The Time is Right: Developing a UAV Policy for the Canadian Forces

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Abstract:

The recent success of Unmanned Aerial Vehicles (UAVs) in the Global War on Terror has increased both interest in, and acceptance of UAVs. Though the Canadian Forces have a long history of UAV use and development, no clear public policy regarding the Forces' UAV plans has been presented. As the Canadian Forces transform to meet new real-world requirements, it will become increasingly important to chart a course for the future. This paper will examine the roles and needs of the Canadian Forces, and propose guidelines for Canadian UAV procurement and use.

As UAVs become more capable and effective, their potential mission set is expanding. Where UAVs were originally limited to peripheral roles, they are now being seen as a viable alternative to some manned missions, such as long-endurance patrols, and are constantly creating new specialized roles from target acquisition for strike aircraft to real-time surveillance for force security, like the use of the Canadian Sperwer in Afghanistan. Where the American military has UAVs of all shapes and sizes to perform missions from the squad level to globally-capable theatre assets for missions ranging from surveillance to strike, the Canadian Forces require UAVs for a smaller set of missions.

Any Canadian UAV policy must consider overseas missions, such as the ongoing use of UAVs in Afghanistan, their potential use in deployments similar to Operation Apollo, or any other overseas deployment. Further it must also consider other roles, such as the Forces' recent use of leased UAVs for the G-8 Summit in Kananaskis, and the ongoing use of a UAV for naval patrol; roles that are more similar to American Coast Guard and Homeland Security needs than the much publicized military roles.

The Canadian Forces structure and roles are well-suited to the use of UAVs, and through sound, realistic policy, can create a UAV force that will be an example for other similar militaries.

On August 7, 2003, the Canadian Forces acquired, for the first time, an operational Unmanned Aerial Vehicle (UAV) system with the purchase of 4 Sperwer UAVs. The purchase was primarily intended to provide support for Canadian troops in Afghanistan, where it would be deployed within months, fulfilling a 2002 commitment to the North Atlantic Treaty Organization (NATO) for Canada to possess a UAV capability by 2004.[1] Beginning in the mid-1990s, but especially since the September 11 terror attacks, the use of UAVs by western militaries has flourished as technological advances and geopolitical developments have made them an integral part of many militaries.

The Canadian Forces appear committed to procuring a family of UAVs, from small craft for small unit actions to larger, more complex models for theatre surveillance, to be integrated into the military as part of its ongoing transformation into a first-rate network-enabled force. The UAVs will be part of an interoperable network offering complimentary capabilities to the entire chain of command. To date, a Joint Project Office (JPO) has been created to oversee Canadian UAV efforts, and a UAV Roadmap outlining the Canadian Forces' plans is being written. There are also plans to create a UAV Battlelab to explore future uses and technologies, however, the program is still young, having only completed four of the 11 planned stages of Canadian UAV testing and procurement.[2] For the Canadian Forces' UAV plans to succeed, continued interest and support from military and political leaders will be necessary, as well as an understanding of the current structure of Canadian UAV efforts and a realistic appraisal of the risks and benefits of UAV use.

Background

To examine the issues surrounding the use of UAVs, it is first important to have a proper definition. There is a semantic debate regarding UAV nomenclature. As UAVs have developed since the Second World War, many titles have been used from drones to Remotely Piloted Vehicles (RPVs) and Remotely Operated Aircraft (ROA). As the first UAVs were converted from existing target drones, the term reconnaissance drone was fitting, but as the two types diverged over time, the term became less applicable. Similarly the term RPV adequately defined the remotely piloted vehicles of the 1970s that were based on civilian hobby projects, but did not adequately define pre-programmed reconnaissance drones, or the more autonomous UAVs being produced. The Federal Aviation Administration (FAA) introduced the term Remotely Operated Aircraft (ROA) in the late 1990s as it is legally responsible for supervising "aircraft."[3] Likewise for smaller UAVs, the term unmanned becomes redundant, as there is no physical way to have a "manned" version.

The Canadian use of the term "uninhabited aerial vehicles" stems from the differentiation between uninhabited systems where there is a human operator in the system and "unmanned" systems that are completely autonomous.[4] Unmanned Aerial Vehicles has emerged as the most applicable definition, not because it is perfect, but because it most effectively encompasses the full spectrum of unmanned aircraft.

