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The Royal United Services Institute of Vancouver Island is a member of the Conference of Defence Associations. The CDA is the oldest and most influential advocacy group in Canada's defence community, consisting of associations from all parts of the country.

The CDA expresses its ideas and opinions with a view to influencing government security and defence policy. It is a non-partisan, independent, and non-profit organization.

Special Issue Jan 2021

Contents (Control + Enter to follow link)

President's Message

Welcome to 2021!

This RUSI-VI Special Newsletter starts 2021 with an introduction to our upcoming Webinar on Human Intelligence, or HUMINT, scheduled for 20 January. Included in this Special Newsletter are two articles that will introduce you to the HUMINT concept, a relatively new and exciting capability for the Canadian Armed Forces. This interesting presentation will be from a retired Canadian Military Intelligence professional. I encourage you to read the first two articles dedicated to HUMINT before the Webinar.

2020 certainly remains a memorable year, but at the same time a year that we would rather forget; given the pandemic, ongoing tensions with a hostile People's Republic of China and the ongoing chaos created by President Trump south of the border. Unfortunately, our American friends have not only had a very difficult 2020, but will continue to do so, at least until inauguration day.

As we start the vaccine's rollout across Canada against COVID-19, we hope that not only will the vaccination program successfully arrest the surging pandemic, but allow us, by the end of 2021, to return to something like the old normal of 2019. Take care and stay safe!

Scott H. Usborne
President
Royal United Services Institute of Vancouver Island

What is Joint Task Force X (JTF X)

Article published by CF in 2016

The current environment in which the CAF operates is more complex than ever and commanders at all levels require detailed situational awareness to support their decision-making; increasing the demand on various intelligence collection assets to provide relevant and timely information.

The evolution of threats from traditionally large conventional forces to decentralized entities has increased both the requirement for and challenges to today's sensor and collection efforts. Joint Task Force X (JTF X) is Canada's modern day human intelligence (HUMINT) unit, responsible for the provision of strategic, operational and tactical HUMINT resources in support of DND/CAF programs and operations. To achieve its mandate, JTF X must select and generate source handlers and interrogators from within the CAF.

JTF X recalls the name of Camp X which was the unofficial name of the secret Special Training School No. 103, a Second World War British paramilitary installation for training covert agents in the methods required for success in clandestine operations. It was located on the northwestern shore of Lake Ontario between Whitby and Oshawa in Ontario. JTF X Crest is shown at left. In First Nations mythology, the raven is a guardian, a bringer of knowledge, a trickster, a shape shifter and a cunning creature.

What is HUMINT?

HUMINT is a category of intelligence derived from information collected and provided by human sources. It is the oldest form of intelligence collection and its contribution to recent operations continues to demonstrate its effectiveness as a collection capability and force multiplier. HUMINT is critical to understanding how threat actors function within today's operational environments, including the enemy's intent, gaining an appreciation of social norms, customs and values, individual and collective patterns of life, and opinions. This enables the CAF to better predict, prevent or protect against a threat actor's intent and activities. As such, it remains imperative that the CAF retain the ability to ensure a highly trained, equipped and capable group of HUMINT specialists to accomplish this high pay-off task.

How do we collect HUMINT?

Although HUMINT operators are always looking for technological advancements to augment their capabilities, the core aspect of the discipline remains the ability to interact with and gain information from individuals. HUMINT operations include a wide range of activities, such as source handling, interrogation, debriefing and counter-intelligence. HUMINT operators will adapt their operational profiles and tradecraft for each of these activities based on the level of threat, operational environment, and individuals that they are interacting with. Within these activities, source handling and intelligence interrogation operations are two disciplines that provide an extensive and sustained flow of information of intelligence value.

Source handling

Source handlers apply their tradecraft through interactions with a willing individual to answer a commander's Primary Information Requirements. Source handlers are required to identify, recruit and develop sources based on a variety of criteria utilising skills both inherent and trained. They can be employed in all environments, from permissive to hostile. As a result, source handler selection seeks individuals with diverse attributes such as mental agility, flexibility, social adaptability, patience and leadership, coupled with high standards of communications skills, physical fitness, robustness and an ability to work in small teams.

