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RUMOUR CONTROL
The JSF 'Air System': Unprecedented Capability Analysis

The Director of Operational Requirements for the New Air Combat Capability (NACC) project is a former F-111 right-seater. He provides this insight into the process that has shaped the NACC project and Defence's ongoing commitment to the F-35A Joint Strike Fighter as the right aircraft to meet Australia's needs.

By GPCAPT Brian Walsh

The New Air Combat Capability (NACC) to be acquired by the Australian Defence Force (ADF) in the next decade will be the largest single defence acquisition in Australia's history. Designed to ensure Australia's regional air combat superiority for the next 30 years, this acquisition will represent the single most important acquisition the Australian Government will make for decades.

It is vital, therefore, that decisions regarding this new air combat system be based on rigorous capability analysis. Nothing is more important to a modern defence force than superior air combat power. Understanding how a modern fifth-generation air combat system will meet Australia's air combat needs requires very careful attention. I feel very privileged to be helping in this most significant undertaking.

By the time the Australian government decides in 2008 whether to acquire the F-35 Joint Strike Fighter (JSF) to meet its NACC needs, the aircraft will have been subject to more detailed operational and technical analysis than any other defence project in history. Importantly, this analysis is considering the F-35 in a 'systems' paradigm rather than simply focussing on 'platform replacements'.

This 'whole of capability' approach to analysis will ensure that all the interfaces required between the JSF Air System (comprising air vehicle and logistical support) and our current and future ADF systems are fully understood. The F-35's full potential will only be realised through an understanding of these interfaces and by ensuring that provision for them is considered in planning for the NACC. Phrases like 'force multiplier effects', 'better bang for your buck' and 'dominant situational awareness' are all weaved into this 'whole of capability' approach where the networked effect far exceeds the sum of the individual elements.

A 'whole of capability' approach requires the Australian Defence Organisation (ADO) to consider all F-35 capabilities—including sensors, data-links, weapons and stealth characteristics—within the wider context of the ADF systems networked together to enhance operations. These systems include the Wedgetail Airborne Early Warning & Control (AEW&C) capability, Jindalee over the horizon radar, satellites, unmanned aerial vehicles, KC-30B tanker aircraft, Air Warfare Destroyer, Special Forces as well as a myriad of other ADF and allied systems.

My days of F-111 flying at very low level under the cover of darkness are gone. Give me the stealth, tactical flexibility and enhanced situational awareness that the networked JSF combat capability will bring to the table.

Australia's Air Combat Capability Requirements

While the ADF is considering the F-35A as a means to radically enhance Australia's total air combat capability, the requirements against which the F-35A will be tested must first be established. The capabilities required of the F-35 within a 'networked' force are derived from strategic guidance provided by Government. Flowing from this strategic guidance, the NACC Operational Concept Document (OCD) has been developed that details the derived measures of performance against which the F-35A is tested. This OCD is the foundation for defining our air combat capability requirements, capturing the 'solution-independent' capability needs of the warfighter and establishing to what extent the F-35A meets those needs. The OCD provides the context for defining what the future air combat capability must be able to do by articulating what will be required of the NACC, where it will be required to operate, and against what threats - both current and future - as identified by the Defence Intelligence Organisation.

NACC requirements have been derived in the OCD through analysis of operational scenarios, set within a 'strategy-to-task' framework. These endorsed NACC operational scenarios have been analysed using a Joint Military Appreciation Process (JMAP) which captures events, actions and responses reflecting the way the NACC will be used in future conflicts as an element of the future ADF. From this analysis, the Critical Operational Issues (COI) or tasks that NACC must be able to undertake—including the likely location and duration of those tasks—have been identified. Derived in this fashion, the detailed capability requirements of the NACC are captured but remain directly traceable to high-level ADF guidance and, ultimately, government strategy.

The COIs that the NACC must be capable of addressing have subsequently been deconstructed into specific performance measures. These performance measures form the basis by which the F-35 Air System is being analysed for its suitability. The NACC OCD has also considered the capability currently provided by the current F-111 and F/A-18 combat force. The lessons learned from operating these types of aircraft have been captured and their capability benchmarked against the NACC COIs. This activity serves to validate the performance measures set for NACC and to ensure that they are appropriate for the future threat environment.

Importantly, the NACC OCD is not a static document; it is subject to continuous reviews and updates as the future threat environment becomes clearer and nearer.

Detailed Analysis

The operational and technical analysis of the F-35 Air System capability and how it meets these performance requirements for NACC has been underway for several years now.

In Australia, the NACC project has approximately 50 DSTO scientists conducting detailed analysis on a full-time basis, developing advanced simulation models including intelligent agents for even greater detailed analysis. These scientists are tasked by my operational requirements team, comprising experienced fighter and strike weapons system operators. This is in addition to other analysis that has been running in parallel for many years in the other eight partner nations and to which Australia has access.

