
- dry swollen tongue
- rapid pulse
- rapid shallow breathing
- intense thirst
- headache
- nausea or vomiting
- dizziness
- confusion, poor coordination, or slurred speech
- aggressive or bizarre behaviour
- loss of consciousness
- seizures or coma.

First aid for heat stroke:

- call for an ambulance
- if they are unconscious: lay them on their side (recovery position) and check they can breathe properly; perform CPR if needed
- if they are conscious: move them to a cool area and keep them still, give them small sips of fluid, bring their temperature down using any method available (sponge with cool water, cool shower, spray with garden hose, soak clothes with cool water, cool packs)

Do not give a person with heat stroke aspirin or paracetamol – they may be harmful.

increase temperature. While sweating induces evaporative cooling when we are hot. People also use conscious strategies to regulate body temperature, such as choice of clothing, exposure to sunlight or moving air (more or less), level of muscular activity, and ingestion of fluids, preferably chilled.

Prescriptive guidelines for work/rest cycles and continuous work duration have been developed to regulate exposure to hot environments by flight and maintenance crews. Self-care regimes should also be encouraged. Lost body fluids must be replaced to prevent dehydration and symptoms of heat stress. The way essential tasks are conducted may be modified to ensure core body temperature will remain within reasonable bounds.

Temperature and humidity

Due to radiant temperature and humidity, aviation personnel are often warmer than the ambient air temperature in the workplace/ workstation. Radiant temperature and humidity are normally easy to determine and are reasonably effective predictors of comfort and performance. It is worth clarifying our understanding of these two factors.

Radiant temperature differs from air (ambient) temperature. Ambient air temperature is a measure of the average air temperature in a space or location; while the mean radiant temperature is a measure of the net radiant heat gain or loss in that space/location. Radiant temperature is influenced by nearby surface temperatures such as walls, floors, and equipment – as well as your own body.

When you stand in the sun on a cold day, you feel radiant heat gain from the sun even though the air temperature is cold. Similarly, when you stand in the sun after having a swim, you are likely to feel radiant heat gain from the sun on your cool skin even though the surrounding air temperature might be quite warm.

On the other hand, when you open the fridge or freezer door on a hot day, you are likely to notice radiant heat loss as cool air touches your skin. In these cases, thermal comfort is influenced mainly by the difference in radiant heat gain or loss, not by ambient air temperature.

It is possible to experience heat gain from a warm surface and heat loss to a cold surface at the same time. An example of this might be a maintainer working on a hot engine while outside in winter.

Humidity is the quantity of water vapour present in the air. It can be expressed as an absolute, specific or a relative value. Relative humidity is perhaps the most used measure of humidity. It is expressed as a percentage and measures the current absolute humidity relative to the maximum for that temperature.

The relative humidity of air depends not only on temperature but also on the pressure in the surrounding weather system. Higher humidity reduces the effectiveness of sweating in cooling the body by reducing the rate of evaporation of moisture from the skin.

Harris (2011) provided an example of how radiant temperature and humidity interact. For a pilot in a modern aircraft wearing light clothing, at 25°C, comfort occurs between 22 and 60 per cent humidity. Below 22 per cent humidity, one would normally feel cool, then cold; while above 60 per cent humidity, most people will begin to feel uncomfortably warm even though the air temperature is constant.

The impact of hot environments on cognitive performance

High temperatures impact cognitive performance. In general, temperatures above 30°C are associated with diminished cognitive performance, particularly vigilance, dual/multiple tasks, and tracking tasks. These are tasks that require sustained attention. Performance impairment is typically shown by declines in both speed and accuracy and a greater incidence of error.

The cornerstone of performance decline in the heat may be the increasing discomfort that has been likened to a 'cognitive load' that reduces available mental capacity. This discomfort can be characterised by unpleasant to distressing bodily sensations, impaired mood, and the perception of increased workload, which collectively can lower motivation as well as cognitive resources.

Studies have found significant impacts of thermal strain on the following tasks and abilities: target detection (visual attention and discrimination), complex reaction time, working memory, spatial planning, pattern recognition, numerical tasks, logical reasoning, text typing, and auditory discrimination.

Safe and effective performance in the aviation domain is contingent on these abilities, for example, even something as simple as text typing is fundamental to accurate data input into a flight management system.

There is generally a dose-response relationship. The higher the ambient temperature and the longer the exposure, the greater the deterioration in these abilities, sensory sensitivity, and task performance. This is called a dose-response relationship, with the dose being the duration and intensity of the stressor and the response being how the body and mind react.

Different types of tasks incur different levels of impairment. Not surprisingly, complex tasks and multiple tasks are more prone to impairment from high temperature and humidity than simple tasks.

In fact, many simple mental tasks show almost no decline until people experience intense fatigue. However, even psychomotor tasks, if sufficiently complex, such as pursuit and tracking tasks, tend to show heat-induced decrements.

Steering a motor vehicle is a real-life example of pursuit tracking. In one experiment, drivers travelled 600 km (with one rest break) at an ambient temperature of either 20 °C or 32.2°C WBGT.

