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FACT versus FICTION: The Truth about Australia's New Air Combat Capability

Major defence acquisition programs are almost invariably accompanied by controversy. Often such controversy proves to be misplaced, as the exceptional in-service performance of the once-disparaged F-111 strike aircraft and Collins class submarine has shown.

Yet even allowing for that history, much of the debate surrounding the Australian Defence Force's project to acquire a New Air Combat Capability has been extraordinarily misinformed.

This paper has been prepared by the Williams Foundation to separate fact from fiction: to present the best and most accurate information currently available regarding the NACC.

Unlike some of the extreme critics of the NACC project, the authors of this paper have all been qualified military aviators and have flown an extensive range of third- and fourth-generation combat aircraft. Most have also commanded operational squadrons.

Fiction

The arrival in the Asia-Pacific region of aircraft like the Su-30 and MiG-29 will negate the ADF's traditional dominance in the air and place Australia at risk.

FACT

It has been incorrect for at least 40 years to equate platforms (generally strike/fighter aircraft) with the ability to generate and sustain advanced air power. Since the time of the air war over North Vietnam, professional airmen have understood that air combat is won by a *system* of capabilities. Absent any one of the many essential components of that system and you are likely to lose – especially if you are outnumbered.

Fiction

The superficially impressive manoeuvrability and power-to-weight ratio of Soviet-designed aircraft such as the Su-30 and MiG-29 confers a potentially decisive advantage over Western fighters during within visual range (WVR) combat.

FACT

It has been incorrect for some 20 years to equate WVR potential with platform agility alone. Since the 1991 Gulf War, manoeuvring to achieve a kill has been done by air-to-air missiles, not by platforms. No manned fighter aircraft can compete with missiles that attack at over twice the speed of sound and manoeuvre at 60 'g'. (A manned fighter involved in WVR combat typically flies at less than half that speed and manoeuvres at a maximum of 9 'g'.)

No less important than the missile is situational awareness. The classic case study here comes from 1993 and concerns the (British) RAF's Tornado F-3 air defence fighter.

By the standards of the late-20th century the F-3 was a mediocre performer, handicapped by its modest agility and poor acceleration. Despite the high quality of RAF pilots, the F-3 regularly sustained a loss rate of around 3:1 in exercises against the West's best fighter of that era, the USAF's F-15. The turnaround came during an exercise at Mountain Home Air Force Base in the United States when, for the first time, the F-3s were fitted with Link 16 data links. The shift was dramatic. Overnight, the F-3 became an F-15 killer, reversing the loss ratio to 3:1 in its favour. Situational awareness, not manoeuvrability, was the key.

In short, for WVR combat, platform agility is a secondary consideration. It is the system, and in particular situational awareness and the missile, that count.

Fiction

Russian fighters are challenging the West's historical dominance in the air.

FACT

Commentators who assert this are confusing the ownership of platforms with the ability to generate and sustain a first-class air power *system*. Advanced platforms are necessary but not sufficient.

The difference between a platform and a system is the possession of essential enabling capabilities, as follows:

- High quality logistics,
- High quality engineering,
- High quality people
 - Pilots
 - Technicians
 - Battle planners
 - etc,
- High quality intelligence, surveillance and reconnaissance,
- High quality command and control
 - Systems
 - Leadership, and
- Integrated weapons and communications systems across all three combat environments (air, sea, land).

The penalty for being unable to deliver these essential enabling capabilities is ultimately reflected in severely reduced effectiveness, due in part to poor aircraft serviceability rates. Here, the discrepancy between West and East is dramatic, and illustrates the difference between winning and losing.

Over the past 40 years, on combat operations in the Middle East and Central Asia, advanced air forces from countries such as the United States, the United Kingdom, Israel, Canada, France and Australia have routinely achieved aircraft availability rates of 90%, often 95%. By comparison, air forces operating Russian strike/fighter fleets have struggled to achieve 50%.

Fleet numbers thus are effectively halved even before combat starts, and before other systemic liabilities begin to further erode availability rates.

Russian logistics support is notoriously abysmal; their systems integration non-existent; and their ability to adapt, modify and upgrade on the run poor. Perhaps the only air force to have achieved Western standards of availability with Russian platforms has been the Indian Air Force, which has used its strong indigenous aerospace industry and Israeli technology to rectify shortcomings in Russian management practices and equipment. (It is revealing that the Russians themselves reportedly have sought Indian help with the MiG-21 and MiG-29.)

