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CANADIAN FORCES COLLEGE / COLLÈGE DES FORCES CANADIENNES
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EXERCISE/EXERCICE

NEW HORIZONS

THE FUTURE OF MANNED FIGHTER AIRCRAFT IN CANADA:
IS JSF THE RIGHT CHOICE?

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ABSTRACT

This paper will look at Canada's future air force fighter aircraft requirements focusing mainly on the replacement of the CF-18 as well as the introduction and expansion of the UAV and UCAV capabilities. It argues that despite the move towards unmanned platforms, there will still be a requirement for manned platforms well into the 21st century. There are a number of mission and roles that will be well suited to UCAVs, but at the same time there are other roles and mission that require a man-in-the-loop. The main focus of the paper however will be on the manned fighter requirement and will analyse the suitability of the JSF to meet these requirements. The paper ultimately argues that the JSF will not meet all of the essential requirements of Canada's CF-18 replacement aircraft project.

The Joint Strike Fighter (JSF) concept for the development of the next generation fighter originated in the early 1990s through the integration and restructuring of a number of United States Department of Defense tactical aircraft and technology initiatives already underway. The goal of this programme was to use the latest technology in the form of a family of aircraft to meet future strike requirements of three of the four US Services and their Allies.¹ On 26 October 2001 the system design and development (SDD) contract was awarded to Lockheed Martin and the program embarked on full-scale development. To date, Canadian industry has participated in the development of JSF while Department of National Defence official position has been as an observer. Based on the ongoing CF-18 Modernization program, the CF will begin an options analysis in 2007, to consider a replacement manned-fighter aircraft for introduction to service in the 2015 timeframe.

At the same time, many nations have been very proactive in the research and development of unmanned aerial vehicles (UAV) and unmanned combat air vehicles (UCAV), with many variants already operational around the world. To understand the future of these very capable assets for Canada, it is essential to understand the current roles of fighter aircraft by analyzing strategic level defence policy and operational level air doctrine. As well, possible roles and missions that Canada does not currently have the capability to carry out, will be introduced as possible future roles. This essay will examine Canada's future requirements. It will argue that in addition to a robust UCAV capability, Canada will require a follow-on fighter-type aircraft to replace the CF-18.

¹ "JSF History," http://www.jsf.mil/History/History_Intro.htm; Internet; accessed 9 Feb 2005.

However the author will argue that despite these requirements, the JSF is not the right fighter aircraft for Canada. Finally, it must be understood by the reader that although a portion of this paper has been devoted to the understanding of Canada's UCAV requirement, the main focus is the manned-fighter requirement.

Canada's future strategic air requirements.

To better understand the requirements of any future Canadian Air Force acquisition, it is imperative to first understand the strategic direction that guides the Canadian Forces, and more specifically the Canadian Air Force. Although dated, the 1994 White Paper on Defence articulated the time enduring themes of Canada's Defence policy as laid down by the government of Canada. In summary these themes are "... to protect Canada and its citizens from security threats, at home and abroad; to defend North America in cooperation with the United States; and to contribute to international peace and security."² These basic themes are further expanded upon by the Department of National Defence (DND) in its guidance document formerly the Defence Planning Guidance, now referred to as the Defence Plan (On-Line). Within this document the themes are translated into tasks by capability that, in the case of the Air Force, are assigned to the Chief of the Air Staff. The specific tasks that refer to fighter operations, as we know them today are as follows:

- **Surveillance and Control:** Provide the capability to monitor and control activity in Canadian airspace in conjunction with other operational elements of the CF.³

² Department of National Defence, A-GA-007-000/AF-004 *Strategic Vectors: The Air Force Transformational Vision* (Ottawa: DND Canada, 2004), 9.

³ Department of National Defence, *Defence Plan On-Line 03/04* (Ottawa: DND Canada, 2003), 5.

- **UN Operations:** Maintain the capability to provide forces able to operate as part of a multi-national coalition force up to and including mid-level joint and combined operations.⁴
- **Defence of North America:** Through NORAD, be able to detect, track, and characterize aerospace threats to North America, and to support operations that intercept and negate air threats as necessary.⁵
- **International Security:** Provide the capability to conduct mid-level NATO joint and combined operations throughout the NATO area of interest.⁶

For the sake of clarity, and to benefit operational and tactical level planners, doctrine manuals are written that amplify this strategic guidance. Unfortunately, the Canadian Air Force version of this manual, “Out of the Sun” has recently been rescinded, leaving a certain void. The doctrine contained in this manual was dated and it lacked a real vision for the future of Canada’s Air Force. This vision is crucial as both the CF and the Air Force are undergoing significant changes.