The frequency of large steering wheel movements (> 10 degrees) was used as an index of performance degradation. In the latter part of the drive, there was a general trend for steering to become more erratic over time, presumably due to fatigue. This trend was accentuated at the higher temperature.

Heat-induced impairment of psychomotor performance has also been observed in a flight simulator study – but only during complex phases of flight operations. There was little relationship between heat and performance during routine, straight and level flight scenarios (Iampietro et al., 1987).

Core body temperature is key. If heat fails to affect core body temperature, then many of these tasks, particularly sustained attention, are largely unaffected by ambient temperatures up to around 34° C. However, if core body temperature is affected, cognitive performance in general will deteriorate rapidly.

Given the importance of a stable core body temperature, and the potential for grave injury if thermoregulation fails, it has been recommended consideration be given to routine measurement of core temperature in aircrew and maintainers operating in very hot conditions.

SafetyMan: Managing Personnel Exposure to Excessive Heat/Cold Policy and Guidance

Policy core elements:

- Defence must identify all reasonably foreseeable exposure to excessive heat/cold.
- Risk assessments must be undertaken when planning work activities that could involve exposure to excessive heat/cold.
- The risk management process must be applied before conducting operations/training. Risks must continually be re-assessed as environmental hazard input changes.
- Workplace procedural documents such as standard operating procedures must be developed to manage risks relating to worker exposure to excessive heat/cold. The risks are to be documented in workplace risk registers.
- Workers who could be exposed to excessive heat/cold must be adequately trained and supervised so they can undertake tasks in accordance with procedural documents.
- Casualty management procedures for exposure to heat /cold are to be included in workplace procedures and training.
- ADF cadets require additional consideration in relation to the potential effects of exposure to excessive heat.

A small increase in core temperature can enhance performance. Studies of elite athletes have shown that, in some cases, an initial increase in core body temperature has been associated with improvements in performance. This has been attributed to an increase in arousal. It must be noted that the beneficial increment is small — only up to 38.5 °C; beyond that point impairments start to appear, often as a function of task/performance complexity.

The inverted U curve model of stress and performance applies. The Yerkes-Dodson Law postulates that too little and too much stress can adversely impact performance. Optimum performance in most activities occurs at a moderate level of stress or arousal where the individual is in his or her 'comfort zone.' The same relationship appears to apply for temperature and performance. If it is too cold or too hot, performance suffers. The zone of optimal performance can be broadened (the extended-U model) by several techniques, most importantly in terms of cognitive performance, by the conscious and efficient management of attentional resources. (See Hancock and Vasmatzidis (2003) for detailed discussion of the extended-U (Maximal Adaptability) model in the context of thermal stress.)

The other end of the spectrum — the impact of cold

"The most dangerous time we had, I suppose, was the three-and-a half weeks up North Korea. Minus 30°C, most days. Snowing. Cold as buggery. The ground crew, working on the aircraft, had to wear some heavy bloody gloves, because if they touched metal with their hands, they'd lose their skin. The aircraft were so cold."

Richard (Dick) Cresswell, pilot, 77 Squadron Korea, Australians at War Film Archive

The impact of cold on cognitive function has been less investigated by scientists and the results are varied, making it more difficult to draw firm conclusions in this arena.

Where cognitive performance is affected by cold, the mechanism postulated by some researchers to account for this is distraction caused by cold sensations. Redirecting attention to cope with thermal strain is likely to reduce ongoing task performance.

In general, there is little evidence that cold causes cognitive impairment down to temperatures of zero degrees (Harris, 2011). The impacts of cold temperatures are more likely to be on manual dexterity and motivation.

Manual dexterity begins to be compromised at 15° C, while tactile sensitivity is affected at 8° C and below. Finger strength is also diminished in the cold. These findings are clearly pertinent to maintenance personnel.

Simple reaction time is relatively insensitive to cold but low temperatures are associated with increased error in more complex reaction time tasks.

Most studies have not revealed detrimental effects of cold on tasks requiring higher mental function, such as verbal reasoning, navigation, and inspection tasks, although some recent studies report declines in visual vigilance and pattern recognition tasks. Sustained attention appears to be affected as temperatures fall towards 0° C.

The speed at which participants are cooled in laboratory settings seems to make a difference to experimental outcomes – with faster temperature drops associated with stronger performance deficits. For personnel working in field conditions, where a degree of acclimation is likely, laboratory findings may not apply.

On the other hand, complex motor tasks, such as tracking, routinely show cold-related decrements, although it is uncertain whether impairment is related to diminished attention (possibly due to distraction) or diminished manual dexterity, or perhaps a combination of both. Waning accuracy appears to be the strongest factor in lowered performance measures in the cold, rather than declines in task speed.

Changes to motivation and behaviour

Heat studies have found a range of impacts on behaviour and motivation. These include increased impulsivity, reduced frequency of responding, unjustified confidence in one's performance, and increased unsafe behaviours. These are perhaps outcomes of impaired judgement.