Interrogation

Intelligence Interrogations Operations (IIOps) are a significant contributor to the HUMINT collection capability that entails methodical and sustained questioning of individuals in support to operational planning and execution. IIOps require interrogators to be highly resilient, flexible, patient and professional individuals. The highly sensitive nature of IIOps means that interrogators are expected to consistently display the highest level of ethical behaviour; abiding by the laws and policies that regulate the conduct of these operations. Like source handlers, interrogators must undergo a mentally strenuous training program that prepares them to deal with the infinitely wide array of personalities, languages, levels of hostility, and racial and ethnic backgrounds of individuals that they must work with.

The Ultimate Guide to Human Intelligence (HUMINT)

BY BEN STARK ON OCTOBER 12, 2018 http://www.Intelligence101.Com/The-Ultimate-Guide-To-Human-Intelligence-Humint

Human intelligence (HUMINT) is intelligence collected from people.
HUMINT involves collecting information through a variety of conversational techniques, in a wide variety of circumstances. HUMINT 'operators' are typically referred to as Intelligence Officers who use talent spotting, rapport building, and source recruitment to collect on information requirements.

In this article we dive into the world of HUMINT, and discuss

- The role of HUMINT Operators (aka Intelligence Officers),
- The traits of successful HUMINT officers,
- The skills and tradecraft used in HUMINT,
- The training required to become a successful HUMINT collector,
- Difference between HUMINT and other Intelligence Collection Methods.

Roles of HUMINT Operators

The role of a good HUMINT officer is to identify sources and groups who have access to required information (usually secret or classified information) and build relationships to extract or collect this information.

While HUMINT collectors are probably best known for their role in recruiting spies and foreign agents, they routinely collect and report information from friendly forces, civilians, refugees, and local inhabitants too.

HUMINT operators also work in liaison roles with other agencies or foreign militaries, screen various personnel, or serve as an interrogator of captured enemy personnel or suspected criminals.

HUMINT personnel may even infiltrate a group or agency.

All of these functions require different skills, some of which overlap.

HUMINT Skills and 'Tradecraft'

The skills needed for successful HUMINT collection require extensive training depending on the situation or application.

A good HUMINT collector must be able to do all of the following (and much more):

- Profile a target, to include their core motivations, needs, wants, and even their dreams and temper triggers.
- Recognize someone as a viable target – a skill known as 'Talent Spotting'
- Leverage the information they know about a person, to steer them into a specific course of action.
- Understand and recognize mood shifts and nuances in conversation – a skill known as Emotional Intelligence
- Understand body language, facial microexpressions, and other tiny, barely perceptible clues to a target's mindset.
- Successfully use specific techniques to maneuver the target into the place you need them to mentally, emotionally, or psychologically be.
- Approach, motivate and maintain networks of sources and contacts.
- Sometimes "become other people," taking on personalities or roles outside of who they normally are.

Profiling

In the world of HUMINT 'profiling' means being able to understand someone to such a great degree that you can somewhat predict their feelings and actions.

Profiling is required to identify someone's motivations, so ultimately they can be recruited to provide the required information.

Recruitment can occur over a prolonged period with multiple interactions (to build rapport and trust) or over a period of minutes in an interview or conversation.

Profiling involves having an intimate understanding of the following:

- A person's strengths and weaknesses—including the ones they are in denial about or unaware of.
- Their risk factor to your operation and/or goals.
- Their credibility and reliability.
- How they'll behave or react in a variety of situations.
- How to best leverage all of this information for a successful interaction, whether it be long-term or short-term.

That level of understanding does not come easily in most cases; it often takes a literal study of the target, along with a varying amount of time.

There are various techniques that help HUMINT professionals recognize various traits and motivations to be leveraged either in the moment or later as part of an approach.

The core of profiling is understanding what motivates a person. For some, it's validation or acceptance; for others, it may be power or ego.

There are several different possible motivators, and each one can be leveraged to steer the target.

If done properly, the target will not know he has been steered—he will only react, perhaps not even aware of why he is compelled to say or do what he is doing.

Psycholinguistics

Psycholinguistic profiling is a tactic used by the Federal Bureau of Investigation and other federal law enforcement agencies, as well as more espionage-based entities.

A person's language gives many clues as to not only their guilt or innocence in a given situation but also exposes who they are at their core, what their priorities are, and often how they can be best exploited.

Human Terrain Mapping

The core of HUMINT is human terrain mapping.

Just as topographic maps outline mountains and valleys, offering landmarks and allowing someone to forge a path, Human Terrain Mapping outlines the "path" that a collector should take to—and even through—a human target.