Prior to discussing these changes, it is worthwhile to look at the recent past in order to understand why the fighter force is in its current condition. The last decade of the twentieth century saw many changes to the global balance of power; the most significant of these was the end of the Cold War era marked by the collapse of the Soviet Union in 1991. As a result “. . . most western countries began to reduce military forces in

⁴ *Ibid*, 12.

⁵ *Ibid*, 13.

⁶ *Ibid*, 15.

the 1990s,” due mainly to cuts in defence spending.⁷ The result on the Canadian fighter force was the elimination of the 45 aircraft CF-5 fleet, a reduction in operational CF-18 aircraft from 72 down to as low as 48, and cuts to both fighter-related overhead and yearly flying requirement (YFR).⁸

Partly due to these budget cuts, and partly as an insurance policy to guarantee that it is a credible force for many years to come, the Canadian Air Force is currently undergoing a transformation process. The Department of National Defence defines transformation as a “process of strategic re-orientation in response to anticipated or tangible change to the security environment, designed to shape a nation’s armed forces to ensure their continued effectiveness and relevance.”⁹ The Department has recognized that there are limits to CF transformation in that it does not “seek the complete restructuring or re-equipping of Canada’s military forces, but will instead blend existing structures and systems with emerging ones to create significantly enhanced capabilities relevant to future missions, roles and tasks.”¹⁰ It is these significantly enhanced capabilities that will drive the requirements of future Air Force acquisition programmes. One has only to look at the last 15 years to see another form of transformation; the fighter force’s shift away from joint operations.

⁷ Department of National Defence, A-GA-007-000/AF-002 *The Aerospace Capabilities Framework* (Ottawa: DND Canada, 2003), 43.

⁸ *Ibid*, 43.

⁹ DND, *Strategic Vectors*, 25.

¹⁰ Approved by the CDS and the DM at Joint Capabilities Review Board 05/03, 14 April 2003. DND, *Strategic Vectors*, 25.

An argument can be made that the Canadian fighter force tends more towards combined rather than joint operations. This can be attributed to two main trends; the first is the CF's track record of deploying single-service UN and NATO missions, and the second is our defence relationship with our strongest ally, the United States. "From a defence perspective, Canada – United States (CANUS) ties are longstanding and persistent, with some agreements spanning more than five decades of evolving security challenges."¹¹

Take the North American Aerospace Defence Command (NORAD) agreement for example. Founded over 45 years ago, it has provided CANUS with an effective means of defending our combined aerospace. For the past twenty years, Canada's contribution to the aerospace control aspect of this agreement has been in the form of CF-18s on Air Sovereignty Alert (ASA), that have worked in close coordination with USAF assets such as F-16s and F-15s. For all of this time NORAD has been exclusively an aerospace organization and therefore there has been no joint component. The 1991 Gulf War saw the first combat for CF personnel since the Korean War and the CF-18 played a significant role in this campaign. Although there was a limited amount of joint support provided to the naval forces by the CF-18s, in effect very little was done to support the land offensive.¹²

¹¹ DND, *The Aerospace Capabilities Framework*, 30.

¹² It can be argued that the CAP missions were as much in support of Counter Air operations as they were support to the naval forces. DND, *The Aerospace Capabilities Framework*, 36.

In the spring of 1999, 18 CF-18s were deployed to Aviano, Italy in support of Operation Allied Force. For 79 days NATO aircraft bombed targets within Kosovo and the Federal Republic of Yugoslavia. Although many of the missions appeared on the Air Tasking Order (ATO) as Close Air Support (CAS) and Air Interdiction (AI) missions, both of which are traditionally considered support missions to the land component, in this case they were not as there were no land forces in the area of operation. Again a trend is seen in Canadian fighter forces towards a combined vice a joint use of aerospace power.

But this trend appears to be changing. The ongoing DND defence review was recently rejected by the new CDS, General Hillier, and there appears to be a tendency towards increased support for the Canadian army. During his time as CLS, Hillier had been working towards an army that was “. . . rapidly deployable, agile, capable of speedily gathering intelligence, quick to transmit and integrate that information, always aware of the key elements in the ‘battlespace’, tactically nimble, and able to fight in any environment. That is the kind of Army Hillier was shaping. Now it will be the kind of Canadian Forces he will want to be able to draw upon.”¹³ And if this is the type of CF that Hillier may be shaping, then it is imperative that the Air Force understands this shift, and is proactive in voicing the capabilities that it can bring to the table in support of these types of operations.