Similarly, when people are cold, they are usually less responsive to explicit commands, and more likely to be impulsive without prompting. There is evidence that cold may impair short-term memory and affect decision-making.

Acclimatisation and acclimation help to sustain cognitive performance

Strictly speaking, acclimation refers to a process where an individual adapts to an environment in artificial conditions, such as in a laboratory, whereas acclimatisation is graduated adaptation in a natural environment. The two terms are used interchangeably here.

Level of acclimatisation appears to be another moderating factor with respect to the temperature-performance nexus. Many workers who have been in situ for more than two weeks are better able to tolerate hot workplaces. Acclimation is best accomplished by graduated exposure – increasing workload intensity and duration in a stepwise fashion over a period of 1–2 weeks. An absence of more than a week from the workplace should initiate a 'refresher' graduated program.

Readers may be interested to note that acclimation is more effective when it incorporates physical exercise into the program. Aerobic fitness is associated with faster heat acclimation. Fitness is also associated with higher core body temperature tolerance and reduced susceptibility to heat injuries/illness.

There is evidence that acclimation is also effective in reducing the negative impacts of cold on performance. Repeated exposure to cold tends to reduce vasoconstriction, delays the onset, and reduces the intensity of shivering, and reduces perceptions of cold-related discomfort. Cold acclimation has been found to improve performance on tasks of attention, working memory, and logical reasoning.

Broadly, there are three strategies to improve cognitive performance in extreme environmental conditions. Two of these strategies have the associated benefit of reducing the perceptual disturbance of heat or cold and thereby reducing the likelihood of distraction from tasks at hand. This distraction has been postulated to be akin to a cognitive load that diminishes available cognitive resources for work.

The first broad strategy is simply to reduce physiological discomfort associated with heat and cold. Reducing thermal discomfort can entail a range of clothing and equipment options such as cooling or warming vests, air conditioning, and effective protection for the extremities, along with appropriate hydration and work-rest schedules.

Secondly, fostering skill levels in operating tasks will help to reduce the load on cognitive capacity while working and thereby reduce the relative impact of distraction due to any thermal discomfort.

Thirdly, informed programs of acclimation prior to deployment and acclimatisation in theatre/on posting can

Knowledge of how performance is affected by heat and cold is therefore critically important. Like fatigue, thermal strain can be an insidious source of stress.

also reduce thermal strain, with concomitant reductions in cognitive capacity directed to managing perceptual discomfort.

Underpinning any mitigation strategy should be an awareness of the critical importance of ensuring that core body temperature is maintained within safe limits.

Conclusion – the heat is on

Extremes of temperature are potent stressors. In the high-risk aviation domain, physical stressors such as ambient temperature and humidity can contribute to errors that may lead to catastrophic failure. Knowledge of how performance is affected by heat and cold is therefore critically important. Like fatigue, thermal strain can be an insidious source of stress.

In general, the degree and duration of exposure to thermal strain, along with the complexity of work and the level of skill or familiarity with the tasks, are predictive of the degree of cognitive performance impairment (suggesting a three-way relationship between the thermal environment, fatigue and performance). However, core body temperature is perhaps the key factor in predicting performance (as well as health and safety outcomes) under heat stress.

Thermal discomfort does not necessarily induce performance deficits. Experienced operators are more likely to be able to effectively manage lapses in vigilance and motivation that commonly arise among personnel working in thermal extremes. The benefits of experience; however, are likely to be negated by fatigue.

Our understanding of the performance relationship between heat and task complexity certainly has implications for Defence aviation. Newer aircraft platforms are known to impose daunting mental workloads. It is imperative that operational risk assessments for these platforms consider the potential performance impacts of the thermal environment.

As the challenges of extreme temperatures appear to be rising, greater awareness of the risks of thermal strain on mental performance will enable more comprehensive risk assessments, management strategies, and practical mediating techniques across the aviation capability.

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Thermal extremes – helicopter studies

HELICOPTER AIRCREW ARE arguably more prone to thermal extremes than other aircraft due to low-level flight profiles, doors open tasks, heat transfer from the engine, and the greenhouse effect of the windowed cockpit (helicopters typically have more overhead glass).

During summer conditions, non-air-conditioned helicopters can be 7°C or warmer than external ambient conditions. This may explain the number of studies focussed on temperature and performance in helicopter crews.

A retrospective analysis of helicopter safety data in the Israeli Air Force (Froom et al., 1993) revealed a significant relationship between safety incidents (such as navigational errors, equipment losses, near misses and crashes) and ambient heat stress.

Temperature and humidity records pertaining to 500 helicopter accidents and incidents due to pilot error were compared with 1000 non-incident days chosen at random over the same period.

