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The case for the JSF

CAF Air Marshal Angus Houston outlines the best choice for our next frontline combat aircraft

Comparing the JSF and F/A-22
Our involvement in systems analysis
Important set of numbers
Why the JSF is best for us
Key features of the F-35

http://www.defence.gov.au/news/raafnews/editions/4617/features/feature01.htm

Australia's air combat capability is on the threshold of a new era as the F-111 and F/A-18 approach the end of their service lives.

In 2002 Defence Minister Robert Hill announced Australia would become a partner in the System Design and Development phase of the Joint Strike Fighter (F-35) project.

He indicated the government intended to acquire the JSF as Australia's new frontline combat aircraft – though a final decision will not be made until at least 2006. The JSF will be a true fifth-generation, stealthy, multi-role, single-seat, single-engine fighter.

The strength of our future air combat capability – and our largest defence project ever – is a matter of strategic importance.

Are we sure the JSF is going to be good enough? Or should we look at going "top shelf – the F/A-22, which will be the most outstanding fighter aircraft ever built?

Our advice to government to move to a more modern fifth-generation aircraft reflected our view that the fourth-generation aircraft would not meet our needs, nor be good value for money.

For Australia to sustain a decisive combat edge in the air over coming decades, we need to move to the more advanced capabilities of a fifth-generation aircraft over the next decade.

The further upgrading of our current platforms for service well beyond 2020 present high risks and high costs for capabilities which would not be superior to those we can get from the JSF.

We have plenty of recent experience with aged airframes and with the high technical risk of Australian-unique systems integrations on complex aircraft. And we know the logistics costs of operating multiple aircraft types.

We are sure this is not a viable path. Acquisition of new platforms alone is unlikely to provide us with the qualitative edge that we need. in the emerging networked environment.

A qualitative edge will only be achieved through enhancing individual platform capabilities by integrating them as part of a system within which the platform will operate.

We will maintain our capability edge by developing a network-centric air combat system that exploits information and communications systems to create the desired effects.

Of course, fighters remain the essential core of the network, and it is important to examine the capabilities of the individual platform options and their ability to contribute to the system.

Comparing the JSF and F/A-22

NO ONE today is making an aircraft that has the same radius of action on internal fuel as the F-111 in the strike role. For the future, therefore, we are going to have to adapt to a lesser range platform supported by air-to-air refuelling and, in some cases, stand-off weaponry to provide range extension.

The Conventional Take-Off and Landing (CTOL) JSF - retaining stealth by not carrying external stores or fuel tanks - is specified to have an unrefuelled radius of action in the strike role of at least 590nm.

There are no public domain figures for radius of action of the F/A-22 in the strike role. Its radius, though, is likely to be similar to the JSF because, while the F/A-22 has only about the same internal fuel as the JSF for a slightly heavier aircraft with two engines, it is likely to be an extraordinarily aerodynamically efficient aircraft.

Both aircraft should have similar reach when air-to-air refuelling is added to the equation. At present the F/A-22 has no air-to-ground radar capability but a major systems upgrade has been proposed.

The Joint Strike Fighter is well able to fulfil Australia's air combat capability needs.
Photos by Lockheed Martin

The F/A-22 Raptor.

When the F/A-22 has had its radar, computer architecture and avionics processors updated, it would be expected to have a significant air-to-ground capability, but one that will be more reliant on off-board data because it will not have the equivalent of the JSF's EOTS system (see panel at right).

JSF will have the advantage in weapon carriage because its internal weapons bay can carry 2000lb class weapons, including the variants of the BLU- 109 hard target weapon.

The largest weapons that the F/A-22 weapons bay can accommodate are the 1000lb class. Recently there has been increased interest in small weapons.

A combination of greater precision and more effective explosives mean smaller weapons can do the same job as previous generation large weapons.

That means more weapons can be carried on a single sortie. Both aircraft will be able to carry these new generation small-diameter weapons internally, though with a larger weapons bay it is likely that the JSF will be developed to carry more of them.

On the other hand, stealth combined with supercruise and its very high operating altitude would make the F/A-22 less vulnerable to surface-to-air missiles.

On balance, while both aircraft offer a strike capability of quite some significance, the JSF strike capability will be more versatile and comprehensive for our requirements within our region. There is no question that the F/A-22 will be the world's best aircraft for the air superiority task.

Its air combat advantages relate to its ability to supercruise and its manoeuvrability. Fortunately we only expect to do battle against F/A-22s in training exercises.

Against fourth-generation adversaries, the JSF has the decisive advantages of stealth and comprehensive situation awareness, both from its onboard sensors and through the network. It also has some additional advantages.

The JSF has a very large internal fuel load and will not suffer the drag penalties imposed by external stores and weapons. It will be able to operate supersonically more often than most opponents.

The JSF – with its combination of fused data from onboard and offboard sensors – will be able to detect and identify threats before it can be detected and should have a comfortable margin in its ability to achieve first launch in the beyond-visual-range (BVR) arena against fourthgeneration opponents.