¹³ Dianne DeMille and Stephen Priestly, “Expeditionary Force – General Rick Hillier: Streamlined, Integrated, and Effective – How Will General Rick Hillier Help Hone the Canadian Forces?” in *Canadian American Strategic Review* (Feb 2005), <http://www.sfu.ca/casr/ft-column2.htm>; Internet; accessed 03 March 2005.

Air Operational Level Doctrine.

As previously mentioned the Canadian Air Force doctrine manual “Out of the Sun” has been officially rescinded. The plan is to establish an Aerospace Warfare Centre that will be responsible for producing doctrine. In the interim the Air Force will be forced to rely upon the doctrine of other air forces, such as USAF doctrine. The Aerospace Capabilities Framework (ACF), Canada’s guide to Air Force development and transformation, includes an overview of the current missions and roles of the Canadian Air Force. These fundamental Air Force functions as they apply to fighter forces are as follows:

- **Aerospace Control.** This is the primary function of an air force. It can be further subdivided into:
 - **Offensive Counter Air (OCA)**
 - Surface Attack (SA)
 - Suppression of Enemy Air Defences (SEAD)
 - Sweep (SWP)
 - **Defensive Counter Air (DCA)**
 - Combat Air Patrol (CAP)
 - Escort (ESC)
 - Air Intercept (AI)
- **Aerospace Force Application.** This is the primary means of applying force against an enemy’s centre of gravity (CoG). The means to the end of force application is through **Strategic Attack**.
- **Contributing Air Force Functions**
 - **Indirect Counter-Land Operations.** This involves the use of aircraft through **Air Interdiction** missions aimed at destroying, neutralizing or delaying an adversary’s military potential before it can be brought to bear against friendly forces.
 - **Direct Counter-Land Operations.** This involves the use of air assets through **Close Air Support (CAS)** missions aimed at halting, aiding in creating breakthroughs, and guarding the flanks of Army forces.¹⁴

¹⁴ DND, *The Aerospace Capabilities Framework*, 9-11.

Despite these traditional air power roles, as previously mentioned the current CDS General Hillier has a new vision for the CF, a vision that will focus on land-based effects. In order for the Air Force to remain relevant, the fighter force will have to adapt to this new reality. There will always remain a requirement for the traditional roles of aerospace control and aerospace force application, however, there must be a renewed emphasis place on joint operations with support to the Army and Navy receiving a renewed focus, while taking advantage of the latest technologies.

The Proliferation of UAVs.

Unmanned air vehicles are not a new concept. Some systems, such as the Gyrodyne QH-50 vertical take-off and landing (VTOL) UAV, have been operated with onboard sensors for more than 40 years.¹⁵ The UCAV on the other hand is a more recent development that truly ‘came of age’ with the employment of a Predator UAV, firing a Hellfire air-to-surface missile at Al Qaeda operatives in Oman.¹⁶ Subsequently the US budget for UAV/UCAVs is expected to triple by 2007, with a development budget expected to be \$10 billion by 2010.¹⁷ UCAVs will substantially replace manned fighter aircraft in the future. USAF Colonel John Warden, a retired fighter pilot, predicts that by the year 2020 UCAVs will account for up to 90% of US air breathing combat aircraft.¹⁸ Canada also will require a combination of both of these platforms in the future. In fact

¹⁵ William B. Scott, “Unmanned Aerial Vehicles,” http://www.gyrodynehelicopters.com/uavs_today.htm; Internet; accessed 8 Feb 2005, 1.

¹⁶ *Ibid*, 1.

¹⁷ Technology Training Corporation, “The Latest Requirements & Opportunities in UCAVs & Armed UAVs,” http://www.ttcus.com/newsite/defense-seminars/UCAV_S05.html; Internet; accessed 8 Feb 2005.

¹⁸ Scott, “Unmanned Aerial Vehicles,” 2.

programmes such as the Canadian Army tactical UAV Sperwer and the Canadian Forces Unmanned Aerial Vehicles Project both highlight that Canada is moving in the right direction.

