

# PATHFINDER

AIR POWER DEVELOPMENT CENTRE BULLETIN



Issue 170, January 2012

## FIVE GENERATIONS OF JET FIGHTER AIRCRAFT

The notion of aircraft generations, a term that applies to only jet rather than propeller driven fighter aircraft, appeared in the 1990s and attempted to make sense of the leap-frogging improvements in performance to jet fighter aircraft brought about through major advances in aircraft design, avionics, and weapon systems.

While the rationale that constitutes a generational shift is debatable, a generational shift in jet fighter aircraft occurs when a technological innovation cannot be incorporated into an existing aircraft through upgrades and retrospective fit-outs.

### **First generation subsonic jet fighters (mid 1940s to mid 1950s).**

The first generation of jet fighters such as the F-86, MiG-15 and MiG-17, had basic avionic systems with no radars or self-protection countermeasures, and were armed with machine guns or cannons, as well as unguided bombs and rockets. A common characteristic of this generation of fighter was that the jet engines did not have afterburners and the aircraft operated in the subsonic regime.

### **Second generation jet fighters (mid-1950s to early 1960s).**

The second generation fighters saw the introduction of air-to-air radar, infrared and semi-active guided missiles, as well as radar warning receivers into such aircraft as the F-104, F-5, MiG-19 and MiG-21. This generation's fighters also incorporated advances in engine design and aerodynamics, which allowed them to reach and sustain supersonic speeds in level flight. During this period, although air-to-air combat was still within visual range, radar-guided missiles started to extend engagement ranges.

### **Third generation jet fighters (early 1960s to 1970).**

This generation witnessed improvements in

manoeuvrability, and significant enhancements to the avionic suites and weapon systems. They were also the first cadre of multi-role fighters such as the MiG-23, F-4, and Mirage III. Doppler radar supported a 'look-down/shoot-down' capability, and with off-bore-sight targeting and semi-active guided radio frequency missiles like the AIM-7 Sparrow and AA-7 Apex, aerial engagements moved to beyond visual range. The major change brought about by this generation aircraft was that it was no longer necessary to visually acquire opponents to neutralise them and gain control of the air.

### **Fourth generation jet fighters (1970 to late 1980s).**

Through the 1970s and 80s the trend of improvement in avionics such as head-up displays and optimised aerodynamic design continued with the development of 'fly-by-wire' fighters such as the MiG-29, Su-27, F/A-18, F-15, F-16, and Mirage-2000. Most of this generation of fighters had the ability to both switch and swing roles between air-to-air and air-to-ground, as opposed to the previous role-dedicated aircraft.

This in turn blurred

the distinction between control of the air and strike missions.

**Four and half generation jet fighters (late 1980s and into the 90s).** The concept of having a half generation increment stemmed from a forced reduction in military spending, which resulted in a restriction in aircraft development. It became more cost-effective to add 'stealth', radar absorbent materials, thrust vector controlled engines, greater weapons carriage capacity and to extend the range of fourth generation fighters, such as the Hornet, Eagle and Flanker, than to design new aircraft. The F/A-18E/F Super Hornet is



*F-86 Sabre and F/A-18 Hornet in flight*

an example of a 4.5 generation fighter evolved from a fourth generation aircraft. The addition of an Active Electronically Scanned Array (AESA) radar was a significant enough game-changing combat capability for these redesigned fighters to be deemed a generation of their own, hence the generation 4.5 rating. Some manufacturers designed new platforms, such as the Eurofighter Typhoon, Saab JAS 39 Gripen and Dassault Rafale, which incorporate many of the generation 4.5 advanced characteristics. Advances in computer technology and data links also allowed 4.5 generation fighters to be integrated into a network centric battlespace where fighter aircraft have much greater scope to conduct multi-role missions. As an example, the AESA radar allows fighter aircraft to perform a limited Airborne Early Warning and Control function.



*F-35 Lightning II Joint Strike Fighter*

**Fifth generation jet fighters (2005 to date).** The F-22 Raptor, introduced in 2005, is considered the next generation fighter aircraft. Soon to follow are aircraft designs like the F35-Joint Strike Fighter, the Sukhoi PAK FA (and the planned joint Russian/India variant) as well as the Chinese Chengdu J-20 which is believed to reflect features of this generation of fighter. A quantum improvement in the fighter's lethality and survivability has been a qualifying requirement to achieve generational change and the fifth generation fighters personify these traits. The advances over earlier generational fighters include nose-to-tail low observable or stealth technologies as part of the aircraft's design that make it almost impossible for even other generation five fighters to detect them; improved

situational awareness through having multi-spectral sensors located across all aspects of the airframe which allows the pilot to 'look' through the airframe of the aircraft without having to manoeuvre the fighter to obtain a 360 degree picture which in turn, enhances the aircraft's ability to use its suite of weapons to engage and neutralise an adversary without the adversary even being aware of the threat. These aircraft are also 'born' networked which allows them to receive, share and store information to enhance the battlespace picture. Fifth generation fighter capabilities are largely defined by their software and it will be the ongoing development of their software that will ensure they maintain their edge against evolving threats. The F-35 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 and sophistication of the F-35 software is that it uses about 100 times the number of parameters than a fourth generation fighter does to define a potential threat.

Ultimately, a fifth generation aircraft allows the pilot to maintain decision superiority over an adversary. This provides greater chances of survivability, which when combined with effective lethality, assures battlespace dominance.

- *Jet fighter aircraft generations clarify the quantum improvements in operational performance brought about by technological innovation.*
- *The concept of a half generation (4.5 generation) stemmed from a forced reduction in military budgets.*
- *Fifth generation aircraft create decision superiority leading to battlespace dominance.*

*I have had the misfortune to fly a fourth generation fighter against a fifth generation fighter and there was an extreme capability gap ...*

Air Marshal Geoff Brown, AO  
Chief of Air Force, RAAF



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