The end result is that Western forces have without exception achieved air supremacy within days of a campaign's start (see Operation Desert Storm in 1991, Operation Deliberate Force in 1995, Operation Allied Force in 1999, Operation Enduring Freedom in 2001, Operation Iraqi Freedom in 2003, and so on).

Aircraft that are unavailable for one reason or another are useless - except possibly as a source of spare parts - regardless of any superficially impressive ability to 'turn and burn'.

Fiction

The Australian government should have spent hundreds of millions of dollars re-engineering the 1960s-designed F-111 to keep it in service as part of Australia's overall NACC (strike/fighter) mix.

FACT

Arguments that the government should have spent an enormous amount of money rebuilding the F-111 from the wheels up were operationally naïve, technologically simplistic, and fiscally irresponsible.

With its exceptional potential within the Asia-Pacific region to shape events and to deter actions (and to respond militarily if necessary), the F-111 was perhaps the ADF's single most important capability during the second half of the 20th century. However, the concept of operations on which the aircraft's design was based has been largely obsolete since the 1991 Gulf War (Operation Desert Storm), especially when confronted by a modern, integrated air defence system.

The F-111 was designed specifically to attack targets at very high speed at very low level, a tactic that was valid when the aircraft entered service. However, in the 1991 Gulf War, six (British) RAF Tornados were either shot down or crashed using precisely that tactic, a loss ratio far and away the worst of any allied strike aircraft involved in the war. Improved air defences which demanded improved allied systems and tactics had made the Tornado/F-111 concept of operations redundant.

Modern air warfare is conducted at medium and high altitudes, using an integrated system which exploits a carefully structured combination of stealth, networking, superior situational awareness, dominance of the electromagnetic spectrum, precise targeting, superior planning, advanced radars, advanced weapons, and the like. It is an environment in which fifth-generation aircraft excel; fourth-generation aircraft can function effectively – if skilfully operated; and their predecessors are obsolescent. The F-111's ability to survive in this environment is unacceptably low.

As far as rebuilding the F-111 is concerned, simply keeping the aircraft in service for 36 years has been an enormous achievement by the RAAF and Australian industry, for which they deserve great credit. However, the effort involved is no longer worth the expense. It is no coincidence that Australia is now the world's sole operator of the F-111.

Despite that reality – which was well-understood within the ADF - the argument in favour of rebuilding the F-111 at times extended to include, among other things: new wings, new wing-

carry through boxes, new engines, new radars, new avionics, new weapons systems, new stealth characteristics, and new data links. Modifications to the fuselage and tailplane would also have been necessary. The RAAF would have had to manage this fanciful program by itself, and the Australian government would have had to bear the entire cost and risk. No professional airman or informed politician could ever support such a manifestly untenable proposal.

By planning to retire the F-111 in 2010, the ADF and the Government have made the only rational decision. The sooner the resources the aircraft currently consumes are redirected towards a 21st century air weapons systems, the better.

Fiction

The RAAF's F/A-18F Super Hornets will be inferior to contemporary Russian strike/fighters.

FACT

Former defence minister Brendan Nelson's decision to order 24 F/A-18F Super Hornets at a cost of around \$6 billion remains controversial, particularly as it was reported to have been taken with little reference to Defence. Nelson was, however, clearly concerned by the possibility of a capability gap emerging between the (then) planned retirement of the F-111s in around 2012 and the delivery of F-35s, which realistically could not start before about 2013.

Contrary to statements from some observers, the Super Hornet is a highly capable aircraft. As a central component of the ADF's evolving networked combat system, the Super Hornet will be superior to Russian-sourced aircraft and will help to maintain the RAAF's regional superiority. Furthermore, the recent decision by the current government to have 12 of the aircraft wired to allow for potential conversion to a specialised electronic warfare role at a later date is prudent.

The Super Hornets also will provide the ADF with a valuable growth path into future networked operations with the F-35, noting that the two aircraft share many common systems and architecture.

While representing an excellent bridging capability, the Super Hornet will not be as advanced as the F-35. There will, however, almost certainly be pressure on Defence to keep the Super Hornet in service longer than the original bridging period out to 2020 because of its high acquisition cost. Of more concern would be any decision to keep the Super Hornets indefinitely, with a commensurate reduction in the number of F-35s acquired. This would at best delay the transformation of the RAAF into an all fifth-generation F-35 fleet, and would at worst mean that for the foreseeable future the Air Force would be operating a mixed fourth/fifth-generation fleet and never reap the major benefits inherent in a single-type fleet.