To clarify the requirement for a manned-fighter aircraft, it is imperative to have an understanding of the roles that could be carried out by UAVs and UCAVs. Canada will certainly not possess UCAVs capable of carrying out every role highlighted by this paper, just as the current fleet of CF aircraft are not able to carry out all of the doctrinal roles of air forces. In some cases Canada may rely heavily on her allies for these capabilities. Many early theorists recognized the characteristics of air power that include such positive strengths as speed, range, surprise, elevation, precision, flexibility, mobility responsiveness, and concentration. Unfortunately there are also negative characteristics of air power such as impermanence, limited payload, and vulnerability. UAV and UCAVs add three new characteristics to this list; persistence, expendability and stealth. Persistence is interesting because UAVs actually reduce the negative characteristic of impermanence in that most UAVs are designed to fly for extremely long periods of time, giving them a much greater capability in the surveillance roles. With respect to expendability, William B. Scott noted:

“Sending unmanned instead of manned aircraft into the teeth of a modern integrated air defen[c]e system or a battlefield contaminated by chemical or biological agents makes obvious sense. Drones really are fearless—and

expendable. Although not cheap, losing a few UAVs is better than having a manned fighter shot down and a pilot captured.”¹⁹

UAVs andUCAVS would therefore have the secondary effect of reducing combat search and rescue (CSAR) as recovery missions would not be sent to recover downed drones.

As critical force enablers, the roles in whichUCAVs can be expected to be employed by the 2020 timeframe will include suppression of enemy defences (SEAD), strike missions in support of manned strike packages, SCUD hunter type missions, and even homeland defence.²⁰ In fact, “. . . U.S. Congress has mandated that a third of all U.S. deep-strike aircraft be unmanned by the end of this decade.”²¹ Retired Colonel Warden foresees “. . . that the proper combination of long-endurance of unmanned aircraft, multi-spectral sensors and directed-energy or advanced kinetic-kill weapons could solve the mobile target problem Pentagon officials have been wrestling with since the 1991 war with Iraq.”²² In the homeland defence role, the quiet, persistent UAV could monitor suspects covertly, however, whether aUCAV would be used to target such a target is questionable, especially when one considers that this would be taking place over sovereign territory. Canada’s Air force will require a combination of UAV andUCAV capabilities if it is to remain a capable, relevant and survivable force well into the 21st century, however the exact mix of these platforms is beyond the scope of this paper.

¹⁹ Scott, “Unmanned Aerial Vehicles,” 2.

²⁰ Technology Training Corporation, “The Latest Requirements & Opportunities inUCAVs & Armed UAVs.”

²¹ “Robots Herald New Era,” *Defence News*, (2 April 2001), 22. in Elinor C. Sloan, *The Revolution in Military Affairs* (Kingston: McGill – Queen’s University Press, 2002), 5.

²² Scott, “Unmanned Aerial Vehicles,” 3.

Roles/capabilities that must be carried out by a manned aircraft.

However despite the UAV and UCAV requirements, there are limitations to the extent that UCAVs will replace manned fighter aircraft for the foreseeable future. Take as an example the scenario where an airliner has been seized and must be shot down in order to avoid a tragedy similar to that of 9/11. Many have argued that in this situation eyeballs on the target and a pilot's finger on the trigger will be required prior to shoot-down authority being given. Additionally, there is no doubt that "[p]iloted aircraft will be dedicated to missions where on-scene judgement is a priority--such as close air support (CAS) or strike missions near civilian populated areas."²³

In addition to these more traditional roles, many new fighter missions have been introduced in other air forces over the past decades. Lessons learned from recent conflicts such as Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) have identified an emerging role of air power referred to as 'flexible' or 'time sensitive' targeting. Essentially, this mission "... could be used for attacking any moving or moveable target of high importance, especially one that through electronic emissions, communications, or other telltale signs gave only brief indications of its location."²⁴ For the fighter crews involved in these two operations, their missions moved quickly from the traditional role of strikes on pre-planned targets, to a more flexible, time-critical targeting role. "Indeed, 80 percent of the targets struck by US airpower were "Flex targets"—

²³ *Ibid*, 3.