The Canadian Aviation Regulations, the legal charter regulating aviation in Canada states "unmanned aerial vehicle means a power driven aircraft, other than a model aircraft, that is designed to fly without a human operator on board." (Canadian Aviation Regulations 101.01) This definition effectively defines UAVs from the regulatory perspective, but does not differentiate between an autonomous cruise missile and a remotely operated reconnaissance UAV. The United States Department of Defense provides this distinction, defining a UAV as:

> A powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or non-lethal payload. Ballistic or semi ballistic vehicles, cruise missiles, and artillery projectiles are not considered Unmanned Aerial Vehicles.[5]

Though UAVs and cruise missiles share a common genealogy, with weaponized UAVs becoming more prevalent, it is important to differentiate between the two. A simple differentiation is whether a craft is intend for a one way mission, as is the case for a cruise missile, or a round-trip mission.

Though the actual air vehicle is the most recognizable component of a UAV system, a complete UAV system is comprised of three main components: a control system, communication architecture, and one or more air vehicles.[6] The control system for a UAV may be as simple as a laptop computer programmed to control the air vehicle for smaller models, or may be as large as a trailer complete with an airplane-like cockpit and displays to keep track of the aircraft and its systems.

The complexity of the communications architecture for a UAV depends on the size, range, and application of a system and is responsible not only for the control of the aircraft, but also to relay the imagery from the UAV to any relevant party. For short-range UAVs, line of sight (LOS) radio controls are sufficient, but for long range, beyond line of sight (BLOS) operations satellite communications or a radio relay is needed. For Predator UAVs operating in Afghanistan or Iraq, imagery is sent real-time not only to the ground station, but often to nearby strike aircraft, and the Central Command regional theatre headquarters in the Persian Gulf as well as the continental United States headquarters in Tampa Fl., and the Pentagon.[7] The communications architecture can quickly become very complex for a modern BLOS UAV.

Finally, UAV systems are generally comprised of several aircraft for a single control station, allowing for a reasonable maintenance schedule and room for attrition without incapacitating a system.

Classes and Missions

Traditionally, UAVs have been tasked with "Dull, Dirty, and Dangerous" missions: the missions that were too dull, such as long range surveillance, dirty, like the monitoring of potentially hazardous environments, or dangerous, such as reconnaissance in hostile airspace. In the 1990s, the change in the geopolitical climate stemming from the end of the Cold War created the need for smaller, more effective post-Cold War militaries. The changing makeup of western militaries, coupled with the explosive growth in computer technology contributed to an ongoing Revolution in Military Affairs (RMA) that is changing not only the structure and composition of western militaries, but also the way they fight. As an element of the emerging RMA, UAVs became more capable at a time when their abilities were needed, leading to an increase in the roles and acceptance of UAVs in western militaries as they were used more frequently in new capacities through the 1990s.[8]

Additionally the spectrum of UAVs expanded through the 1990s, with numerous systems available for a broad range of missions. These systems break down into five general classes: High Altitude Long Endurance (HALE), Medium Altitude Long Endurance (MALE), Tactical UAVs (TUAV), Mini-UAVs, and Micro-UAVs. Though Air Forces typically see anything that flies as their jurisdiction, they are usually only responsible for strategic-level HALE and MALE UAVs, with the smaller, more tactical TUAVs, Mini and Micro UAVs being service specific assets. The tenets of warfighting and network-centric forces aim to reduce the friction caused by this division of assets, drawing information from all forces to create a complete, joint, intelligence picture. The division between these classes is arbitrary, and some UAVs could conceivably fit in two different classes.

Existing HALE UAVs, the size of small airliners, fly at altitudes above commercial air traffic, with an endurance in excess of 24 hours. They are intended to be theatre and national level assets, providing strategic intelligence to the highest levels of government and military command. HALE UAVs are truly unmanned, flying a preprogrammed route from takeoff to landing, but unlike earlier drones, HALE UAVs can be reprogrammed in flight.

MALE UAVs are smaller than HALE aircraft and generally have an endurance of 16 hours or more. Arguably the most recognizable MALE UAV is the American Predator, which has shown the versatility of the class, operating in many roles, including photo reconnaissance and surveillance, target acquisition and marking for strike aircraft, and even precision attack missions. MALE UAVs are intended to serve at the Theatre, Corps, or Divisional level, and are generally flown manually by a pilot seated in the control system.

The TUAV Class, to which the Canadian Sperwer belongs, is the most active class, flown by a pilot on the ground from launch to landing. TUAVs operate in the most hazardous environments, at relatively low altitudes in support of front line troops, and are intended as Divisional or Brigade level assets.[9] This creates ownership and regulatory issues as TUAVs are generally Army assets, but are large and complex enough to attract the attention of Air Force officials. Where HALE and MALE UAVs can fly above many threats, TUAVs are intended to operate at the forward edge of a battle, where they are more vulnerable to ground fire, and any intelligence collected must be distributed quickly to be of any tactical use. Due to their hostile operating environment, TUAVs are often considered attritable; they are too valuable to be disposable systems, but it is understood that they will suffer significant loss rates.

