



Dubai International Air Chiefs Conference 2011 - Chief of Air Force: Air Marshal Geoff Brown AO – Defining a 5TH Generation Fighter

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Introduction

Your Highness Sheikh Ahmed Bin Saeed Al Maktoum, fellow chiefs, ladies and gentlemen, first let me thank our host, Major General Mohamed Bin Swaidan Al Qamzi, Commander of the United Arab Emirates Air Force and Air Defense for the invitation to address such a prestigious audience.

I am here today to provide an insight into the capabilities a 5th generation fighter can bring to a fight and some of the challenges we face in transitioning a force from one capability generation to another.

The Royal Australian Air Force has a proud history of maintaining its professional mastery of air power since its inception in 1921. Nothing is more important to a modern defence force than superior air combat power. For Australia, it's the cornerstone of our national security. We seek to develop and maintain a leading edge in each air power role we undertake, whether it is control of the air, strike, ISR, or air mobility.

Fighters have always been critical to the success of many of the activities undertaken to realise these roles. Indeed, modern fighters are able to conduct many of the activities previously performed by specialist ISR and strike platforms.

From the Meteor to the Sabre, Mirage to the Hornet, and through to the Super Hornet, Australia has always sought to maximise its fighter capability for the operational environment we face.

With the introduction into service of the Super Hornet nearly complete, Australia is already looking to its next major challenge; transitioning its fighter force to a 5th generation capability – to be provided by the F-35 Lightning II Joint Strike Fighter..

We all appreciate that while air power has a wide number of roles, its principle role is to establish and maintain control of the air. This prime role allows our forces freedom from attack and therefore the freedom to attack.

However, the ability to achieve these freedoms is constantly being challenged by opposing, and evolving, air power capabilities.

To realise a freedom of manoeuvre requires us to establish and maintain an operational advantage over any threats in the air domain. The objective to gain and maintain control of the air has been the catalyst for continued fighter development and spurred the generational changes we have witnessed in fighter capabilities.

History

The use of **aircraft generations** as a term to describe game-changing advances made in jet fighter aircraft design entered our lexicon in the 1990s. In reality, significant landmark changes in fighter capabilities have occurred almost every decade since World War II.

What constitutes a generational shift is open to debate, but for this forum I propose that the concept relates to major advances in aircraft design, avionics, and weapon systems which cannot be incorporated into a previous generation via upgrades and retro-fitments.

1st Generation

1st generation jet fighters in the 1940 and -50s, such as the F-86 Sabre, MiG-15 and MiG-17, had basic avionic systems with no radars or countermeasures, and armaments of machine guns or cannons, as well as unguided bombs and rockets.

These pioneering designs started the slide of classic propeller-driven fighters into obsolescence and forever changed the character of air warfare.

2nd Generation

The 1950s and into the 60s saw the introduction of radar, infrared and semi-active guided missiles, as well as radar warning receivers into **2nd generation** jet fighters such as the F-104, F-5, MiG-19 and MiG-21.

Advances in engine design and aerodynamics allowed this generation of fighters to be the first to sustain supersonic speeds in level flight. Engagements were still within visual range, but radar-cued missiles started to stretch out engagement ranges. Survival in the aerial combat arena began to rely on more than the mark-one eyeball.

3rd Generation

During the 1960s, improvements in manoeuvrability, combined with significant enhancements to the avionic suites, saw the emergence of the first cadre of multi-purpose **3rd generation** fighters such as the MiG-23, F-4, and Mirage III.

Doppler radar allowed a look-down shoot-down capability, and with off bore-sight targeting and semi-active guided RF missiles like the AIM-7 Sparrow and AA-7 Apex, engagements moved to beyond visual ranges. Being able to visually see your opponent was no longer a prerequisite to establishing control of the air.

4th Generation

Through the 1970s and 80s the trend of improvement in avionics and aerodynamic design continued with the development of fly-by-wire **4th generation** fighters such as the MiG-29, Su-27, F/A-18, F-15, and F-16.

For many, though not all, of this generation of fighters, the ability to switch missions between air-to-air and air-to-ground became the norm. The line between control of the air and strike became blurred.

Generation 4.5

During the late 1980s and into the 90s a reduction in military spending resulted in a slowing down of aircraft development.

For many, it was more efficient to add radar absorbent materials, thrust vector controlled engines, greater weapons carriage and extended range performance to 4th generation fighters, such as the Hornet, Eagle and Flanker, than to build new aircraft.

However, the addition of an Active Electronically Scanned Array radar was a significant enough game-changing combat capability for these redesigned fighters to be deemed a generation of their own – Gen 4.5. Some manufacturers designed new platforms, such as the Eurofighter Typhoon, Saab Gripen and Dassault Rafale, which incorporate many of the Gen 4.5 advanced characteristics.

5th Generation Characteristics

With so much capability inherent in generation 4 and generation 4.5 fighters, it is hardly surprising that the effort to design and build a generation 5 fighter can only be described as monumental.