Asset Targeting

In HUMINT work, professionals need to be able to find, recruit, and maintain various contacts, information sources, and even subordinates that can perform various tasks (such as moving messages or serving as a cut-out).

Assets are chosen based upon a wide variety of criteria including their personality, their level of access to a specific program or information, and their ability or willingness to be exploited or recruited.

There are different types of recruits, and HUMINT targets don't always have to be high-profile.

For example, a factory worker on an aerospace project can be a highly valuable source of information.

Other potential sources could be the wife or significant other of your actual target.

Targeting is often a slow, calculated process, not a quick cold call.

In some cases, one may even recruit several degrees away from the main target, slowly working their way closer to the goal; a barista at a coffee shop frequented by people who hold information you want, in the hopes of gleaning information from overheard conversations, or someone who works out at a gym with the person you eventually want to approach.

Consideration – Sometimes assets recruit back, and HUMINT professionals need to be able to recognize those efforts. Defectors, walk-ins, and other individuals who seek to offer information or place themselves in a position to be recruited could be looking to fulfil a role in another, opposing operation.

HUMINT collectors can sometimes be in an incredible amount of danger while attempting to recruit a source or asset.

Training Required

Building Rapport and Interpersonal Communication

One of the biggest weapons in a HUMINT professional's arsenal is the ability to be disarming, to build that interpersonal rapport.

HUMINT operators must able to carry on conversations with strangers in a friendly, engaging way, build rapport by 'pushing the right buttons' .

How? Start engaging people with trivial comments about 'the weather', 'the game on the weekend' or their shoes (it doesnt matter).

Personally, I like to note the front page of the newspaper each day when I get my coffee. Then I use the headline as a conversation starter…

Keep in mind that rapport doesn't necessarily mean that the source likes or cares about the HUMINT professional.

In fact, it's possible to have a level of dislike from the source and yet still have a valuable informational relationship.

Common misconception: Rapport is not 'getting your source to like you.'

Building rapport is about doing what is necessary to facilitate the transfer of information. In some cases, a source may respond better to an authoritative or even rude persona. It all goes back to the profiling and adaptability.

TIP: one of the best resources on the topic is the book '*How to win friends and influence people*' by Dale Carnegie (first published in 1936).

Elicitation

Elicitation is the act of collecting information that the target is unaware they're giving.

This is often done in the form of a casual conversation about a seemingly unrelated subject, meant to pull information while the target thinks you're just chatting with them.

Not every HUMINT collection effort involves a full-on recruitment, in which the person being approached knows they are expected to provide information or perform an action.

While people who have secrets or access to certain types of information are often on guard while in their official capacity or work-related situations, they may not be as vigilant in "off-duty" scenarios.

Casual conversations at these times, especially if they occur over multiple interactions and while steering clear of sensitive or problematic topics, can often net big informational rewards.