The Canadian Forces Experimentation Centre (CDEC), the body conducting Canada's UAV trials, intended to leave TUAVs to the end of Canada's acquisition strategy, dealing with the "simpler" classes before tackling TUAVs, however, operational necessity required that the Sperwer be purchased to support Canadian Forces operations in Afghanistan.[10]

Mini UAVs are relatively portable , and are is designed to provide information at the Battlegroup or Company level to a range of about 30km. The Canadian Army has purchased the Silver Fox UAV to provide intelligence at the Battlegroup level, and intends to purchase an inexpensive mini UAV, the Pointer, based on a commercial hobby design for company level operations. The Silver Fox can be broken down into man-portable pieces and transported in a standard vehicle while the Pointer UAV can be carried in the backpacks of two or three soldiers. Both systems use a laptop computer-based control system that does not require any specialized training to operate.

Finally, Micro UAVs are the least developed class, and will not be operational for any practical purpose for at least a decade. A Micro UAV, intended to be portable, and in some cases disposable, is often described as being hand-sized or smaller, with the ability to provide the user with short range, "over the hill" information. Eventually the Canadian Forces hope to equip individual soldiers with Micro UAVs and to create autonomous systems where swarms of Micro UAVs operate in concert to accomplish a task.[11]

Canadian UAV History

Though it seems that UAVs are a recent phenomenon, UAVs have a long history, and Canada was, at one time, a global leader in UAV development. Through the Cold War, a pattern of "lost opportunities" emerged in Canada, where the military would show interest in a UAV project, become involved in the development or testing, but not invest in the system. As a result, Canada, and Canadian manufacturers were frequently involved in state-of-the-art UAV projects, only to walk away from the project allowing others to benefit instead.

Canada's first involvement with UAVs began in the late 1950s when the Royal Canadian Air Force helped conduct cold weather testing for a United States Air Force air-launched target drone project. The KDA-4 Firebee I drone would later be used very successfully as a reconnaissance UAV in combat from Vietnam to Iraq, but Canadian involvement ended after the cold weather tests.[12]

The first Canadian UAV of note was the Canadair, now a subsidiary of Bombardier, CL-89, a missile with a camera in the nose designed as a divisional reconnaissance asset. Work began on the CL-89 in 1959 as a way of diversifying Canadair's product range, as aircraft sales waned and the Sparrow II missile system was cancelled as part of the Avro Arrow termination.[13] Following the early trend of converting existing target drones into reconnaissance platforms, the Canadair team based their project on an existing design for a target from the Sparrow II program. Canadair then approached two Canadian Army majors who were part of a NATO working group examining battlefield surveillance, and convinced them of the potential of the CL-89 concept. These officers then wrote an operational requirement for a reconnaissance drone for the military, knowing that the Department of National Defence (DND) would not consider the project unless there was an existing operational requirement.[14] With a newfound operational requirement, the Canadian military decided to join in the development of the CL-89.

The Canadian and British governments, later to be joined by West Germany, elected to jointly sponsor the design of the CL-89, with the United States providing the Yuma Proving Grounds for the project at no cost. The maiden flight took place in 1964, and the design was considered state of the art in every respect. After launching from a modified truck, the CL-89 flew a preprogrammed course, taking photographs, or infrared images at set points along its path before returning to a homing beacon to land.[15] The CL-89 would prove itself operationally with West Germany France and Italy in the 1970s and 1980s, and with the British as late as the 1991 Persian Gulf War. Despite putting Canada at the cutting edge of UAV development in the 1960s and 1970s, the Canadian military chose not to adopt the CL-89.

The success of the CL-89 was followed with the CL-289, an updated version of the CL-89 intended as a corps-level asset, that secured the largest military export contract in Canadian history, worth $411 million in 1987, to build systems for the French and German militaries.[16] Canadair began development work in the mid-1970s and the CL-289 was hailed in the early 1980s as "one of the most important of today's battlefield reconnaissance [UAVs]."[17] The CL-289 was a workhorse over Bosnia and Kosovo with the French and German militaries. Again, the Canadian military chose not to adopt the CL-289, and played a minimal role in its development.

Although both France and Germany lost several aircraft over Bosnia and Kosovo, the CL-289 was effective at monitoring cease-fire agreements and providing pre- and post-strike imagery. In a single year long deployment French CL-289s flew over 500 missions.[18] The system, however was beginning to show its age as post-Cold War missions changed, and the trend in UAVs was shifting to remotely operated aircraft that provided real-time imagery to commanders, with longer endurance than the short range CL-289s that flew pre-programmed routes and whose film took several hours to develop. As a result, the expected follow-on purchases did not materialize.