The likelihood of an incident due to pilot error on days when ambient dry bulb temperatures were above 35°C was significantly increased – 6.2 times greater – when compared to days when ambient temperature was between 25°C and 29°C. For days with temperatures between 30°C and 34°C the relative risk of safety incidents was 1.6 compared to the lower temperature range. The researchers concluded there was a dose-response relationship between ambient heat stress and pilot error in operational settings. This was the first study outside a laboratory to confirm a connection between heat stress and accidents due to human error.

The vulnerability of cognitive processes to heat stress was demonstrated by Caldwell et al. (2006). The performance of a group of helicopter pilots was tested in temperatures of 33°C (control), 37°C (moderate) and 39°C (hot) in a simulator.

The pilots completed a series of sorties comprised of eight flight circuits, each involving take-off and landing tasks. During each of the circuits, pilots were required to solve two operational problems.

As can be seen in the figure, average performance on problems progressively deteriorated over time under moderate and hot temperatures. Further, some pilots' perceptions of their performance were inaccurate. Although pilots in both the moderate and hot conditions showed reductions in their performance, only pilots in the hot condition gave low ratings to their performance. Thus, in the moderate condition, the pilots appeared unaware of the deficits in their performance, suggesting the impact of the thermal environment can be insidious.

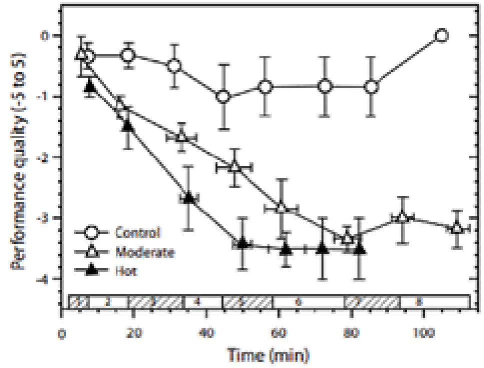
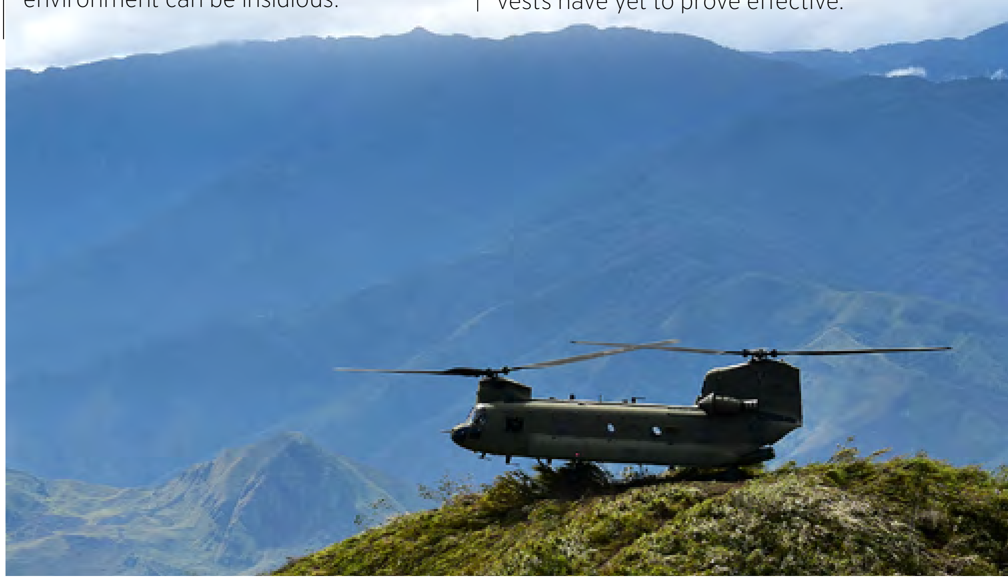


Figure 1. Flight performance scores during successive circuits in a helicopter simulator

More recently, Grönkvist et al. (2021) investigated the utility of different cooling vests on personnel in the rear cabin of a helicopter during simulated desert-climate missions (45°C, 10% humidity, solar radiation). One of the eight subjects finished the 3-hour flight simulation prematurely due to heat exhaustion, thereby proving the research premise that "helicopter personnel may be at risk of heat exhaustion during desert missions" as well as demonstrating that some ventilation vests have yet to prove effective.



Safety champions recognised

Words of advice from RAeS Dr Rob Lee Award recipients ...

WO2 Aaron Bamford

"We should understand that everyone, regardless of role or rank, has an impact on aviation safety and workplace safety in general. Active participation in aviation safety can happen at any level within the workplace – especially at the lower levels within the organisation that are routinely at the coal face, either discovering risks associated with their roles or implementing directed controls to reduce/eliminate risks in everyday tasks. Anyone can make a positive impact on aviation safety and if everyone has a basic understanding of risk identification and passes that information on to respective managers, they are working towards a generative safety culture within their workplace."

Royal Aeronautical Society
Dr Rob Lee Defence Flight Safety Award

Recognising **individual or collective efforts** that have enhanced Defence flight safety. Nominations are open to all members of Defence aviation, including foreign exchange and loan personnel, Defence civilians and contractors.

For details on the 2023 nomination process please visit the DFSB Intranet site.