²⁴ Rebecca Grant, "An Air War Link No Other," in *AIRFORCE Magazine Online, Vol 85, No 11*, (November 2002), <http://www.afa.org/magazine/nov2002/1102airwar.asp>; Internet; accessed 28 February 2005, 5.

those given to pilots enroute.”²⁵ It could be argued that these missions were nothing more than close air support missions and were just an old mission with a new name. The difference however lies in the proximity of friendly troops. CAS takes place in close proximity to friendly troops and always within the confines of some form of fire support coordination measures such as a fire support coordination line (FSCL). In OEF, many of the time sensitive targeting missions occurred before ground troops were deployed into Afghanistan, and hence could not be considered as CAS missions. However because special operations forces could be involved in locating and identifying these targets, their proximity will be in many cases warrant the use of manned platforms, again to reduce the likelihood of fratricide.

In cases where a fighter aircraft is working autonomously, either without or with very little input from other sources, the armed reconnaissance role is essential to ensure that time-critical targets are prosecuted. Armed reconnaissance is quite simply “[a] mission with the primary purpose of locating and attacking targets of opportunity, i.e. enemy material, personnel, and facilities, in assigned general areas or along assigned ground communications routes, and not for the purpose of attacking specific briefed targets.”²⁶ Taken one step further, a platform that is capable of carrying out armed reconnaissance, could also be used to control other aircraft onto targets. This is exactly what was done in Vietnam, arguable not very successfully, and then more successfully in Desert Storm. In 1966, Pacific Forces came up with the idea of using fast aircraft in the

²⁵ *Ibid*, 1.

²⁶ <http://www.dtic.mil/doctrine/jel/doddict/data/a/00493.html>; Internet; accessed 04 March 2005.

forward air controller (FAC) role. Previously, this role had been limited to slower moving aircraft in the observer role. In the first Gulf War, however, the strike aircraft were having fairly limited success against the Iraqi Republican Guard. This in essence was the birth of the killer scout mission.²⁷

Killer scout, otherwise known as fast FAC missions, have a fairly simple tactical concept. They would “. . . validate targets in the ATO that had been assigned to the [strike aircraft] and then find other lucrative targets in the area. They would provide indirect control, target area deconfliction, threat information, and updated target coordinates and descriptions to inbound fighters.”²⁸ Essentially, the fast FAC aircraft control aircraft beyond the FSCL, the area in which strike aircraft are normally carrying out air interdiction (AI) missions. The area short of the FSCL is normally left to more traditional FAC assets. Both the armed reconnaissance and killer scout missions are prime examples of dynamic, information-driven operations that will require immediate on-scene decisions that only a manned platform can provide.

Finally, new and unforeseen missions and roles will be developed to compliment the previously discussed UCAV capabilities. One such mission could entail UCAVs being remotely controlled by fighter aircraft. Scott suggests that “[m]anned aircraft in strike packages might be UCAV control nodes, with crewmembers making on-scene

²⁷ Mark A. Welsh, “Day of the Killer Scouts,” in *Airforce Magazine Online*, Vol. 75, No. 4 (April 1992), http://www.afa.org/magazine/perspectives/desert_storm/0493scouts.asp; Internet; accessed 04 March 2005, 3.

²⁸ *Ibid*, 5.

decisions when human intervention is required.”²⁹ All of the above mentioned missions would ensure that Canada’s future fighter capability would be relevant to Canada’s needs, and would provide a significantly increased level of support to the other services during joint operations, with a specific emphasis on land-based effects.

General requirements of a replacement fighter aircraft.

Up to this point we have determined that there is a requirement for a follow-on fighter-type aircraft, and we have also identified some of the possible roles. The remainder of the paper will focus on the manned-fighter operational requirements and will include DND current efforts towards this capability. The Aerospace Capability Framework includes a New Generation Fighter Capability (NGFC) that details the expectation that once the CF-18 reaches its life expectancy, that there will be a requirement for a follow-on manned fighter capability, and it also highlights the basic requirement of this new generation fighter. They are as follows:

- Highly manoeuvrable, supersonic with significant range, endurance and acceleration;
- have long-range, sensors capable of monitoring large volumes of airspace and able to detect, track, identify and engage multiple targets in all conditions day and night;
- have an integrated situation awareness display capable of portraying air-to-air and air-to-ground targets and threats and communicate this information to other forces;
- have jam-resistant and secure-communication and information systems;
- capable of employing a full range of air-to-air weapons in day, night, and all-weather conditions;

²⁹ Grant, “An Air War Link No Other,” <http://www.afa.org/magazine/nov2002/1102airwar.asp>; Internet; accessed 28 February 2005, 4.