Coupled with the ability to simultaneously engage multiple targets, the JSF, like the F/A-22, offers the potential for real advantages in exchange ratios in BVR combat against fourth-generation opponents.

Platform agility is not an unimportant consideration even in the BVR arena (or the strike role for that matter). There is a threshold level of agility needed to defeat adversary missiles.

There are specific manoeuvres, combined with countermeasure employment, that need to be conducted when airborne or ground-based missile launches are detected.

Our analysis supports the view the JSF has adequate agility for this purpose. The F/A-22 has a clear margin in agility over the JSF as the F/A-22 has a higher thrust to weight ratio and has vectored thrust engines.

As for the JSF, the Pratt & Whitney F135 engine is performing well and meeting performance targets. When we were last buying a fighter, more than 20 years ago, agility was a central consideration, particularly in the within-visual-range (WVR) air combat arena.

Since that time there have been two quite radical technological developments affecting WVR combat. The first is the advent of highly agile, countermeasure-resistant "dogfight" missiles.

The second is the perfecting of helmet-mounted sighting systems that allow pilots to acquire and launch "dogfight" missiles at targets far from the aircraft's line of flight - even behind the launch fighter's own wing line.

If decisive and superior exchange ratios are to be achieved in the air combat arena of the future, it will have to be done in the BVR arena.

Looked at another way, an air force that wishes to leverage its BVR capability advantages needs first to ensure that its adversary is unable to gain advantage through orchestrating WVR engagements.

There are a number of prerequisites to being effective in the WVR arena:

- dominant situational awareness;
- helmet-mounted sighting systems;
- highly agile "dogfight" missiles;
- superior countermeasures; and
- a threshold (but not necessarily superior) level of platform agility.

This threshold of agility is needed to ensure we can fire well before an adversary can destroy us.

On current indications, the JSF has this capability with a margin to spare, though of course our analysts and technology experts are watching this area very closely as the project progresses through its development phase.

The JSF will not aim to fight in the WVR arena, but will be capable of fighting there if necessary. While there is little doubt that the F/A-22 would do the air combat job outstandingly well, everything we are seeing to date indicates that the JSF will do the job very well too, and it is a more versatile strike aircraft.

Our involvement in systems analysis

WE HAVE a great deal of absolute information about the JSF capability that the US intends to release to us.

About 30 Defence Science and Technology Organisation scientists are working independently on analysing JSF capability to ensure it will deliver what we need.

This will allow the government to be fully informed when the time comes to make an acquisition decision. As a partner in the project, our pilots and scientists have had the opportunity to participate in the structured systems analysis and evaluation being conducted in a dedicated simulation facility in the US.

This facility uses a combination of computer modelling and man-in-the-loop simulations of operational scenarios and is loaded with the latest JSF performance data as the system development phase proceeds.

The simulations are also loaded with the threat systems of greatest interest to us.

Our participation means we are able to monitor how the project is developing in considerable detail, access a great deal of technical information, and refine our independent assessments of the JSF's operational suitability to our concepts for operations.

Important set of numbers

THERE has been no government decision yet on the number of aircraft to be acquired under the new air combat capability project.

The 2000 Defence White Paper and subsequent reviews propose the acquisition of "up to 100 aircraft", and the Defence Capability Plan 2004-2014 identifies a notional budget for the project of $11.5bn to $15.5bn.

But much intensive operational analysis and force balance studies remain to be done before a final decision on numbers will be made.

Key issues to be taken into account in determining the number of aircraft to be acquired include:

- the balance between numbers of JSF, AEW&C and air-to-air refuelling (AAR) aircraft, the aim being to achieve the most cost-effective force structure overall (noting that AEW&C and AAR aircraft make significant contributions even when not supporting combat aircraft);
- the contribution from other force elements such as the new Air Warfare Destroyers;
- the number of geographic areas that may need to be supported simultaneously;
- potential for concurrent air superiority, strike (maritime and land) and ground support operations – noting that as a true multi-role aircraft the JSF can perform all tasks, even on the same mission;
- rotation of forces, which recent operational experience has shown is a major issue;
- aircraft required in a maintenance pool, expected to be low given the JSF's expected reliability and minimal deeper maintenance requirements; and
- attrition aircraft to cover losses throughout the service life of the aircraft.

The JSF will require the Air Force to rethink the basis of squadron sizing, taking into account the increased endurance of the JSF and the expected increased availability of aircraft.

Overseas operators are looking at squadron sizes ranging from 12 through to 24 aircraft. Our current thinking is that a larger number of smaller squadrons might be preferable, providing greater flexibility for a relatively small force.

Options of 12 or 16 Fully Mission Capable aircraft are currently being examined, which would require either about 14 or 18 aircraft in a squadron, allowing for maintenance requirements.

The recent decisions to acquire five AAR tankers and the additional two AEW&C aircraft (giving a total of six) are an acknowledgment of the need for the Air Force to have the capability to conduct air control operations in two separate areas simultaneously.