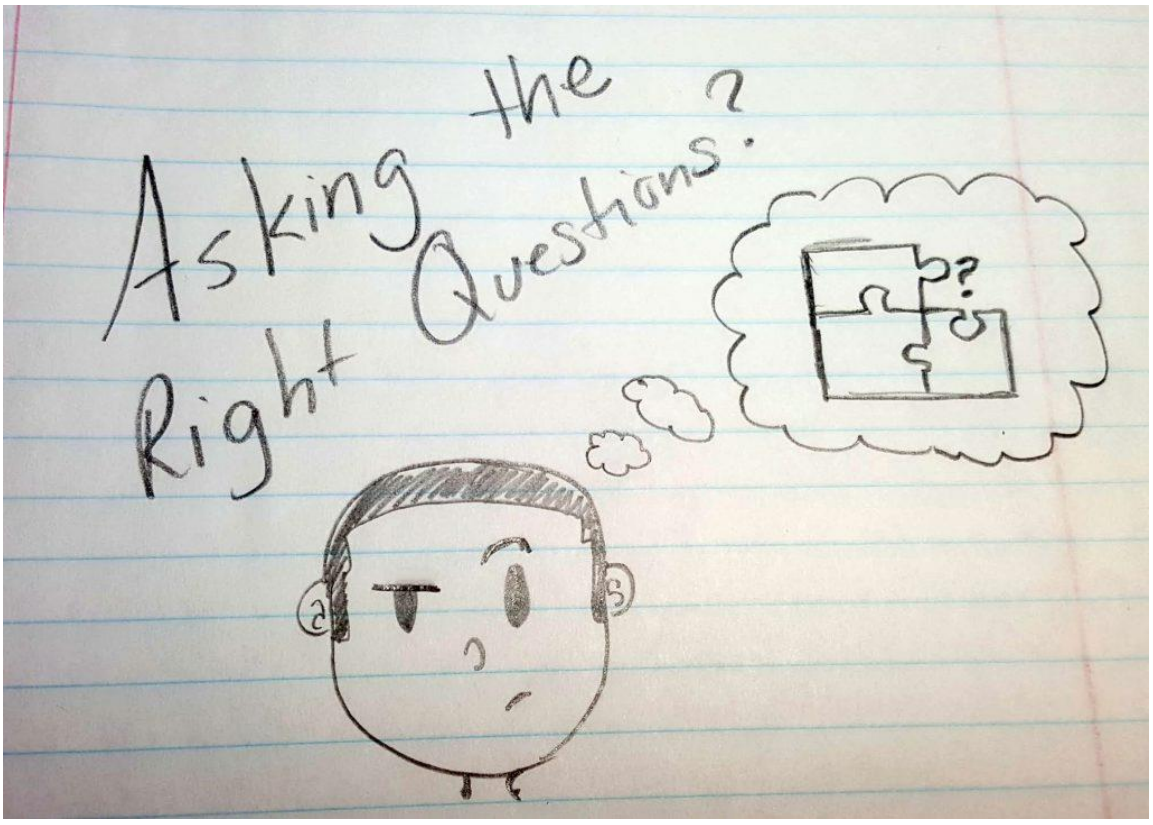
Profiling plays a heavy role, and HUMINT collectors become very adept at recognizing human needs that can be exploited at the moment.

Someone who likes to complain, for instance, can be leveraged if someone offers them a chance to be heard…

Think about that dissatisfied colleague at work who just *loves* to complain if given a supportive ear.

Someone who needs to feel important or has a high-functioning ego may be a bit more loosely-spoken if they are complimented or looked up to.

Certain human traits and needs lend themselves well to exploitation, and a savvy HUMINT collector understands both those traits and how to recognize and leverage them in a variety of ways—often on the fly.



First Contact or Approach

The first contact with a potential recruit or target when looking to recruit or 'flip' a source is a critical one.

in the first instance, introducing yourself as a HUMINT professional working for X entity who wants information from them is obviously a bad idea.

Instead, HUMINT collectors often look for an opportunity to meet the target by "chance," or be introduced by a mutual acquaintance.

In some cases, they seek to become part of the target's background—such as the barista or fellow gym-goer—in an effort to slide into the target's world in a natural way and take advantages of opportunities to chat with them.

In an interrogation scenario, however, the dynamic is much different. The target is well aware that the HUMINT professional wants information and may employ a number of strategies in order to prevent that goal from being realized.

In an approach situation, regardless of whether it takes place in an interrogation room, a foreign village, or your local coffee shop, there are three things that they all have in common:

1. An approach establishes and maintains a level of **conversational control** over not only the individual event but the overall collection effort as well.
2. An approach must begin and maintain a level of **increasing rapport** with the source or target. If the source does not have a level of trust with the collector, they will not give information.
3. Create a valid profile for the source, in which suspected motives, needs, wants, emotional stability, cultural mores, and other information is c**onfirmed and leveraged** successfully.

There are certain situations in which people also tend to be more forthcoming with information. If a target is in a very stressful or frightening position, for instance, the first person they talk to who shows them kindness and compassion is in a great position to glean information.

People also tend to open up when they think they are speaking to someone who shares their worldview.

Therefore, a non-judgmental reaction—no matter what is confessed to or talked about—is critical.

Law enforcement uses this tactic often when talking to suspects in violent or sexually-based offences.

If the suspect feels they will be judged for what they say, they may not say it at all.

A sympathetic posture is often more effective, regardless of one's own feelings are about the subject matter being discussed.