By Rebecca Codey

ADF MEMBERS FLTLT Clinton Harrison and WO2 Aaron Bamford (then SGT) have been recognised for their dedication to enhancing aviation safety, presented with the Royal Aeronautical Society (RAeS) Dr Rob Lee Defence Flight Safety Award.

The recipients, who demonstrate a passion for aviation safety consistent with the award's namesake, the late Dr Lee, were each presented with a certificate and $500 from RAeS by then Director Defence Flight Safety Bureau (Defence Aviation Safety Authority) GPCAPT Dennis Tan at the end of 2022.

"It is deeply important that we've recognised the contributions from both award recipients," GPCAPT Tan says. "In my view, one of the key drivers towards a generative safety culture is recognising and rewarding individuals who are doing the right things. FLTLT Harrison and SGT (now WO2) Bamford are clearly two people who are having a positive influence on aviation safety."

"I also want to mention the deep humility that I felt when making these awards in the name of the late Dr Rob Lee whose contribution to aviation safety over a lifetime has been without peer. Rob was a truly great man and a dear friend."

Through extraordinary individual effort in his previous role as Deputy Unit Aviation Safety Officer at No. 1 Flying Training School, FLTLT Harrison (now 32SQN), significantly enhanced the aviation safety management system of the unit, achieving results far beyond that expected of a member in his position.

As the officer responsible for the day-to-day running of the safety management system during 2021, a particularly challenging year for flight safety, FLTLT Harrison tirelessly championed all facets, providing expert leadership and advice to his team of safety officers and other staff. He provided the unit executive expert counsel on emerging issues with clear recommendations. He shouldered a considerable burden of hands-on safety management, including numerous investigations.

WO2 Bamford applied extraordinary efforts to be an exemplar, utilising his extensive knowledge, experience and professionalism in the role of 20th Regiment

with RAeS award

Standards Sergeant. He continuously worked above and beyond expectation in his own time, setting an example for his superiors and his peers, while always striving for professional development and the continued safe operation of Unmanned Systems.

Then a sergeant, he also contributed to the Regiment's Aviation Risk Management Plan and provided expert advice to supervisors on matters above his rank and skill level. He was able to identify a normalised deviance from procedure and implement recommendations for change. This provided a temporary fix until the final investigation report was released from the Aviation Safety Investigation Team for a Shadow 200 crash. Without his eye for detail, these small changes from procedure would not have been picked up.

Both recipients were surprised and honoured to receive the RAeS Award.

FLTLT Harrison reiterated that "2021 was a challenging year, and I feel like it would have been much more difficult had it not been for a committed and cohesive safety team that was well supported by the CO and unit executives". "The award is a reflection of the efforts of all the individuals involved in the team at the time."

WO2 Bamford added, "Aviation safety is important to me because while we do not fly inside the RPA (Remotely Piloted Aircraft), meaning the direct risk to the remote pilot is low during RPA critical failure, we need to continually monitor, understand and implement changes in Orders, Instructions and Publications so that when we fly with manned aircraft we can do so safely, professionally and minimise risk too far as is reasonably practicable."

FLTLT Harrison said, "Safety culture can have a profound effect on unit morale and its capacity to achieve output. For me being involved in aviation safety, and having a positive impact on that morale and capability of the unit is very rewarding."

The Royal Aeronautical Society's Dr Rob Lee Defence Flight Safety Award recognises an individual or collective effort that enhances aviation safety in Defence and is open to all members of the ADF, Defence civilians, Defence contractors and Australian Air Force cadets.

FLTLT Clint Harrison
"It is easy to get caught up in 'safety work' and not pay attention to how the work you are doing in safety is affecting day-to-day operations. I would highly encourage anyone involved in safety to carefully consider how the safety system is directly contributing to safe frontline operations, and use an evidence-based approach if making changes to the system. I believe the biggest impact individuals can directly have on safety is to help generate open and honest communication within their unit, and bring a healthy level of critical thinking to safety discussions."

The award considers the following:

- demonstrated commitment to improving aviation safety
- overcoming barriers to addressing aviation safety issues
- outcomes resulting from the aviation safety initiative
- engagement with stakeholders in making the contribution.

Nomination forms are available on the Dr Rob Lee Defence Flight Safety Award website and may be submitted at any time. To be considered for the current calendar year, nominations must be submitted by 30 September in each year. Nominations received after this will be considered in the following year.

Good Show Awards

Mr Andrew Tanti

Airbus Australia Pacific C-130J
TLS Program

ANDREW TANTI has been praised for his technical mastery, vigilance and dedication by Commander Air Mobility Group (AMG) AIRCDRE Bradley Clarke, who presented him with a Good Show Award for identifying a significant defect in a structural fitting of the C-130J-30 and contributing to the continued safe operation of the aircraft.

As a direct result of the Airbus employee's actions, additional faulty fittings already fitted to other C-130J-30 aircraft, were identified and subsequently replaced. According to Mr Tanti's award citation, "had the defect remained unnoticed, it had the potential to lead to a serious incident or accident resulting in the loss of one or more aircraft and crew".