From the US side, the JSF was designed from the ground up to be a multi-role strike fighter to replace the capability of the F-16, F/A-18, AV-8B, and A-10. As such it is required to effectively execute air-to-air missions including defensive and offensive-counter-air against advanced threat fighters and cruise missile defence, as well as air-to ground missions such as providing support to land and maritime forces, suppression and destruction of enemy air defences and precision attack against stationary and moving targets. A big difference between the F-35 and previous generation aircraft is that it is designed to go out and hunt surface-to-air missiles (SAMs) – not just keep away from them. In total, F-35 capability analysis has been ongoing since before 1994 – representing over 20 years of analysis by the time we have an operational capability in Australia.

The DSTO scientists and technologists supporting NACC analysis are divided into two groups. The largest group is focussed on analysing the capability of the JSF Air System as well as undertaking a technical risk analysis. This group has representatives from eight of DSTO's 12 divisions including Defence Systems Analysis Division; Human Protection and Performance Division; Air Vehicles Division; Maritime Platform Division; Command, Control, Communications and Intelligence Division; Intelligence, Surveillance and Reconnaissance Division; Weapon Systems Division; and Electronic Warfare and Radar Division. This first group considers in detail the F-35's air frame, systems, C4I and weapons and is responsible for the development of sub-system models that inform the analysis of the second group of DSTO scientists from Air Operations Division. It is this second group that undertakes analysis addressing the requirements stemming from the OCD, and the associated measures of effectiveness and performance.

Personnel in these two groups cover an impressive range of academic disciplines. They include physics, chemistry, computing, aeronautical engineering, engineering, mathematics, psychology and more. DSTO personnel are also embedded within the NACC Integrated Project Team (IPT) to ensure that their analysis is closely aligned with the real-world expertise of RAAF personnel – people like me and my team.

ARTEMIS

One of the prime tools utilised by DSTO scientists is the Australian-developed Air Tactical Engagement Mission Simulator (ARTEMIS). ARTEMIS uses an architecture that allows various sub-system models, such as that of the radar, weapons, data links, etc to be rolled together and then linked either to real pilots or computer-based intelligent agents as well as off-board supporting systems. This highly-advanced tool allows for better 'whole-of-system' analysis.

The NACC IPT and DSTO continue to conduct analysis on the required fleet size to satisfy the ADF's future air combat capability requirements. A key determinant of the eventual fleet size will be concurrency requirements—both in terms of the number of roles to be conducted at any one time and the number of areas in which operations will be conducted.

Currently, we feel that a fleet of up to 100 JSFs to provide four operational squadrons and a training unit—integrated as part of the networked ADF—is the most cost effective solution to address Australia's unique air combat capability needs. A final decision on total aircraft acquisition numbers, however, is subject to ongoing analysis and, of course, what our Government decides in 2008.

Ongoing analysis of the ADF's air combat requirements will continue to 'set the bar' for the capability required for the F-35 air system. These future needs will also form the basis for consideration for the regular planned upgrades to the F-35.

Tactical Simulators

In parallel with the detailed JSF analysis underway at DSTO, ADF fighter pilots, test pilots and operational pilots have been flying high-fidelity JSF mission simulators in the US against future air and surface threats to develop tactics for the employment of the JSF air system and its weapons. As an indication of JSF maturity, here we are, probably five or six years before we take delivery of the aircraft, already flying high-fidelity simulators and developing tactics – and very different tactics to those of the F-111.

The primary aim of tactical simulator events is to conduct F-35 missions in realistic virtual environments to provide insight into the operational effectiveness and suitability of the F-35. Simulation events are conducted by individual JSF partner nations and also in multi-nation teams representing a coalition force to develop combined tactics. Tactical simulation facilities provide event participants with a mix of high and low-fidelity cockpits for the conduct of missions involving multiple F-35s and multiple threats, and offer comprehensive briefing and debriefing facilities so that maximum benefit can be drawn.

During these events, pilots and analysts are exposed to the use of the complete sensor and data-linked information available on the F-35 while executing missions that span a wide scope of air power roles against advanced current and future threats. To cover our COIs, missions flown have covered offensive counter air, sweep, force protection, defensive counter air, strike and offensive air support to surface forces, as well as suppression/destruction of enemy air defences. The results of these various missions are analysed and compared with results of other analyses to provide a clear picture of the JSF capability. These activities have proven to us that the F-35 Air System has a vastly superior combat capability to anything we are likely to face well into the future.