Canada Buys Israeli Drone for Arctic Maritime Surveillance

Levon Sevunts, Radio Canada International

Posted: Tuesday, December 22, 2020 at 14:30 — Last Updated: Tuesday, December 22, 2020 at 14:55

Employees check an Elbit Systems Ltd. Hermes 900 unmanned aerial vehicle (UAV) at the company's drone factory in Rehovot, Israel, June 28, 2018. (Orel Cohen/REUTERS)

Ottawa will shell out more than $36 million to purchase an advanced Israeli drone to help the federal government keep an eye on the growing maritime activity in Canada's Arctic, federal officials announced Monday.

In a joint statement, Minister of Public Services and Procurement Anita Anand and Transport Minister Marc Garneau, said the contract with Elbit Systems Ltd. for the acquisition of a Hermes 900 StarLiner remotely piloted aircraft system (RPAS) was awarded through an "open, transparent and competitive procurement process."

The federal government has also engaged in consultations with Indigenous groups in Canada's North, where the drone will operate, officials said.

The Hermes 900 StarLiner, a civilian version of Elbit's medium-altitude long-endurance military drones, will join Transport Canada National Aerial Surveillance Program aircraft fleet. It is expected to be delivered by December 2022.

According to federal officials, the Hermes 900 StarLiner is capable of operations of up to 72 degrees north latitude and has a range of more than 1,400 nautical miles. It comes equipped with back-up command and control and navigation systems, electrical optical infrared camera, synthetic aperture radar and mapping camera system.

The drone is controlled from a remote location and also includes autopilot capabilities, such as automatic takeoff and landing.

Transport Canada plans to use it to detect oil spills, survey ice and marine habitats, and monitor activity on the ocean in Canada's Arctic, officials said.

The aircraft is fully certified to operate in civilian airspace and will take-off and land in civilian airfields.

In addition to the drone itself, the $36.16-million contract includes communication links, ground control stations, sensor packages, training and the optional purchase of spare parts.

"Canada is committed to protecting our endangered species and our marine environment," Garneau said in a statement.

Integrating remotely piloted aircraft into Transport Canada's fleet will make federal surveillance operations more robust than ever, he added.

"The National Aerial Surveillance Program also helps with search and rescue, humanitarian efforts, illegal fishing enforcement, and the development and regulation of Canada's drone industry," Garneau said.

Experts welcomed the announcement.

Timothy Choi, a maritime strategy expert and Fellow of the Canadian Global Affairs Institute, said the federal government was facing a limited choice when it went shopping for this new capability.

"Large maritime surveillance drones – that is, ones equipped with downward-looking radar and AIS receivers to detect shipping – have not been as prevalent in the global drone market as their land-centric counterparts," Choi said. "Of these, there are even fewer that have been tested in Arctic conditions."

The model that Canada is acquiring has, however, been undergoing operational trials in Iceland via the European Maritime Safety Agency ever since summer 2019, Choi said.

In September 2020, the same model was also selected for demonstration for the UK's coast guard.

The Hermes 900 StarLiner is also significantly cheaper than the used Euro Hawk drone Canada tried to buy from Germany last year, Choi said.

"Operationally, the new drone will greatly help 'connect the dots' when it comes to surveilling Arctic waters and enforcing Canadian regulations," Choi said.

"While our RadarSat satellites can and do detect oil spills, their brief visits over the Arctic make it difficult to identify the exact nature of the oil spill or its origins: the ability of a drone to loiter for long periods of time with higher-resolution sensors will help fill this gap."

Those same sensors, which are required to be able to discern details as minute as fishing nets on ships, will collect valuable evidence to document any activities such as illegal dumping and fishing, Choi said.

How Canada's Air Task Force-Romania is Adapting & Evolving

BY CHRIS THATCHER | NOVEMBER 27, 2020

The intercept of a Russian Su-27 Flanker by two CF-188 Hornets over the Black Sea on Sept. 23 might have been relatively straightforward, but it was a significant marker and confidence-booster for the Royal Canadian Air Force (RCAF) detachment conducting enhanced air policing and training with the Romanian Air Force.

"It's one of those things that really electrifies the morale of the task force," admitted LCol David McLeod, Commander of Air Task Force-Romania, which began operations on Sept. 5 following a certification ceremony from NATO on Sept. 3 at Mihail Kogalniceanu Air Force Base.

A Royal Canadian Air Force CF-188 Hornet takes off for a combat training flight during Operation Reassurance, Air Task Force-Romania, on Oct. 13, 2020. Combat Camera/Zach Barr Photo

"Once that first intercept is complete, it is easier to settle into the [mission]. You tick that box: we've been able to do what we came here to do. The pilots were amped up and our maintainers and everyone else on the detachment was really excited."