"The vigilance you displayed during what was a routine task, and your persistence in ensuring that additional testing of the component was completed is to be commended and is a great credit to you, the maintenance standards of the C-130J TLS program structural team, and Airbus Australia Pacific. Your technical mastery and dedication have ensured the continued safe operation of C-130J aircraft and you can be justifiably proud of your contribution to aviation safety in the Royal Australian Air Force."

Background

Cracking was noticed in the lower Fuselage Station 817 (FS817) bulkhead fittings during an inspection related to a Special Technical Instruction (STI) on C-130J A97-450. Replacement fittings were sourced through the supply chain, cross matched with the components being removed and accepted for fitment.

Mr Tanti was assigned with the replacement task in the capacity of primary tradesman. He is a highly experienced senior technician within the Airbus structural team, often selected to carry out highly complex safety- and time-critical tasks.

While carrying out the vital step of jig drilling the new fittings, Mr Tanti noticed that the drill bits and reamers were 'biting in' more than usual and not producing clean holes. Drawing on his vast experience, Mr Tanti suspected that something was wrong and paused the task to raise the issue with his supervisor and leading hand.

Mr Tanti was advised that the fittings had passed both supply inspection and technical assessment, and that the part numbers were correct. However, Mr Tanti persisted and the team leader was notified of his concerns.

A collective decision was implemented to conduct hardness and conductivity testing on the new fittings. The testing revealed the fittings did not conform to appropriate hardness specifications and were highly unsuitable for aircraft use. The items were subsequently rejected. Further investigation revealed that five fittings from the same batch had been fitted to three different C-130J Aircraft. All five fittings were replaced, and testing revealed the same non-conformance.

Written by WOFF Andrew Coppleman, HQ AMG

CPL Toby Hadler

35 SQUADRON (now 33 SQN)

CPL TOBY HADLER was presented with a Good Show Award for his exceptional application of technical knowledge, identifying the incorrect Emergency Location Transmitter policies on the C-27J fleet when at 35SQN.

The avionics technician's use of previous platform experience and attention to detail uncovered the yearly requirement to replace the Emergency Location Transmitter for manufacturer testing. Due to the incorrect policies, the testing requirement had been unnoticed on some aircraft for more than three years.

There was potential that the Emergency Location Transmitter may not function correctly, leading to an inability to locate the aircraft and subsequent reduced emergency response time in the event of an aircraft crash.

CPL Hadler's award citation read: "The diligence you displayed during an unrelated routine task is commended and a credit to the maintenance standards of both 35 Squadron and 84 Wing. You can be justifiably proud of your contribution to aviation safety in the Royal Australian Air Force."

SNAPSHOT 2023

MORE THAN 14,500 respondents from across the Defence aviation community took part in the 2023 Defence Flight Safety Bureau (DFSB) *Snapshot* Survey held from 26 April to 19 May 2023.

Research and Human Factors Specialist and *Snapshot* Survey manager, Nicholas Lewins, from DFSB Reporting Intelligence and Research (RIR), has thanked those from across Air Force, Army Aviation, Fleet Air Arm, Air Domain and other select elements for their participation.

"Your responses are integral to us gaining a clearer picture of safety within our organisations and enable us to both celebrate our bright spots and better understand the challenges we are facing," Mr Lewins says.

"It is promising to see that of those that participated in this year's *Snapshot* 72 per cent saw value in contributing to the survey and 76 per cent received feedback from their commander or senior manager on the previous *Snapshot*. It is through this feedback loop that we can maintain continuous improvement via an open, just and fair examination of safety-related issues." 2023 *Snapshot* results will start rolling out across organisations from June.

As part of fostering a generative safety culture, *Snapshot* captures information on a broad range of issues that impact the safety, performance and overall health of participating organisations. Some of the specific aims of *Snapshot* include: providing a picture of a workgroup's safety/organisational climate; benchmarking against other units; tracking changes from one year to the next; identifying risks and hot spots; and assessing the effectiveness of recent interventions.

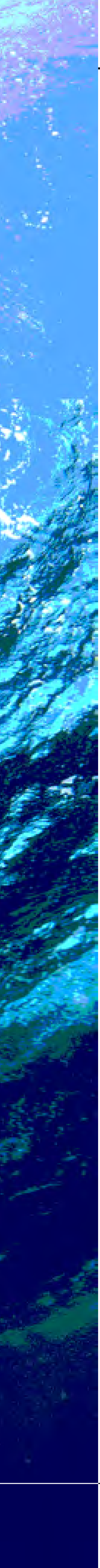
RIR encompasses Aviation Safety Reporting (ASR), Safety Intelligence Systems, and Research and Human Factors, with military members and civilians providing a holistic approach through a balance of subject matter expertise and operational knowledge and experience.

In addition to *Snapshot*, one of the products produced by the RIR team that truly encapsulates this blended approach is the Annual Aviation Statistics Report.