It is not my intent to debate the adequacies of the term “**5th generation**”, rather to focus on the capabilities and missions that the very latest generation of aircraft can bring to the fight, as well as some of the challenges that we can face in transitioning to a new generation fighter.

So what makes a fighter 5th generation?

Through the generations the most successful fighter aircraft have been those that best combined effective lethality with high degrees of survivability.

Stealth

5th Generation fighters are designed nose-to-tail with low observable or stealth technologies that make it almost impossible for even other ‘gen 5’ fighters to detect them. True stealth is more than applying a coat of radar absorbent material to an aircraft. It is a feature that is considered in every facet of the aircraft’s design from internal weapons storage to air inlet aerodynamics, to low power, multi-aspect radars and a cooperative targeting capability.

Reducing the radar cross-section, infrared and visible signatures, as well as minimising electronic emissions, breaks an adversary’s kill chain in ways never before considered feasible.

Situational Awareness

However, not being seen is only one aspect of survivability. The 5th generation fighter must have the ability to see who is around, both friend and foe, well before anyone can get close enough to threaten friendly forces.

The situational awareness on previous fighter generations has been restricted to sensors with limited arcs of coverage and the mark one eyeball. 5th generation fighters will have the unheralded ability to build a 360 degree situational awareness picture around them.

Pilots will be able to “look” through the floor of the fighter or behind the aircraft without having to manoeuvre the jet. This will be achieved by fusing the multi-spectral sensors located across all aspects of the airframe.

Electronic support sensor technology will enable targets to be detected without the knowledge they are being tracked. Cueing for many capabilities of 5th generation fighters is not limited to on-board sensors but available from multiple off-platform sources.

Networked

5th generation fighters will be wired for combat like no other aircraft before them; they will be born networked. While in their own right they will be more than a match for most aircraft, they bring to the fight a degree of networking that is a force multiplier.

The situational awareness picture the pilot receives will automatically have fused any available feeds from other fighters, Airborne Early Warning and Control platforms, such as Wedgetail, remotely piloted aircraft, air warfare destroyers or ground-based Command-and-Control.

No longer will pilots have to stitch off-platform information into a mental picture or enter data into on-board systems while in the middle of a combat manoeuvre. The focus can be solely on the fight - not managing data that supports the fight. They can be electronically muted and still have a situational awareness picture that is second-to-none.

Decision Superiority

This allows **decision superiority**, which as USAF fighter pilot and air strategist Colonel John Boyd argued, allows the pilot to get inside the OODA loop of the opposition. Once you can make better decisions faster than your adversary, combat success is virtually guaranteed.

Equally, 5th generation sensor data can be shared with other platforms in real-time to enhance the battlespace picture of other combat elements in the area, or alternately the information can be stored and down-loaded at a later stage for post-flight analysis.

Weapon Systems

However, we should never assume perfection in any system. In the event that a 5th generation aircraft is detected, or an adversary gets close enough to bring weapons to bear, an advanced countermeasures suite provides a degree of multi-spectral protection not previously witnessed in fighter aircraft.

5th generation aircraft bring a new meaning to the term “combat survivability”. But survival in a combat environment is not enough. In the fighter world, the ability to defeat your adversary in most cases requires lethal force.

Many adversaries may be engaged and neutralised without ever being aware they were under threat. If they are detected the engagement time will be so short as not to permit sufficient time to take defensive actions. Survivability, combined with effective lethality breeds dominance.

Complexity

Are 5th generation fighters inherently smart?

At the heart of 5th generation capabilities is of course an aircraft that, in comparison to previous generation fighters, appears unbelievably smart and seems to defy some of the laws of physics.

In reality, generational design changes have always pushed the boundaries of scientific belief so we should not be surprised by the astonishing abilities of new platforms. Gen 5 fighters will have an insatiable appetite for data.

The ability to generate the full extent of 5th generation fighter capability will depend on the quality of technical intelligence data that will run through its electronic veins. 5th generation fighter capabilities are largely defined by their software - and it will be ongoing development of their software that will ensure they maintain their edge against an evolving threat.

The JSF has more software than any other air combat aircraft, with 7 million lines of code in the aircraft, and a further 7 million lines of code in the supporting ground systems. An example of the complexity of the F-35 software is that it uses about 100 times the number of parameters than a 4th generation fighter does to define a potential threat.

Training

But modern military capabilities are made up of more than the combat platform. In many cases, the ability to integrate all the contributing elements in a capability determines relative combat effectiveness.

The ability to fly an aircraft does not mean you have the ability to fight with the aircraft. This is never more so than in 5th generation fighters. The effectiveness of a training system has always been the key determinate to combat success and 5th generation training takes a more systems-centric approach than a platform-centric one.

As with the current trend of training, heavy emphasis is placed on simulation. However, the training does not focus solely on the pilot. Intelligence, maintenance, weapon-loading, and even some logistics elements will be conducted in the virtual environment, enhancing safety and bringing a degree of realism not previously encountered.