Importantly, F-35 manned tactical simulation exercises contribute directly to the realisation of the F-35's full potential by providing a means for the pilot warfighter to influence development of the human machine interface. Additionally, they provide data on F-35 capability with a 'human in the loop', an important contribution to analysis being conducted by DSTO.

Program highlights and progress

Another key part of efforts to ensure the F-35's superiority into the future is that upgrades to its capability will be made biannually to ensure it is able to deal with emerging threats. As a partner in the F-35 Follow-on Development Program, Australia has access to 100 per cent of the benefits for three per cent of the cost. Because of the sheer numbers of aircraft involved this is one of the key benefits of the JSF Program that other projects are not able to match.

The F-35 will be fitted with either the Pratt & Whitney F135 or the General Electric/Rolls-Royce F136 engine. The reliability of new generation engines is considerably more than current generation aircraft engines. The single-engine F-35 will in fact be more reliable than current generation twin-engine fighter aircraft. Furthermore, the onboard health monitoring system of the JSF will provide

significantly greater prognostic information to anticipate engine failure well before it occurs, allowing preventative maintenance or engine replacement.

There has already been extensive testing of F-35 combat systems. The radar, electronic warfare suite, distributed aperture system, electro-optic targeting system and countermeasures systems are already flying in surrogate aircraft and meeting performance requirements. There has been extensive wind tunnel testing and finite element modelling of the overall air vehicle. And of course those who saw the documentary 'Battle of the X Planes', saw the testing of the prototype X-35.

As mentioned, performance of the overall system has already undergone extensive testing in manned tactical simulator exercises. Lockheed Martin, the JSF Program prime contractor, is reporting huge improvements in production efficiency results on the first aircraft. In some areas there has been as much as a 90 per cent improvement in production efficiency and build quality when compared with mature programs such as F-16. Lockheed Martin is confident these gains will enable JSF target costs to be met.

While there are undoubtedly risks associated with such a large, complex project, we believe that the current project plan achieves the appropriate balance of risk, cost and schedule while aiming to meet the warfighters' delivery date. But challenges remain and that's why we have many ADF and DSTO members working alongside our international Partner colleagues in the US to help provide Australian expertise to the project as well as help us understand any issues that may develop. There is still a long way to go on this project and known and unknown risks could generate issues that will need management – you can't develop new technology, superior capability without taking on some risk – that's always the case with taking on leading-edge capability.

Consideration of Alternatives

The decision to join the JSF Program in 2002 was taken after considering all of the realistic air combat alternatives. That analysis showed the clear performance benefits of the only two fifth generation aircraft, the F-35 and the F-22A. The F-35, however, provides clear cost as well as performance benefits and represents the most cost effective solution for Australia's requirements.

Much has been written about the air dominance capabilities of the highly capable but very expensive F-22A. Even disregarding cost, the F-22A simply cannot do all the things that we need our fighter to do—it does not meet all our needs. And the F-35 is more rugged, more suited to the Australian environment because it's been designed to operate in the very tough environments experienced by the US Navy (USN) and US Marine Corps (USMC).

There are two indisputable facts: if the F-22A could conduct the full range of air combat roles the United States Air Force (USAF) would not need the F-35 as well as the F-22A; and, if the F-22A was no more expensive than the F-35—as some have argued—the USAF would not have plans to buy 10 times as many F-35 as F-22A. Furthermore the USN and USMC need superior air-to-air combat capability around the world without reliance on the F-22A—they will get this with the F-35.

Bring it on

The totality of F-35 analysis to date gives us confidence that the Conventional Take Off and Landing (CTOL) variant, the F-35A, will meet all of the NACC requirements with capability to spare and growth potential well into the future. The assessed performance of the JSF aircraft—

based on a combination of actual measurements and modelling—is meeting or exceeding specifications. The F-35 looks set to significantly enhance Australia's air combat capability and meet any threats we are likely to face well into the future. The F-35's combination of stealth, fused situational awareness and weapons give it the capability advantage in our region. Importantly, its supportability advantages that result in more sorties per plane per day are also a key force multiplier.

While our overall analysis shows that the F-35 is the most cost-effective aircraft for Australia, I want the best operational capability, the most deployable airframe, the jet that you can turn around and fly again quickly, something with the range we need to handle the vast distances that are our geographic reality, something that can bring the biggest combat load to the target—from an operational capability perspective, I want the best combat effect. Numbers of airframes are also important given the large area we need to cover and the range of tasks we need to conduct concurrently.

Our detailed and ongoing analysis shows that the JSF is the best option for Australia and, importantly, it can do the job in a way we can afford now and throughout its life. For me, the sad fact is that it is the next generation of aviators that will get to operate this 5th generation capability when the thrill of flying F-111 will be but a fading memory.

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