Some key responsibilities of RIR include:

- The ongoing management and support of ASR in Sentinel – providing a closed-loop process for the reporting, investigation, tracking and review of aviation safety events and issues.
- Ongoing management and support the Salus application to support the sharing, exchange and analysis of safety data across the Defence aviation community.
- The conduct of applied safety research and broader promotion of Human Factors-related issues across Defence aviation. This is achieved through safety surveys such as *Snapshot*, research products, human factors advice, guidance and tools and the implementation of Non-Technical Skills training framework.

Hey look, there's a SHARK!



By Air Commodore Mark Lax (Retd)

DISTRACTION WHILE FLYING can be fatal, and in the case of this accident, it almost cost two lives. It was the Monday before Christmas in 1965 when a Winjeel, A85-459 of No. 1 BFTS[1] struck the water, flipped over and sank into Port Phillip Bay.

The accident occurred just 400 m from Point Cook airfield. The impact tore off the engine, port wheel, the tail section and a large section of the port wing. The aircraft settled upside down on a rock ledge in about 2-3 m of water.

Fortunately, the pilot, a Winjeel QFI, and his student, the Adjutant of the Victorian Air Training Corps undergoing a refresher, were able to get free. Both were conscious and realised they were now inverted, still strapped in and under water. Attempts to jettison the canopy were futile until the canopy filled with water and the pressure equalised. The canopy then drifted away.

The instructor pilot who was seated in the starboard seat was first to surface after he managed to unclip his seat harness. He swam over the side of the cockpit, still wearing his parachute. Not seeing his passenger, he unclipped the parachute and was about to dive when his passenger popped up.

To make his escape, the passenger had to swim under the port wing after which he surfaced, and he too then released his parachute. The instructor was seriously injured with compression fractures of the spine, bruising and abrasions. Somehow, the pilot under instruction suffered only minor injuries.

Following this initial under-water ordeal, both inflated their Mae West survival vests and held onto the wreckage. Now by pure chance, the CO of AVMED, WGCDR Warren Bishop, was out fishing from a boat on his day off. He picked them up and waved off two airmen who were swimming out to assist. The three would-be rescuers became prime eyewitnesses.

Why no crash boat?

Normally, the Point Cook airfield had the full range of crash rescue vehicles. These were an early rescue vehicle, a pair of base fire trucks and a crash launch, all on immediate call. When flying was programmed, the crash launch would be moored to the Point Cook pier. However, this was the Christmas reduced-activity period and these services had all been NOTAMed out of service until early January to allow for regular routine maintenance – the only time of the year that this could be conducted. The same applied to the crash launch.

The CO of No. 1 BFTS had arranged for interim rescue facilities to be available to allow for some limited flying instructor continuation training to be carried out when the usual cadre of cadets were on leave. These interim facilities amounted to an open tray truck, a driver and three fire extinguishers in the back.

In an emergency, technical personnel were expected to assist. This solution was not appropriate for a crash response and a very loose interpretation of the standing orders which cover minimum facilities that must be available when flying is in progress.

The Winjeel

The CAC CA-25 Winjeel is a tandem two-seat basic trainer that could be fitted with a third passenger seat behind the pilot. The aircraft captain would usually sit in the right-hand seat as this was the instructor's position.

Australian designed and built, it was given the name Winjeel after an aboriginal word meaning 'Young Eagle'. To the instructor's left sat a student or passenger.

The aircraft was powered by a 450 hp Pratt & Whitney Wasp junior radial piston engine which burnt high octane avgas fuel. When doing aerobatics, the smell of fumes in the cockpit was almost overpowering – the crew had no oxygen masks.

Salvage was completed the following day and a careful examination of the wreck and components failed to establish any technical reason for the crash.

The Winjeel was solidly built and when full weighed 1970 kg. Its fixed undercarriage could take a lot of ab initio student punishment. Max cruise speed was about 300 km/h (160 kts) and normal cruise about 135 kts. Service ceiling was 15,800 ft. It came into service in 1955 and was replaced as a trainer by the CT-4 in 1975.

Let's examine the circumstances

The flight was briefed and authorised by the CO as general flying in the Point Cook Flying Training Area and would involve stalling, spinning, aerobatics, practice forced landing and circuits. The circuits were to be carried out at Laverton which unlike Point Cook, had full ATC control. The instructor then briefed his student and advised him that the flight would also include a number of glide approaches to familiarise the student with the final stages of a forced landing. All was as to be expected.

The instructor was very experienced with 3546 flying hours, mostly as a multi-engine aircraft captain. As a QFI, he had 780 hours on the Winjeel. He was rated fit and healthy and had completed an aircrew medical six months prior.

The weather was quickly discounted as a factor as despite Melbourne's reputation for variable weather, the day in question clear with good visibility and light south-easterly breeze. A high-pressure system ensured relatively clear skies and little turbulence.