While the CL-89 and CL-289 were advanced aircraft when introduced, they were no longer able to meet the requirements of post-Cold War militaries. Though French and German CL-289 missions accounted for 37 percent of the UAV missions flown in Operation Allied Force, they only accounted for 10 percent of the total UAV flight time.[19] Although Canadian manufacturers were the prime contractors for all systems on the CL-89, the lack of Canadian military interest in UAV development, coupled with the subsequent support abroad, resulted in German and French contractors advancing over time while Canadian manufacturers did not. As a result French and German companies were able to provide the sensors and control systems for the CL-289, initiating UAV industries in those nations at the expense of the Canadian UAV industry.

The third major case of Canadian "lost opportunity" stems from the Canadair CL-227 Sentinel/CL-327 Guardian family of vehicles. These helicopter UAVs were described by the United States Navy during testing in 1991 as being generations ahead of contemporary systems.[20] The system was conceived for ship-board surveillance in all weather, with a potential anti-submarine role, but was not limited to naval applications. Again, at the end of the Cold War, Canadian interest in the project ended. The United States Navy purchased a system of four vehicles for testing, and in 1999, the United States Air Force considered the Guardian for use in support of small-scale contingency operations, such as standoffs and hostage situations.[21]

The Sentinel and Guardian systems have been hampered by reliability problems but unlike the CL-289 are more suited to the new, post-Cold War world. A naval test of the Guardian in a drug interdiction role demonstrated the effectiveness and stealthiness of the system, as although trained spotters and tracking aircraft frequently lost track of the UAV, it never lost track of its target.[22] The system was also designed for a two-man crew to operate a pair of UAVs from a HMMWV (Hummer) with a trailer using a laptop computer to direct the aircraft.[23] This relative stealth and ease of use, as well as the systems' ability to operate from small, unprepared locations are all significant benefits, but the craft never attracted a significant contract.

Without the backing of the parent country it is very difficult for a UAV, or any other military system, to achieve success and the Canadian Forces have passed on at least three excellent opportunities. By deciding in each case that the systems did not address existing Canadian requirements, the Forces missed opportunities to become a world leader in UAV design and use. Ironically, the French firm SAGEM, the creator of the Sperwer UAV acquired by Canada in 2002, was a subcontractor on the CL-289.[24] As the Cold War drew to a close, European nations were able to draw from their experiences using Canadian UAVs, and were able to produce a new generation of UAVs suited to the post-Cold War security environment.

Following the success of foreign UAVs in the Bosnian and Kosovo theatres, the Canadian Forces has developed a new interest in acquiring UAVs as part of the military's transformation into a joint, network-enabled fighting force. Five key test programs, or operations, have taken place in Canada since 2000 to examine the role of UAVs in the Canadian Forces.

The first event was the Canadian participation in American Global Hawk HALE UAV overflights in 2000. Secondly, in Exercise Robust Ram, in April 2002, three different UAVs were tested in conjunction with a brigade-level exercise. The next test was during the G-8 Summit held in Kananaskis in June 2002, where a leased General Atomics I-GNAT UAV was used to provide real-time information for security forces. Fourth was the Pacific Littoral Information Surveillance and Reconnaissance Experiment (PLIX) test held on the west coast using an Israeli Aircraft Industries Heron in July 2003.

Finally, the Atlantic Littoral Information Surveillance and Reconnaissance Experiment (ALIX) test was held in eastern Canada in August and September 2004 involving a General Atomics Altair UAV and a Canadian Forces Silver Fox mini-UAV.

The 2000 Global Hawk overflights of British Columbia and Alberta, though less noticeable than the other examples, originating and ending in the United States, and not going below 17 km in altitude, well above any commercial air traffic, were a key development.[25] To proceed with the flights, members of the Canadian Forces, the United States Air Force, Transport Canada, and Nav Canada would have to agree on a regulatory framework for the flights to ensure that they would comply with Canadian laws. Additionally, the flights provided the Canadian government and military with a demonstration of current UAV capabilities.