The intercept was “fairly benign, which is what we expect to see from the professional aviators flying out of those other bases on the other side of the Black Sea,” said McLeod, who was one of the pilots on quick reaction alert (QRA) duty that day.

The two Hornets were tasked to interdict the Flanker by NATO’s southern Combined Air Operations Centre at Torrejon, Spain, after the Russian aircraft was detected by the Romanian Air Force’s Control and Reporting Centre. They made contact and identification over the Black Sea and tracked the SU-27 to the edge of the Romanian flight information region (FIR) without incident.

The encounter was nothing like an intercept by Russian Su-27 pilots of a U.S. Air Force B-52 over the Black Sea on Aug. 28. In a video released by the U.S. military and posted online, the Russian pilots can be seen flying alongside and then crossing within 40 metres of the nose of the B-52 while in afterburner, generating turbulence and causing the B-52 to shake noticeably.

“That is not what we saw,” said McLeod, “just a calm, professional intercept.”

The intercept coincided with Kavkaz 2020 (Caucasus 2020), the largest Russian military exercise of the year. The event was held across the Southern Military District and involved a reported 80,000 troops and 60 Ilyushin IL-76 military transport aircraft.

“We had been running through different readiness states over the course of that week,” said McLeod, noting that the Russian exercise generated a lot of NATO and U.S. interest. “As we were finishing up one mission, we were redirected to check out a contact that was in the FIR off the coast.”

The Air Task Force deployment, the fifth rotation since 2014, is part of Operation Reassurance, Canada’s contribution to NATO assurance and deterrence measures in Eastern Europe. Comprised of six CF-188 Hornets and around 135 personnel, most from 433 Tactical Fighter Squadron at 3 Wing Bagotville, Que., the detachment is augmenting Romanian air policing and flying training missions together with the Romanian Air Force and allies in the region into December.

In addition to holding a very high readiness QRA posture for the first weeks of the mission, the Air Task Force participated in several NATO exercises and in joint training with Romanian, Bulgarian and U.S. air forces.

The joint exercise with the Romanians and Bulgarians, an annual event known as Exercise Blue Bridge, is intended to improve coordination and interoperability between the forces and extend the air policing mission across the airspace of both countries. The 2020 iteration focused on QRA activity and allowed the Canadians to “participate in some of the bilateral discussions,” said McLeod.

A follow-on exercise, Thracian Viper 2020, focused on cross-border operational capacity and interoperability with Romanian F-16 Falcons and MiG-21 Lancers; Bulgarian MiG-29s and Aero L-39 Albatros; and U.S. Air Force F-16 Fighting Falcons supporting Bulgarian air policing for a month.

More recently, the detachment worked on maritime integration, conducting air defence exercises with the Romanian F-16s and the Royal Navy’s air defence destroyer, HMS Dragon, operating in the Black Sea.

In part because of Kavkaz 2020, the first six weeks of the mission were a demanding period involving more flying than previous deployments. “That’s a reflection of the intensity of that exercise and the lead up to it for the Russians and the interest in it from the NATO side,” said McLeod.

Since then, the flying tempo has returned to a level consistent with previous deployments. In fact, the overall amount of cockpit time has decreased slightly due to limitations imposed by COVID. In past years, the Canadian contingent participated in events such as the Czech Republic’s NATO Days airshow and conducted close air support and other exercises with the Canadian-led multinational battle group in Latvia. This tour, the ATF has had to say no where the deployment of supporting assets are involved. “If we can do it from our main operating base here, we are still doing it,” he said.

COVID has also crimped some of the off-base activities and changed how the detachment supports local charities, orphanages and other organizations. “We are trying to find innovative ways we can maintain that community connection,” said McLeod. “Even if we can’t go out in-person, at least we can still support some of these charities that are probably even more in need with the COVID situation.”

In the weeks before a second wave of the coronavirus affected much of Europe, the commander had permitted activities such as dining in Costanta restaurants. “We had to shut that down a couple of weeks ago as cases started to rise in Romania. We really limit any off-base travel.”

Ever evolving

McLeod first deployed to Romania in 2014 and then again in 2016 and has seen the Air Task Force role evolve from strictly a bilateral training mission to the more complex NATO air policing and multinational training. He’s also seen the Romanian Air Force reform as it has integrated further with NATO and introduced new capabilities and equipment such as the F-16 Falcons, acquired from Portugal in 2013.