When the aircraft had been salvaged, the crash investigators found the aircraft had been serviceable and had been pre-flighted correctly. The Winjeel was full of fuel, payload was only the two pilots, and the aircraft was operated within its correct limits and CofG. With pilot incapacity, weather and serviceability not considered factors, the flying safety investigating committee next turned to the flight profile.

The flight

The flight commenced as briefed. During the initial stages of the flight, the instructor demonstrated the first glide approach at Point Cook and carried out a touch and go. Next the student carried out three more glide approaches followed by a touch and go. At this point the instructor decided to head off to the training area to conduct the upper air sequences. As soon as the aircraft began to climb out, the instructor took control.

At approximately 200 ft a starboard climbing turn was initiated in preparation to leave the circuit. During the turn the instructor glanced out and saw a shark in the water near the pier and at the same time observed several people swimming nearby. The climbing turn was continued while both pilots observed the shark, the instructor's intention being to call the control tower so that the swimmers could be warned.

The instructor's next realisation was that the aircraft had stalled. Stall recovery action was initiated immediately; however, there was not sufficient height available to affect recovery. Realising this the pilot attempted to at least get the aircraft into a favourable ditching attitude. Nevertheless, the aircraft struck the water, cartwheeled, turned onto its back and sank.

What the witnesses said

As well as the wing commander and the two airmen who started to swim out to the wreckage, two air traffic controllers and several other duty crew witnessed the crash. All gave the same account of what happened. The aircraft was flying at about 200 ft in a starboard climbing turn, but the nose 'seemed higher' than normal. Suddenly, the bank increased to almost 90°, the nose dropped below the horizon and the aircraft entered a 'fairly steep' dive.

For a few seconds it appeared that the pilot levelled the wings; but the dive continued. Just before hitting the water, the nose was slightly raised. The Winjeel then hit the water one wing first in a nose down attitude and appeared to cartwheel before being lost in the spray of the water.

Examination of the wreckage

Given the shallow depth and proximity to the Point Cook pier, the wreckage was quickly recovered and formed the basis of the technical examination. Investigators agreed the initial impact to be at the port main wheel and port wing tip. Both had broken off and the drag caused the aircraft to cartwheel breaking off the engine assembly. Another section of the port wing then broke off.

Although one might expect the water to put an immediate break on an upside down, engineless Winjeel, the aircraft travelled a further 20 m in the direction of travel. Here the aircraft finally came to rest as the tail section detached, held on by just the control cables. The jettisoned canopy gradually sank beside the wreckage.

From the evidence it was clear the sortie proceeded according to the briefing up until the starboard turn was initiated at approximately 200 ft on the climb out. At this point the pilot saw a shark in the water near some swimmers and he attempted to keep it under observation and alert ATC so a warning could go out. Neither pilot was paying attention to the aircraft attitude and the evidence suggests that the turn was probably tightened. Given the tendency to lean over to keep the shark in view, the instructor probably inadvertently pulled up the nose. Consequently, the airspeed got too low, and the aircraft stalled at a height which was insufficient to effect safe recovery.

Flight Safety Examiner conclusions

The cause of this accident was assessed as an error of skill on the part of the pilot in that he stalled the aircraft at a height which was too low.

A contributory cause was both pilots allowed their attention to be diverted from the primary task – that of flying the aircraft – because a shark in the vicinity of swimmers captured their attention.

Some last thoughts

One of the first flying skills inexperienced pilots learn is about stalling and safe recovery. How a very experienced instructor could allow a distraction at such a low altitude during a critical phase of flight defies explanation. Fortunately, in this case, the crew survived.

The crew of two other Winjeel accidents attributed to stalling were not so lucky. On 28 June 1961, A85-433 lost control following an engine failure after take-off. The pilot attempted a turnback – a fatal mistake that all pilots are warned of – and the aircraft stalled, crashed and caught fire. Then, on 28 March 1988, A85-409 flown by an experienced FAC pilot and an airman passenger, stalled and crashed while turning base at RAAF Base Williamtown. In this case the accident was personal – the pilot was Flight Lieutenant Paul Carter, an Academy mate of mine.

Author's note: This article was derived from information contained in 'DFS Accident Review No. 81', A Review of Three Major Accidents During Late 1965 – Early 1966.

Endnote

1 No. 1 Basic Flying Training School, a forerunner of No. 1 FTS.

Given the tendency to lean over to keep the shark in view, the instructor probably inadvertently pulled up the nose. Consequently, the airspeed got too low, and the aircraft stalled at a height which was insufficient to effect safe recovery.

Do you know a Flight Safety Champion?

ROYAL AERONAUTICAL SOCIETY
AUSTRALIAN DIVISION

Royal Aeronautical Society

Dr Rob Lee Defence Flight Safety Award

Recognising **individual or collective efforts** that have enhanced Defence flight safety.

Nominations are open to all members of Defence aviation, including foreign exchange and loan personnel, Defence civilians and contractors.

For details on the nomination process for the 2023 award please visit the DFSB Intranet site.

DEFENCE FLIGHT SAFETY BUREAU
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