This is consistent with White Paper 2000 guidance that identified the need for land forces to conduct two concurrent but geographically separated operations.

Each area could need at least one squadron of fighters deployed to cover air control tasking, possibly more if intensive 24/7 operations were in prospect.

It is quite possible that at the same time direct support of land operations may be required.

And concurrent strike operations may also be required – either land or maritime. Four squadrons looks like being the minimum prudent operational force to meet potential concurrency requirements.

With four deployed squadrons of even 14 aircraft, backed up by a squadron-sized rotation capability, the total number is already up to 70 aircraft.

To this must be added aircraft for training – possibly 10 to 18 – plus a pool of aircraft undergoing deeper maintenance or regular upgrades, and additional aircraft to allow for expected attrition over the life of the fleet.

The number quickly gets up to 100. So the number mentioned in the White Paper, and accepted by government to date, is pretty close to the mark.

A much greater number obviously would be much more expensive and possibly difficult to sustain, and a much smaller number could leave us seriously exposed. The latest unit cost forecast for the CTOL JSF is about US$45m, though this is for aircraft well down the production run.

Earlier aircraft will be more expensive and there will be additional costs for any additional equipment or Australian unique modifications. The JSF nonetheless remains cheaper than most of the original contenders for the Air 6000 project.

Admittedly, the project is at an early stage, and despite the heavy management focus on cost control, costs may well rise before the aircraft goes into full rate production. Indeed, we are budgeting on this to a certain extent.

Current project office estimates are that 100 CTOL JSF – along with necessary integration/support/training requirements – can be accommodated within the original Air 6000 funding provisions.

A recent Government Accounting Office report quotes the unit cost estimate for the F/A-22 at US$153m.

While the F/A-22 program is more mature than JSF, there is still the potential for cost increases because the F/A-22 has to be fitted with new avionics processors and architecture in order to achieve its full air-to-ground capability.

It is reasonable to estimate that the budget currently earmarked for a 100 aircraft JSF program probably would support an F/A-22 acquisition of only about 30 aircraft.

A force of 30 aircraft is clearly inadequate to provide the capability for concurrent air control and strike operational tasking and to support an organic training organisation.

Why the JSF is best for us

THE CONCLUSION is clear.

The JSF is the more cost-effective option for us, even though the F/A-22 might do important parts of that job better.

Of course, the final performance of the JSF is far from being proven and there are a number of key risks still to be managed in the project. But the track record of the US military and the US aerospace industry in delivering on projects like this is very good.

On all the indications of the moment (and we now have a ringside seat) the JSF will be able to do the job set for us by government:

- It promises the margin of capability we require for the tasks we intend for it.
- It will be the most “network-enabled” capability on offer.
- It will be truly multi-role, giving us great operational flexibility and cost effectiveness.
- It can be acquired in operationally meaningful numbers within the available budget.
- It will be able to be supported in service at lower cost than any alternative.
- It will have the best growth potential, at lowest ongoing cost to us, of anything on offer because of its large production base.
- And finally it offers the potential for a significant and long-term industry program that should exceed in value and benefits the conventional offset arrangements of any alternative.

Key Features of the F-35

THE JSF is intended to set new benchmarks in affordability, availability and supportability for a high-performance stealth aircraft.

Apart from its stealth design, it does not break a lot of new ground in its aerodynamic design. But its designers have squeezed in an extraordinary amount of fuel for a singleengine fighter of this size.

The JSF's advanced sensors and communications systems are key to its ability to integrate into a networked air combat capability.

At the heart of the JSF's sensor suite is its Active Electronically Scanned Array radar. It is state-of-the-art, capable of both air-to-air and air-to-ground target detection, identification and weapon allocation.

The radar also acts as a passive, highly precise long-range sensor for emissions from threat systems, and can actively jam other air and ground emitters. Importantly, it can conduct most of these activities simultaneously or near simultaneously.

A radar warning receiver provides information on threat emissions for those areas outside the scan area or frequency coverage of the radar.

The JSF will be fitted with an advanced Electro-Optical Targeting System that provides long range infra-red search and track of air targets, long range detection of ground targets, a laser range finder and a laser target designator.

Unique to the JSF is a Distributed Aperture System comprising six infra-red sensors that provide a spherical display in the pilot's helmet visor of the position of other flight members, targeting for air-to-air missiles, locating ground targets and detection of threat aircraft and missiles.

The JSF has an extensive communications and data link suite. The high capacity inter/ intra flight data link allows a flight of JSFs to act as a fully fused team. Link 16 allows sharing of data with other air and surface players.

Satellite communications provide for beyond line-of-sight communications (JSF is the first fighter aircraft to have satellite transmit and receive capability).

There is a software driven Joint Tactical Radio System, primarily for communications with ground forces, and there is a prognostics and health management data link that provides for integration with the JSF's logistics system while still airborne.

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