Exercise Robust Ram in Suffield, Alberta was primarily concerned with testing the connectivity of a family of UAVs as well as their command and control. The exercise, just four months before the purchase of the Sperwer, was the initial test of the Army's Information, Surveillance, Target Acquisition and Reconnaissance (ISTAR) concept of creating a system of collection systems feeding information into a network of commanders and analysts to create a network-enabled "Army of the Future."[26] At one point, the exercise had three different UAV types airborne, an I-GNAT TUAV, a Guardian TUAV, and a Pointer Mini UAV, making Canada only the second military to operate three dissimilar UAVs at the same time.[27] The exercise was considered a success, having adequately distributed imagery to the necessary parties, including to CFEC in Ottawa, but no decision had officially been made as to whether or not the Canadian Forces would purchase any UAVs.[28]

The use of an I-GNAT TUAV to provide security for the G-8 Summit gave Canada the opportunity to test a state-of-the-art TUAV in a real-world operational setting. To conduct the operation, appropriate no-fly zones were created to ensure deconflicted airspace, and a communications architecture had to be created to disseminate the information collected by the UAV, and from the experiment, the Canadian Forces learned that a single mission commander was needed as a point of contact for UAV operations, just like manned missions, to ensure that a logical chain of command is followed.[29]

The PLIX experiment operated out of Tofino airport on the west coast of Vancouver Island, was used to test UAV connectivity in a multi-sensor Line of Sight operation, in conjunction with several types of Navy ships. The UAV was treated as a Canadian Forces aircraft, flying through a "safe" corridor, providing frequent warnings to local air traffic to a block of restricted airspace.[30] The experiment demonstrated the effectiveness of the UAV by increasing the situational awareness of maritime commanders in classifying and identifying unidentified ships in Canadian waters.[31]

The ALIX experiment in the summer of 2003 was the capstone of Canadian UAV trials, testing a Beyond Line of Sight UAV with a multi-sensor payload, in conjunction with other UAVs and military assets in deconflicted civil airspace. For the first time ever in Canada, a UAV was given a file-and-fly permit to operate within civil airspace under the same regulations as any civil aircraft, requiring the cooperation of Canadian Forces, Transport Canada and Nav Canada officials.[32]

The missions were extremely successful, taking off under LOS control from Goose Bay Labrador before handing off control to BLOS operators in Ottawa, demonstrating the ability of a UAV to operate in the Canadian North and territorial waters for extended periods. Imagery from the flight was also distributed online to various military units and government agencies in real-time.

Two shortcomings appeared during the flights; the lack of bandwidth in northern regions, and altitude fluctuations in the UAV's flight path.[33] Existing satellite capabilities were completely consumed for the flights into northern regions, indicating that future Canadian BLOS flights into the Arctic will require relay stations or improved satellites. A "blackout" period where the UAV would operate autonomously during a mission until satellite coverage was returned is not a feasible option, as it risks the aircraft losing control in civil airspace, and defeats the purpose of having real-time imagery. The altitude deviations will have to be corrected to ensure a Canadian UAV could stay within its assigned airspace before regular UAV operations could commence.

While the aforementioned experiments were planned in advance, the purchase of UAVs for Afghanistan was not. As noted by LCol Steve Newton of CDEC, the Canadian Forces originally intended to purchase its TUAVs last.[34] As a senior Air Force officer remarked at the University of Calgary, the Army "scooped" the Air Force in buying the Sperwers.[35] Canada's first deployment to Afghanistan in 2002 demonstrated the effectiveness of the Coyote armoured reconnaissance vehicles in the relatively open terrain of Kandahar. Future deployments to Kabul would not benefit as much from the Coyote's sensors in an urban environment, and a UAV was seen as the solution. Despite the relatively minor, but much publicized Sperwer mishaps, in two rotations in Afghanistan, Canadian Sperwers conducted 87 missions, and were an intrinsic part of the Canadian deployment, providing intelligence for commanders, and an element of force protection for troops conducting patrols within the city.[36]

How to Proceed?

Canada has a history of testing UAVs and observing their benefits, only to walk away from the program, however the Army's purchase of the Sperwer may well have forced the Canadian Forces into a commitment to UAV procurement and development. In addition to acquiring UAVs, with the use of the I-GNAT over Kananaskis and the Sperwer in Afghanistan, Canada has now used UAVs operationally. Though a military can transform over time, operational deployments effectively compress learning curves, as "war does for armies what the marketplace does for business."[37] Under operational conditions, peacetime planning, no matter how thorough, will be adapted to reflect real-world events. Nonetheless, with realistic training exercises and extensive planning, less changes will be required in the time of conflict.

Having recently completed several experiments and two operational deployments using UAVs, the Canadian Forces must decide on the proper UAV family structure. As a component of a democratic nation, the Canadian Forces is ultimately an instrument of the Canadian government used to protect the nation and further Canadian foreign policy abroad. In addition to overseas deployments, like the recent deployments to Afghanistan, Canadian UAVS will also be used at home in the form of maritime and Arctic patrols to defend the nation and protect Canadian interests.