- capable of employing near-precision and precision guided munitions (PGM) in day, night, and all-weather conditions;
- have accurate navigation and positioning systems;
- be fitted with laser, radar and missile approach warning systems;
- have stealth characteristics and adequate self-protection equipment; and
- have an air-to-air refuelling capability.³⁰

Although this list indicates that there is a roadmap for the replacement of the CF-18, unfortunately these requirements do not differ significantly from the capabilities of the recently modernized CF-18. The exception may be in the area of significant range, stealth characteristics, or missile approach warning systems. There are a number of additional capabilities that must be considered in order to ensure that Canada has a viable air force well into the twenty-first century. These capabilities can be generalized into the areas of survivability, multi-crew capability, and flexibility.

Survivability. Survivability can be summed up as the ability to carry out a mission successfully and return safely. There are a number of factors that either add to or detract from this ability. Many modern air power experts advocate stealth as one of the most important contemporary air power characteristics. Although it can be argued that low-observability is important, stealth in itself should not be considered the most important capability of Canada's next fighter aircraft. If we analyse the previously prioritized roles based on strategic guidance, we find that stealth has only limited value. In the Defence of Canada and North America roles, the focus of our defence has transitioned from the large strategic bomber and cruise missile threats, to a more asymmetric threat that includes the

³⁰ DND, *The Aerospace Capabilities Framework*, 69.

use of airliners by terrorists. This mission relies very little on stealth, but rather on the ability to seek out, identify, and then destroy these threats, with timely shoot-down authority being the key to success. The same applies for operations other than war (OOTW) in which one key role of air power is as a show of force. Again stealth is of little importance when you actually want your presence to be known.

In the contingency role, on the other hand, significantly reduced radar cross section (RCS) such as that of a stealthy aircraft, can be quite important. In a medium to high threat environment in which surface-to-air threats have not been entirely suppressed and air supremacy has not been achieved, the ability to penetrate deep into enemy territory, undetected, is essential. We have already ascertained, however that in the future this mission would be more suited to a UCAV. Therefore it is less likely that Canadian strategic policy makers would risk its aircrew and limited assets in this type of threat environment.

There are those such as Earl H. Tifford and Pat Cooper who argue that stealth is not as critical a requirement as many had thought. During Operation allied force, for example, “[w]hile the Serbs did not shoot down many aircraft, the downing of one F-117A and the damage of a second stealth fighter proved to be a significant coup, one that should give the United States pause in its fascination with stealth as the key to aerial warfare in the future.”³¹ In addition, “[s]tealth technologies require continual advances to make up for improved detection capabilities. U.S. military sources acknowledge that

³¹ Earl H. Tilford Jr., “Operation Allied Force and the Role of Air Power,” in *Parameters*, (Winter 1999-2000), 31.

current stealth technology will likely be defeated in the next few years by advances in radar and infrared technologies.”³²

Redundancy is another key survivability feature of any modern combat aircraft. Almost all essential systems, such as flight controls computers, weapons systems, fuels systems, have some form of redundancy. Obviously one of the most critical components of any fighter aircraft is the engine. A single-engine fighter suffers from a significant lack of redundancy. Whether caused by enemy surface-to-air or air-to-air fire, because of compressor stall, engine fire or failure, or simply due to bird injections while at lower level, with no working engine the single-engine aircraft essentially becomes a rock with a very poor glide ratio. This will have a direct affect on survivability in all roles; NORAD – in many cases operating over austere locations of northern Canada where suitable landing areas are practically non-existent, or during contingency operations where the availability of suitable landing areas over hostile territory definitely do not exist. Regardless of the reliability of jet engines they can and will inevitably fail at some point. If the failure occurs over the arctic or over hostile territory, it will result in the loss of a valuable asset, and even more gravely, could result in the loss of life. This shortcoming can be easily overcome by ensuring that any follow-on fighter is a two-engine aircraft.