Politics is not always rational, and we have to deal with the world as it is. The Super Hornet has been ordered, and it will provide a high quality interim capability. Whether or not that comes at the expense of a superior capability, namely, an optimal fleet of all F-35s, remains to be seen.

The F-35 Joint Strike Fighter

The furore over the F-111 seems to have petered out following the firm decision to retire it in 2010. However, for reasons that are not clear to many professional airmen, some former advocates of extending the F-111's in-service life have turned their attention to attacking the ADF's preference for the NACC fleet, the F-35 Joint Strike Fighter. The result has been the dissemination of a large amount of misleading information about modern air combat in general and the F-35 in particular.

The error of defining air combat effectiveness as close-in manoeuvring has already been discussed. Turning to the F-35, a great deal of adverse publicity was generated when, for example, prototypes were delivered overweight, even though this is so common during aircraft

design and development as to be almost routine. Now, however, the fact that weight is no longer an issue with the F-35 goes unremarked.

Despite the fact that the history of military aircraft development is replete with technological challenges, most of which are resolved, some of the commentary on the F-35 has been so ill-informed as to make its rationale difficult to understand. Nevertheless, it is apparent from the media response that the criticism has had some effect, both with the public and politicians. Consequently, the remainder of this paper will focus on fact and fiction as it relates to the F-35 (noting that as yet Australia has not made a firm commitment to buy the aircraft).

A final introductory comment is necessary.

The F-35 is just entering its test and development phase, with some 5000 flight and ground tests scheduled over the next few years. No one except Lockheed Martin (the manufacturers), the USAF and, perhaps to a lesser extent, other potential customers (including Australia), who alone have access to classified information from those tests and their complementary simulations, can be fully confident of their conclusions. At the same time, informed opinions can be reached if judicious assessments of publically-available material are balanced by an understanding of how modern air wars are won.

Fiction

The F-35's ambitious capability suite – precision attack, air-to-air combat, and information/surveillance/reconnaissance – will result in a compromised platform that will never be any good.

FACT

Starting with the Six-Day War of 1967, for more than 40 years, advanced Western air forces have demonstrated a level of superiority perhaps unequalled by any form of combat power in the history of warfare. In the Six-Day War, the Yom Kippur War (1973), the Falklands War (1982), Operation Desert Storm (Iraq 1991), Operation Deliberate Force (Former Republic of Yugoslavia 1995), Operation Allied Force (FRY 1999), Operation Enduring Freedom (Afghanistan 2001), and Operation Iraqi Freedom (2003), advanced air forces have utterly dominated their opponents.

Those operations were primarily planned and fought by the USAF, the Israeli Air Force, and the RAF, arguably the three best air forces in the world. It is noteworthy that each of these air forces is likely to become a major user of the F-35, using it to replace many of the platforms that have underwritten their extraordinary war fighting successes of the past four decades. It is also significant that Israel – not an original partner in the JSF project – has now indicated its intention to join, based on data emerging from the aircraft's test and development program. Other air forces either involved in the program or expressing a strong interest include: Italy, the Netherlands, Canada, Australia, Denmark, Norway, Turkey, Singapore, South Korea and Japan.

If the most successful air forces in the history of air warfare believe that, on the best available evidence, the F-35 is likely to provide the best solution for their future combat needs, then their judgment warrants respect.

Fiction

Australia should buy the F-22 Raptor instead of the F-35.

FACT

The F-22 is unsuitable for the full range of roles the ADF requires from the NACC. In any case, as things stand, the United States will not release the Raptor for overseas sale, even to their closest allies.

There is no dispute that the F-22 will be the world's pre-eminent control of the air fighter for the next two to three decades. It is optimised for the role, with its all-aspect stealth, supercruise, and complementary avionics and weapons systems reportedly generating an exchange (kill/loss)

ratio of 20:1 in exercises and USAF simulations. It will be superior to the F-35 in the air-to-air role.

However, the F-22 will be inferior to the F-35 in air-to-surface strike and as an information/surveillance/reconnaissance system, both of which are essential roles for the ADF.

The F-22 has a very limited strike capability, and will not be able to carry the 2000lb class of weapons that are an essential part of the F-35's inventory. The F-22's radar currently has neither a ground mapping facility nor a precision targeting system. While there are plans to upgrade the F-22 to the F-35's standard there are serious doubts whether funding will ever be available. Even if such upgrades went ahead, the F-22 will never have the F-35's extensive suite of electro-optical sensors.

In short, despite its air-to-air excellence, the F-22 remains a limited war fighting system.