Overseas, the Canadian Forces have 1633 soldiers operationally deployed on 17 missions around the world.[38] As the Canadian government is increasingly willing to deploy the military, UAVs can become a force multiplier for the Canadian Forces overseas. In addition to providing increased security and intelligence to Canadian soldiers, as was done in Afghanistan, sharing UAV intelligence with allied nations will help solidify Canada's role in a coalition's decision-making process. In Afghanistan, the Canadian Forces often acted as a liaison between American and European forces having "trained in both American doctrine and techniques and had experience operating with British and European militaries."[39] As multinational operations, like Afghanistan, are increasingly network-centric, or network-enabled operations, the Canadian Forces must keep pace with the times.

Though the Canadian Forces' familiarity with American military doctrine and techniques is of great importance overseas, the domestic component to Canadian UAV operations is different from the American experience. Where maritime patrol within Canadian waters, border security, disaster relief operations, and special cases like the Kananaskis G-8 Summit are seen as Canadian Forces missions, such missions fall outside the American military's jurisdiction, whose domestic role is restricted to National Guard units.[40] Instead, the Canadian Forces must draw from the experience of other American government department's UAV tests. Operating under the jurisdiction of the Department of Justice's Customs and Border Patrol and Drug Enforcement Agency's successful test of a MALE UAV for drug interdiction and patrol missions along the US-Mexico border arguably serves as a better template for Canadian UAV operations than 48-hour Global Hawk missions or the CIA's use of a weaponized Predator in Yemen.[41]

Similarly, the United States Coast Guard, part of the Department of Homeland Security is actively seeking UAVs both for shipboard use and surveillance of maritime environments, and it is likely that UAVs will be considered for other law enforcement agencies as legal and liability issues regarding UAV flights in civil airspace are resolved.[42] Likewise, the Canadian Coast Guard and the Royal Canadian Mounted Police are currently considering using UAVs to further their respective intelligence capabilities, and Canada will probably see increased domestic roles, as legal issues are resolved.

ALIX and PLIX have shown that UAVs can be a useful tool for finding, monitoring and identifying ships in Canadian waters.[43] As ALIX demonstrated, Canadian Forces UAVs would be well suited to Maritime patrol missions, by providing longer endurance than manned equivalents.[44] In the event that a UAV discovered illegal fishing, or any other breach in Canadian security, reinforcements could be called up just as quickly as from a manned patrol aircraft, given the real-time control of the aircraft. As Canadian sovereignty becomes increasingly contested in the Arctic, UAVs could provide similar long-range Arctic patrol missions.

Canadian Plans

The Canadian military acknowledges that Micro UAVs are not yet feasible, and given existing budget concerns, the cost of acquiring HALE UAVs is likely beyond the Canadian Forces' current means. Furthermore Canada's overseas deployments are not so large that the strategic reach of a HALE UAV will be required. Global Hawk-like assets are useful for the American military that has the ability to deploy a greater number of troops to a theatre than are enlisted in the Canadian Forces. Similarly, PLIX and ALIX have shown that a MALE UAV, with an endurance of over 24 hours, more than the 8.2 hour endurance of Canada's existing maritime patrol aircraft, would be sufficiently capable for any current Canadian patrol requirement.[45]

A Canadian MALE UAV would likely be the most important piece of the nation's UAV puzzle, acting as the workhorse of the fleet. The Department of National Defence has therefore placed $250 million aside for the purchase of MALE UAV systems, demonstrating a real interest in completing its UAV family.[46] Where Canada's Mini UAVs and TUAVs are Army platforms, a MALE UAV would be Air Force-owned, and jointly operated, providing imagery and intelligence for the whole military, as well as being able to provide strategic information as well as to supplement, or substitute for Mini UAVs or TUAVs if the need arose.

The Army currently plans for two types of Mini UAVs but eventually there may be more deployed at the Company and Battlegroup level. Initial plans are for systems of four Silver Fox UAVs deploying at the Battlegroup level, with nine Pointer UAVs per Battlegroup deployed at the company level.[47] This mix would effectively provide forces, deployed either in warfighting or Peacekeeping missions, a robust mix of near and medium range tactical surveillance, providing critical information about what is around the next corner, and over the next hill, especially in urban operations. A similar structure has been proved effective by American Army and Marine Corps units operating in Operation Iraqi Freedom.[48]

At the TUAV level, the Sperwer's success in Afghanistan is evident, despite its relatively minor, but highly publicized growing pains. Though rushed into service, the Sperwer fit into the Canadian deployment meeting the tactical needs of troops in Kabul, and the surrounding countryside, as well as operational support for Canadian, and Allied leaders. The Sperwer deployment in Afghanistan should be used as the basis for future operational and doctrinal development. Now that the Canadian Forces have operational experience with UAVs, they must create a doctrinal framework, as the Army is developing with ISTAR, to ensure that they are used to their utmost ability.