Multi-crew. The single versus two-seat debate is practically as old as the fighter aircraft itself. Next generation aircraft are being outfitted with a myriad of systems and sensors such as radar, IFF interrogator, FLIR, laser designator, night imaging systems, visual

³² Pat Cooper, “U.S. Stealth Enhancements are Key to ‘Air Occupation,’” in *Defence News* (16-22 September 1996, 1. in Elinor C. Sloan, *The Revolution in Military Affairs* (Kingston: McGill – Queen’s University Press, 2002), 5.

spectrum enhancing systems, lock-on-after-launch short-range air-to-air missiles, increasing range radar missiles, and a host of precision air-to-ground munitions. Additionally, data-link systems are becoming the standard to ensure interoperability with allies. Needless to say that the information that pilots of the future will have to assimilate is increasing exponentially. In order to counter this, onboard systems are becoming better at fusing all of this information, and essentially, the pilot will be displayed with information, although he may not even know which source or sensor has provided this information. But as pointed out by Timothy Thomas, “. . . increased information, or data, does not equate with increased knowledge and understanding – indeed, it could just as likely lead to sensory overload.”³³

Even if the future pilot is capable of assimilating all of this information, there are many other essential tasks that need to be carried out. With new and more complex roles, such as fast FAC, or time sensitive targeting, or ultimately if the fighter aircraft has the ability to act as a hub for a formations of UCAVs, a lone pilot will be unable to fight his aircraft effectively. Using the previously mentioned killer scout mission as an example, “[f]or the pilot identifying possible targets, juggling all the input coming from the ground and air resources on different frequencies, dealing with various maps in the cockpit, making the best use of tactical resources, maintaining situational awareness, and flying the aircraft all at the same time – is demanding.”³⁴ In the future, sensory overload for the

³³ Timothy L. Thomas, “Kosovo and the Current Myth of Information Superiority,” in *Parameters* (Spring 2000), in Elinor C. Sloan, *The Revolution in Military Affairs* (Kingston: McGill – Queen’s University Press, 2002), 5.

³⁴ David Sarvai, “F-16 AFAC,” in *Code One Articles*, (19 November 2004), http://www.510fs.org/index.php?option=com_context&task=view&id=29&Itemid=65; Internet; accessed 04 March 2005.

single-seat aircrew will lead to mission degradation, and possibly failure in some cases. The obvious fix for this problem is to ensure that the follow-on fighter aircraft is a two-seat aircraft.

Flexibility. One of the most significant advances in fighter aircraft capabilities over the years has been the incorporation of air-to-air and air-to-ground capabilities into a single platform. Traditionally, these platforms have been capable of effectively operating in only one of these two roles on any given mission. Ideally, the fighter aircraft of the future will not be limited by this paradigm and will be able to operate simultaneously in air-to-surface and air-to-air roles, as well as any future roles that are created. However, this will require some specific capabilities. Ideally, this platform would have significant range and endurance, able to remain on station for long periods of time prior to in-flight refuelling. A myriad of relevant onboard systems and sensors are also essential to ensure flexibility. And possibly even more important than quantity and quality of these systems, interoperability with our allies is a must.

Another key area that will enhance overall flexibility is weapons load. A platform may have adequate range and endurance capabilities, but if it runs out of weapons in the first thirty minutes of combat operations, then it essentially loses this flexibility. This means that the future fighter aircraft must be capable of carrying a significant quantity of air-to-air missiles, both short and long-range, and precision-guided air-to-surface munitions on the same missions; this would ensure the ultimate in flexibility.

JSF suitability based on these basic requirements.

The Joint Strike Fighter is a relatively low cost, common fighter replacement that was originally designed to meet USAF, USN and USMC requirements. It is currently under development in three different variants; the USAF standard field-based variant, the USN carrier-based version, and finally the USMC VTOL variant. Unfortunately there are some significant issues in the areas of survivability, multi-crew capability and flexibility inherent in the JSF that must be considered before the Canadian Air Force embarks on full-scale involvement in the JSF programme.

The first is the JSF single-engine configuration. As previously mentioned Canada's next fighter aircraft must be a two-engine platform. With the recent rationalisation and reduction of the current CF-18 fleet from 120 plus down to 80 aircraft, it is safe to assume that the Air Force will procure from 60-80 replacement manned fighter, augmented by a fleet of UCAVs. The loss of just a single JSF out of a fleet of 60 due to an engine failure would be unacceptable. And the probability of losing a single-engine fighter aircraft to an engine related problem is much higher than for a two-engine aircraft.

Second, the JSF is only being developed as a single seat aircraft. This configuration would definitely limit the future capabilities of this platform to roles and missions that are similar to current fighters, and little more. Finally, in the area of flexibility, the JSF has a relatively limited weapons loadout capability. In its full low observability mode the JSF carries all of its weapons internally in weapons bays. These

bays are very limited in their payload capacity. In fact, the JSF will only be capable of carrying two air-to-air missiles and two PGMs in this configuration.³⁵ When compared to the CF-18, it is essentially capable of carrying the same weapons load, thereby limiting the flexibility of the JSF as a multi-role platform to that of current generation fighters.