Fiction

The F-35 will be outclassed by other fighters in air-to-air combat.

FACT

There are two air-to-air domains to consider here: Beyond Visual Range, and Within Visual Range.

Authoritative American simulations have indicated that BVR engagements will dominate future air-to-air combat (as indeed they have since 1991). The estimate is that 93% of all engagements will occur at BVR and transitional distances,¹ that is, at ranges greater than about 14 kilometres; while only 7% will occur WVR, that is, inside 14 kilometres.

Based on the best information publicly available, the only aircraft superior to the F-35 in the Beyond Visual Range domain will be the F-22. In other words, the F-35 will be better than every fighter – Russian, European, Asian, and American - except the F-22. And since it is improbable in the extreme that Australian F-35s would ever have to challenge American F-22s in combat, any thought of competition between the two is of academic interest only.

The key determinants of BVR dominance as reflected in the F-35 and F-22 are as follows:

- Both are described by the US Services as having 'all aspect Very Low Observability'. VLO has to be built in from the ground up and cannot be added to fourth-generation aircraft.
- Both have enhanced situational awareness compared to fourth-generation aircraft, with the F-35 being the more advanced because of its extensive array of electro-optical sensors and data fusion capabilities.
- Both have advanced networking capabilities, including inter-flight data links that permit the transfer of high fidelity information between aircraft in a formation, allowing them to operate as a fully-integrated team.
- Both use the same air-to-air missiles. The F-22 will carry more AIM-9s than the F-35, but the F-35's will be a later (i.e., better) version.

¹ Transitional distance is the area in which combat moves from beyond visual range to within visual range. For modern air combat this transition generally takes place between 14 to 24 kilometres.

Within Visual Range, the F-35 will enjoy significant advantages through its exceptional situational awareness systems and advanced radar (both of which will be better than the F-22's), and its advanced missiles and high off-bore sight aiming system (which allows a pilot to fire his missiles without having to manoeuvre to advantage).

Special mention should be made of the F-35's distributed aperture system, which uses multiple infrared sensors to generate a full spherical image and allows the pilot to 'look' through the airframe via a helmet mounted display. While the sensor's manufacturer, Northrop Grumman, may be overstating the case by claiming that it will make manoeuvrability 'irrelevant', the technology is a potential game changer. When the F-35 enters service it will be the only fighter in the world with such a system.

Simulations indicate that the F-35 will have a kill/loss ratio of around 8:1 against every competitor other than the F-22. By any standards that is a historically high figure. Furthermore, given the F-35's superior BVR capabilities, pilots almost invariably should have the option of breaking off a pending engagement should they assess that the odds are against them.

Conclusions about the F-35 as an air superiority system based on assessments of platform manoeuvrability, acceleration and maximum speeds, are ill-founded. Instead of focusing on such secondary issues, political and defence decision-makers would be better off contemplating why the most successful air forces in the history of air warfare are planning to make the F-35 the centrepiece of their operations for the first half of the 21st century.

Fiction

The RAAF's F-35s (and Super Hornets) will not have sufficient range.

FACT

The F-35's unrefueled range will be less than that of the F-111's, but so is every other fifth-generation strike/fighter's. In any case, in a high-threat environment, the F-111's range is irrelevant, the aircraft's performance being only as good as the fighters that must escort it.

In the VLO configuration – that is, with no external stores – the F-35 carries slightly more fuel than the F-22, and as a smaller, lighter, single-engine aircraft will have greater range/endurance. Anyway, there is a broader issue. In the era of air-to-air refuelling, single-pilot strike/fighter aircraft routinely fly missions in excess of 10 hours. Air-to-air refuelling has revolutionised platform performance in exactly the same way as have, for example, superior situational awareness and advanced missiles.

Many of the criticisms about the alleged range and endurance limitations of aircraft like the F-35, the Super Hornet and the F-22 reveal the same lack of understanding of modern air warfare evident in the 'turning and burning equals performance' mindset.

Fiction

The F-35 will cost as much as the F-22.

FACT

Cost estimates for new military aircraft are notoriously unreliable, as Australia's F-111 acquisition demonstrated years ago. No one, including the manufacturer, can provide a reliable estimate in Year 1 of the likely costs over a probable in-service life of more than 30 years. Nevertheless, several trends can be confidently predicted.