Issues and Concerns

Purchasing UAVs for the Canadian Forces is only the first step in creating a UAV capability, and there are many hidden costs and legal, material and technological issues regarding their use. In addition to creating a doctrine for their employment, UAV units will need to be created, trained, based, and supplied. Though UAVs can be used in place of manned aircraft, they will, at least initially, be providing a supplementary or complimentary ability, and will not be replacing existing units or assets.

While much is made of UAVs being cheaper to buy and operate than manned aircraft there are many hidden costs. A Predator system comprised of four air vehicles and one ground station costs roughly $30 million US, depending on the desired sensors, with Predator B systems costing slightly more.[49] Furthermore, as was shown in the ALIX exercise, Canada's satellite communications infrastructure was not sufficiently robust for continuous BLOS UAV operations.

As part of any future purchase of HALE or MALE UAVs, the Canadian Forces will be required to acquire or lease additional satellite bandwidth for Arctic UAV operations. Fortunately, to improve interoperability, the Canadian Forces are requiring a common operating infrastructure for UAVs. As a result, the laptop computer used to control Mini UAVs will be the same for any Mini UAV in the military, and the same ground station will eventually be used for HALE, MALE, and Tactical UAVs. By increasing commonality, logistics and training costs will be reduced, resulting in greater savings and increased capabilities.

United States Department of Defense studies have found that the cost of an aircraft, manned or unmanned, is directly proportional to its empty weight, costing about $1500 US per pound.[50] However, the cost savings of removing all equipment attributable to the pilot, about 10-15% of the aircraft's weight, must be invested in the UAV's ground station.[51] Further, the cost of developing mission critical software for a UAV can approach $600 US per line of code, and $200 US per line for non-critical software.[52] Further, Canadian UAV trials have shown that operating a squadron of MALE UAVs, about three systems of 4 aircraft, requires approximatley as much personnel as a similar manned squadron.[53]

There are cost benefits resulting from UAV use arising from the fact that a UAV squadron is considered to be about four times as effective as its conventional counterpart, mainly due to the increased endurance of UAVs.[54] There are also savings in that the loss of an air vehicle leaves the system intact, and it can be replaced at a fraction of the cost of an entire system, unlike the case when an entire manned aircraft is lost. Further, it is more likely that control problems or aircraft glitches can be fixed through software patches than is the case with a manned aircraft.

There is much criticism of the high accident rate of UAVs. This is a Catch-22 situation as, though manned aircraft must have extremely low expected accident rates, it is accepted that UAVs are attritable, and to create a UAV with the redundant systems of a manned aircraft would entail a larger, heavier aircraft with less range and payload, thus incurring higher costs due to its larger, more complex design. American UAV Battlelabs are attempting to improve the "graceful system degradation" of UAVs, attempting through improved software and system sensors to make UAVs better able to correct for damaged components.[55] It has also been found that UAV loss rates were reduced by an order of magnitude as better communications equipment were developed.[56]

The concern regarding UAV reliability is the greatest factor slowing UAV certification in civil airspace. As with any aircraft licensed to fly in Canada, Transport Canada must certify UAVs operating outside of restricted military airspace. This process takes time, and adds cost to a system, as evidenced by the fact that the Netherlands recently spent 8 Million Euros ($12.5 million Canadian) to certify their Sperwers for Dutch civil airspace.[57] As part of the process, it must be shown that the UAV has an equivalent level of safety as conventional aircraft, both in terms of reliability, so that it does not crash onto private citizens or their property, and controllability to insure that the UAV stays where it should in the air, out of the way of other aircraft.

Fortunately, once Transport Canada has certified a UAV as safe to fly, Nav Canada will treat it like any other certified aircraft, having only to submit a flight plan and follow standard airspace regulations. After three years of collaboration with Transport Canada, the Altair UAV used for ALIX was the first "file and fly" UAV to operate in Canadian civil airspace, with the handlers in Ottawa dealing with flight traffic controllers as if they were a normal pilot.[58] The United States is proceeding slower than Canada with UAV regulations, as each individual UAV flight must be examined for anywhere from two weeks to two months before a flight through civil airspace in order to ensure that there is adequate deconfliction of airspace. The exception is the Global Hawk HALE, which is certified to fly above civil airspace so long as it is accompanied by manned aircraft through civil flight space.[59]

An area of contention in the legal definition of UAVs arises from the variety of systems. While it is clear that a HALE or MALE UAV is an aircraft, and requires trained pilots and national certification, it is similarly clear that a 0.5-kilogram Micro UAV does not require the same level of certification or pilot training. Under the Aeronautics Act, however, so long as the UAV is powered, and not a hobby plane, Transport Canada must certify the UAV to operate outside of restricted airspace.