Combat simulator training will not be limited to the single fighter with collective training possible through real-time links to other dissimilar-type fighters and other combat elements, such as the AEW&C and RPA.

This brings me to one of the questions we face in 5th generation training.

How do you train against other 5th generation fighters?

If you are unable to detect a 5th generation opponent and they are unable to target you, how do you train? One possible solution is to load the fighter with a device that makes it more detectable, but would this lead to training outcomes that are not representative of the real world. This issue highlights the need for dissimilar training opportunities.

If you have 5th generation fighters and your potential adversaries do not, then you need to have the opportunity to train against a variety of other generation fighters to develop your tactics, techniques, and procedures and operational competencies.

5th Generation Missions

So we have a new generation fighter capability; are there new generation missions they will undertake?

The answer is no. They will still perform the air-to-air roles of offensive and defensive counter air. They will still undertake air-to-surface missions like strike in the land and maritime domains, perform interdiction and close air support, and engage in electronic warfare and ISR.

These styles of missions have not changed across many of the generational shifts in fighter capability. But, unlike past generations, 5th generation fighters will be able to undertake many of these missions either simultaneously or concurrently.

When describing the Raptor, Lieutenant General Dave Deptula once said that it is not just an F-22, but an F/A/B/EA/RC/E-22A. New capabilities breed new methods, and how a 5th generation fighter undertakes these missions may more closely resemble a video game than traditional aerial combat.

Generations Transition Issues

So what is the nexus between generations 4.5 and gen 5 fighters?

The greatest challenges we face are the transitional issues that arise in moving a force from one generation to another. In Australia, we have had to face the inter-generational issues that have arisen in our transition from the F-111 and classic F/A-18 to the Super Hornet, and will continue to face with the introduction into service of the F-35 Joint Strike Fighter.

The F-35 and the digital revolution represent a generational shift for everybody, operators and maintainers alike. The F-35 will challenge traditional sustainment practices, where we're talking about early onboard diagnostics and fault isolation rather than waiting for events to occur.

I recall when we upgraded our F-111s from an analogue to a digital cockpit. The new avionics were a quantum leap in technology with inertial guided navigation systems slaved to GPS data. At last we knew where we were at all times, though an F-111 navigator would never admit otherwise anyway.

The strange thing was that during training missions we followed many of the old practices, including overflying common landmarks every 50 miles or so. Eventually, I asked the navigator what the relevance of the landmarks were, thinking they may have been family properties. It turns out that the old navigation systems drifted so much they had to be updated regularly, and the landmarks were known radar offsets. Even though we had a better capability we continued to fight and fly the old way.

Group think was alive and well.

Another example was when we upgraded the multi-function display in the F-111. We spend an enormous amount of time and resources digitising the Attitude Indicator and compass displays. The end result was a digital system that made the new displays look like the old.

The lesson here is that when transitioning to a new capability, whether it is an upgrade or a generational change, we can not afford to simply adapt old practices to the new system. The benefits of change come through an evolution of professional culture, not simply a

marrying of the old and the new. Transitioning to a 5th generation fighter will challenge us to step outside our comfort zones and question the efficacy of past habits. I posit that the cultural shift will take time, but if we approach it from an enlightened perspective we will get a better outcome, quicker.

Global Requirements

So, does everyone need 5th generation fighters?

The answer is clearly no. The question each country has to address is: what fighter capability do I need in the foreseeable future to maintain a relative competitive advantage in my area of interest?

For many, this answer may be that generation 3, 4 or 4.5 are sufficient to provide the competitive advantage required in their region. A key consideration for any deliberations is how the acquired capability is to be integrated in a networked force.

Technology advances have enabled every generation of fighter to be ungraded so they are vastly more superior to their original versions. Upgrades are a normal part of a capability life cycle and in many cases fulfil the air power needs of a nation.

Australian 5th generation milestones

Australia took delivery of its 24th Super Hornet last month and we expect to have a full operational capability by the end of 2012. Much of this capability has been built around our F/A-18 classic experience and the transfer of resources following the retirement of our F-111s last year.

While we plan continued operations of the generation 4 Hornet until 2018, and the generation 4.5 Super Hornet until at least 2020, we will commence the transition into the 5th generation F-35 starting in 2014. Australia is set to realise a 5th generation fighter capability by 2018.

We are under no illusions that these plans will encounter many challenges, but our New Air Combat Capability team has been working on many of the issues already for well over a decade.

Conclusion

5th generation fighters such as the F-22 Raptor and F-35 Joint Strike Fighter offer a quantum leap in air power capabilities over their compatriots, but they come with great challenges.

Training, intelligence, logistics, and even our service culture will need to adapt to the new capabilities this new generation of fighters will deliver. We can not simply adopt old methods to new capabilities.

The missions they will undertake may not be totally new, but the capabilities 5th generations fighters bring will vastly change the character and effectiveness of how they are undertaken. I can only but wonder how long do we have until a 5th generation fighter cannot guarantee control of the air?

When do we start asking the question - What will a generation 6 fighter need to bring to the fight?