There are provisions within the design of the JSF to install external pylons to increase the weapons payload. If this is done, the JSF will have a better weapons capability in the form of four air-to-air missiles and six PGMs thus increasing its flexibility. However, if this is compared to the F-15E Strike Eagle which is currently in service with the USAF, one quickly realizes that even the Eagle has a significantly increased capability over the JSF, capable of carrying eight air-to-air missiles and up to 12 PGMs simultaneously.³⁶ It would require basically two JSF sorties for every F-15E sortie. Also, this increased payload of the JSF will significantly increase its RCS. Therefore if flexibility is considered as an essential requirement, then stealth suffers.

In fact, there are questions being raised about the stealth capability of the export version of the JSF. Because it is the first stealth type aircraft being offered on the export market, the US government is currently wrestling with the disclosure policy on this issue. For some who remain close to this subject, “[t]he clear implication is that the ‘international’ JSF would have a larger RCS than the US version, would be easier to

³⁵ “F-35 JSF Weapons Carriage Capacity”; <http://www.aerospaceweb.org/questions/planes/q0163.shtml>; Internet; accessed 08 March 2005.

³⁶ “McDonnell Douglas F-15E Strike Eagle”; http://www.home.att.net/~jbaugher/f15_10.html; Internet; accessed 08 March 2005.

detect by hostile radar and would consequently be more susceptible to attack.”³⁷ In essence, DND must take a long hard look at whether or not JSF meets its requirements; this paper has argued that it will not.

As the Canadian Air Force moves into the next decade there will be many changes that will occur, but probably none as exciting as the fielding of UAV andUCAV capabilities. When the CF-18 reaches its life expectancy around 2017, it will have to be replaced by a fleet of 60-80 manned fighter aircraft, and a fleet of UAVs andUCAVs. These capabilities will be essential tools in the Air Force’s tool box, ensuring that they will remain a capable, survivable and interoperable force, able to contribute significantly to General Hillier’s new joint focus of land-based effects. Traditional missions such as CAS, AI, OCA and DCA must remain a part of our doctrine, but at the same time new missions such as time sensitive targeting, killer scout, and armed reconnaissance will help to provide the desired joint effects. Additionally, the roles of future UAVs andUCAVs within the CF will evolve. This paper has suggested thatUCAVs will replace manned-fighters in certain roles including SEAD, and deep strike; essentially any mission that may unnecessarily put a pilot in harms way. Canadian Air Force combat power, including bothUCAVs and manned aircraft must be able to provide all of these capabilities in order for combat air power to remain relevant both to the CF and our allies.

³⁷ Bill Sweetman, “JSF Security Technology Costs up to US\$1Bn,” in *Janes International Defence Digest*, May 2004, 4.

To accomplish this critical level of relevance, a number of specific requirements have been addressed. The CF must acquire a more robust fleet of UAVs and UCAVs, as well as a follow-on fighter aircraft. This fighter must be a two-seat, two-engine platform, capable of carrying a large number of weapons, and it must be equipped with interoperable, up-to-date sensors and equipment. These essential criteria will ensure that Canada has a viable, multi-role fighter aircraft, capable of being employed in all of the roles and missions assigned by the political leadership, well into the 21st century. It has been argued that the JSF would not provide Canada with all of these essential requirements, and is therefore not the right fighter aircraft for Canada.

List of Abbreviations

ATO	Air tasking order
ACO	Aerospace coordination order
ACP	Aerospace coordination plan
AI	Air interdiction
CAS	Close air support
CSAR	Combat search and rescue
DND	Department of National Defence
FAC	Forward air controller
FAC(A)	Airborne forward air controller
FLIR	Forward looking infrared
FSCCL	Fire support coordination line
IFF	Interrogator friend or foe
JSF	Joint Strike Fighter
NGFC	New generation fighter capability
NORAD	North American Aerospace Defence
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OOTW	Operations other than war
PGM	Precision guided munitions
RCS	Radar cross section
SEAD	Suppression of enemy air defences
SOF	Special operations forces
UAV	Unmanned air vehicle
UCAV	Unmanned air combat vehicle
USAF	United States Air Force
USMC	United States Marine Corps
USN	United States Navy
VTOL	Vertical take-off and landing
WSO	Weapons systems officer
YFR	Yearly flying requirement

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