The first is that the F-35 will cost more than current estimates. It would be a world first if it did not. At the same time, commonsense and an appreciation of previous strike/fighter programs suggest that the F-35 will cost much less than the Raptor, for the following reasons:

- The F-35 is smaller and lighter, and history shows that you largely pay for aircraft 'by the pound',
- The F-35 will have one engine, not two, a significant cost factor for both acquisition and sustainment,
- The F-35's total build is expected to be around 16 times larger than the F-22's, providing a huge economy of scale. (Analysis of the 'learning curve' effect for aircraft production shows that the cost of an aircraft reduces to about 86% every time the number built is doubled. Thus, if there are 16 times as many F-35s as F-22s, this doubling occurs four times, leading to a reduction in cost to about 55%.)
- Unlike the F-22, the F-35 is being built from the ground up to maximise affordability, taking in to account advanced digital avionics, greatly enhanced reliability, and manufacturing techniques.
- The F-35 is benefitting greatly from the lessons learnt during the F-22's development, with many of the same people – some of whom now have 15 years experience working with fifth-generation strike-fighters – involved.

Finally, unlike the F-22, the F-35's contracted cost will incorporate systems that are usually regarded as extras, and which incur very large additional expense, including: electronic countermeasures; the electro-optical targeting system; the radar warning receiver; the countermeasures dispensing system; and the distributed aperture system.

Based on those facts, it is fair to assume that the through-life cost of an F-35 will be about one-half that of an F-22.

Fiction

There have been major cost blowouts in the NACC project since Australia joined the F-35 program.

FACT

While there have been increases in the cost of the F-35, there has been no commensurate increase in the NACC budget, which has remained stable since the Air 6000 (NACC) project was presented in Australia's 2000 Defence White Paper. There are numerous reasons for this situation, including:

- From the outset, Defence did not base its NACC costing provisions on Lockheed Martin's initial JSF estimates, instead taking a more conservative approach.
- By contributing a fixed amount of USD 150 million to be a Level 3 Partner in the JSF program from the beginning, Defence and the NACC project have been largely insulated from increases in the development portion of the F-35 program.

Becoming a Level 3 Partner has proven to be a very good investment for Australia, for the following reasons:

- It has covered our full contribution to non-recurring cost recoupment, which otherwise could have been in the order of USD 1 billion,

- It has precluded the expense of any Foreign Military Sales fees, potentially around USD 100 million, and
- It has opened up significant opportunities for Australian industry in the global F-35 program. (So far 25 Australian companies have won more than USD 150 million of work in the development phase alone.)

Some Cautionary Notes

As noted before, much of what has been presented as debate on Australia's NACC program has been so weighted towards the negative or so misinformed as to be seriously misleading. Regrettably, a good deal of the mud has stuck and has become accepted wisdom with some sections of the media and the Parliament, and with the public generally. Consequently, in an attempt to restore balance, this paper has tended to emphasise the positive qualities of the ADF's preferred NACC choice, the F-35 Joint Strike Fighter. While the Williams Foundation believes that the best evidence supports our conclusions, we acknowledge the risks inherent in taking this approach.

The most obvious risk is that a great deal of flight and laboratory testing, incorporating many leading-edge technologies, must be completed before the F-35 can achieve its operational specifications. Despite the magnitude of some of the associated challenges, the Williams Foundation believes that a strong degree of confidence is justified, noting that in the past, challenges that seemed at least as daunting were overcome in the development of great combat aircraft such as the F-51, B-29, F-4, F-111, F-15, and many more. It is also the case that the F-35 program will be able to draw heavily on lessons learned during the F-22's development.

Additionally, modelling and simulation have developed to the point where the F-35 program can complete a great deal of testing on the ground, where it is cheaper, safer, and easier to fix problems. F-35 flight testing will be conducted largely to validate models, rather than to 'discover' what the aircraft will do in flight, as used to be the case.

Perhaps the greatest risk to Australia's NACC program is neither aeronautical nor technological, but financial. As the US economy struggles to deal with the global financial crisis, let alone start to recover, there must be a possibility that Congress will cut defence spending to the extent that new programs like the F-35 could experience setbacks. Were that to happen, the purchase of the Super Hornets would seem almost inspired. At the same time, the sheer scale of the F-35 program, and the involvement of a large number of international allies/customers who are important to the US, would suggest that damaging cuts are unlikely.

Conclusion

Much of the debate attending the ADF's NACC program has been stronger in polemic than logic. That so much misinformation has apparently been readily accepted by sections of the media and politics is a matter for regret.

In the opinion of the Williams Foundation, the NACC program has been managed intelligently and skilfully by Defence. If the current direction is maintained, in five or so years, Australia almost certainly will be the Asia-Pacific region's pre-eminent air power.