While HALE and MALE UAVs operate at altitudes where flight plans and altitudes are prescribed by air traffic controllers, Tactical, Mini and Micro UAVs generally operate in less regulated, lower altitudes. At these altitudes, civil aircraft operate under Visual Flight Rules, requiring that they see and avoid other traffic, making it significantly harder to achieve equivalent levels of safety for UAVs than it is for piloted aircraft. While these legal implications only arise in civil airspace, it is important that Transport Canada and the Canadian Forces are in agreement so as to cooperate and create a reasonable regulatory framework.

Another issue facing the Canadian Forces and UAV operations is that of "requirement creep," the addition of extra missions and requirements, and their associated equipment, that drive the price of a system up and performance down, generally leading to a longer development time, and less satisfactory result. An important example of this is the Canadian plan to “leverage joint UAV opportunities in a joint, inter-agency, multinational, and public (JIMP) context.”[60] The ALIX flights were conducted in just such a context and resulted in the cancellation of a flight. Imagery from ALIX was transmitted real-time over the unclassified Canadian Maritime Network (CANMARNET) computer network linking several government departments.

The purpose of integrating ALIX onto CANMARNET was to experiment with allowing other government departments to share Canadian Forces UAV data and, one day, allow them to request information or even flight changes while in flight. During the second ALIX flight, an unspecified “real world event” occurred in the UAV’s operational area that could not be dealt with while connected to the unclassified CANMARNET.[61] This contributed to the cancellation of the planned third flight to avoid getting “into a problem we don’t want to be in.”[62] If feasible, it is not unreasonable to share military assets with other government departments, but any Canadian Forces UAV must be primarily used for Canadian Forces missions. The use of military computer networks by the Navy in Operation Apollo to share intelligence and advice demonstrates the great potential of these forums, however the military cannot let public government access to military intelligence affect the outcome of a mission.

A final point of concern regarding UAVs in the Canadian Forces is the risk of wanting too much, too fast. When Canada set out to develop the Avro Arrow, it had no experience in building supersonic aircraft, but wanted to create the world’s best supersonic interceptor on the first try. The complexity of the process, like “requirement creep,” soon became overwhelming. Similarly, despite recent tests, and operational success in Afghanistan, Canada is relatively inexperienced with respect to UAV use. Though individual Canadian UAV manufacturers have been extremely successful of late, Canada does not have a strong UAV sector in the way that the United States or Israel does. Further, despite the money invested in UAV testing, government defence-related R&D spending in Canada is only a fraction of that of the United States, France, Germany, and Great Britain, and has been dropping since 1995.[63]

The creation of a UAV Battlelab to study future applications of UAVs must be grounded in reality and adequately funded to be effective. Unfortunately, however, research and development interests seem to lie in creating “bio-mimetic intelligence,” artificial intelligence that would allow UAVs to “think” for themselves, and creating “swarms” of UAVs that could think and act as an autonomous group.[64] While projects of this type are excellent long-term projects, a Canadian Forces UAV Battlelab must be primarily oriented towards solving existing UAV shortcomings.

American Battlelabs have been very successful at practicing spiral development, research and development aimed at enhancing the effectiveness of existing systems, leaving more abstract future developments to other agencies. These Battlelabs have relatively small, fixed budgets and staffs to ensure that any project is realistic and attainable.[65] While past projects have included the weaponization of the Predator and providing strike aircraft with real-time UAV imagery, recent efforts have attempted to compress the data flow from a UAV to require less bandwidth, thereby making greater use of existing communications equipment, also a very real concern in the Canadian Forces.[66] The innovative nature of PLIX and ALIX have showcased the innovative thinking of Canadian UAV planners and, with a realistic set of goals, the Canadian Forces could rapidly become a leader in UAV use.

Conclusions

Where Canada has historically missed several opportunities to invest in UAVs, missing opportunities to become a leader in the field, the Canadian Forces now appear committed to acquiring a serious UAV capability. Currently, the Canadian regulatory framework is relatively UAV-friendly; Canadian industry is set up to play a complimentary role, and the Canadian Forces are poised to learn from the experiences of other nations, to develop an effective UAV policy, and acquire a family of vehicles. However, there will be a monetary cost. The Government of Canada must regard this as an investment that will not only further the nation's defence and foreign policies, but also drive the transformation of the Canadian Forces into a network-enabled fighting force that is the blueprint for other nations. As with other military fields in the post-9/11 world, UAV development is extremely fast-paced, and Canada must get involved soon. With a realistic approach, sufficient funding, and government commitment and cooperation, Canada has the opportunity to become a world leader in UAV policy and development.

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