“What you see is this change in mindset as they learn and incorporate these lessons from different NATO allies,” he explained. “It really enhances their capability and their flexibility. In 2014 there was a lot more rigidity in terms of their approach to things. Today, there is a marked difference in flexibility, which is really important to the application of air power. It really makes them a much more capable force.”

Previous missions have helped with the integration of the fourth-generation fighter jet. Tactics and the employment of tactical datalinks are still of interest, but now the emphasis has to more advanced operations. “Some of my senior pilots are talking about four-ship academics with the Romanian pilots,” he noted.

COVID has restricted some of the face-to-face briefings, but Canadian pilots have been able to help their Romanian counterparts with a “building block-type approach” to develop their four-ship concepts of operations. Recently two F-16s and two CF-188s collaborated as a four-ship against an F-16 and CF-188 flying red air.

“We find it exciting to see this capability develop over the year,” said McLeod. “To see how far they have come with the F-16 is truly awesome.”

For 433 Squadron's junior pilots, ramp crews, maintainers and support staff who don't have the operational experience of missions in Libya and Iraq, operating "out of their element" in unfamiliar airspace and with different accents and control styles has been important, he added.

"It's fascinating to live that fresh experience through them as they get used to operating here. They are saying, 'say again,' a couple of times on the radio" as they react to a different style and tempo of communications. "All the right pieces are there, but they have to open their minds up to a slightly different sequence then they are used to back home. It is a really good lesson for all of our crews, that adaptability and integration with NATO."

That has been especially true for staff in the Tactical Operations Centre and in headquarters interacting with NATO procedures. "Even though we are a strong alliance, there is a lot of cross talk that has to happen to make these operations work," McLeod noted. "This demystifies the process for them. It is really good learning."

With each rotation, the Air Task Force has learned lessons of its own to sustain the almost 40-year-old Hornets while participating in more and more training events. For 2020, a sixth jet was added to the previous two rotations of five. The detachment had debated reducing the fleet to five when it became evident that COVID would eliminate some exercises. But with Canadian Armed Forces supply lines to multiple missions around the world effected by COVID, have six airplanes "has proven to be a really good call," said McLeod. "That extra jet has really paid dividends. We've had times where we had to wait a little longer for airlift. That's normal, but we have been able to work through it much more easily with that extra aircraft."

Previous rotations have often conducted jet swaps midway through a tour, trading out one or more aircraft if they required supplemental or periodic inspections. The sixth jet has negated the need for any swap and the challenge of trans-Atlantic crossings and stopovers, "which in COVID times are much more complicated to do," he added.

Swarming, Expendable, Unmanned Aerial Vehicles as a Warfighting Capability

Gary Martinic Writing in the Canadian Military Journal Vol. 20, No. 4, Autumn 2020

Introduction

Unmanned Aerial Vehicles (UAVs) have been employed for ISR (intelligence, surveillance & reconnaissance) missions for more than a century and have been used for strike missions for more than a decade in modern theatres of conflict as effective light weapons platforms. While these robotic technologies have become relatively 'mainstream' today, there has been ongoing research and development (R&D) into the ability of their smaller variants to operate as a 'single unit' or swarm, with the aim of improving their capabilities and performance with respect to adversary targeting. This 'evolution' has occurred primarily because of the tactical advantages that this new developing technology may be able to provide. For example, any military technology that can absorb multiple hits and keep going, from a warfare point of view has a major advantage over other systems, such as manned, and even lone

unmanned aircraft, which can be destroyed by a single missile. Additionally, the technology can be used in three ways by military forces: to attack, defend and to support functions such as ISR, and it reduces the risk of loss of human life and expensive equipment in battle.

The concept of fusing UAVs into swarms has seen two key developments stand out in particular:

• the ability to swarm shortly after being launched from either a pneumatic catapult from an aircraft, a ship or from a submarine; and

• making them inexpensive enough so as to make them 'expendable.'

Discussion

With Adolf Hitler's adoption of advanced tactics and technology, such as advances in communications through Blitzkrieg warfare, and weapons, such as the jet-powered Me-262 fighter and the V-1 'buzz bomb' and V-2 ballistic missile rockets fielded in the latter stages of the Second World War, the Allies were finding themselves constantly 'behind the curve' in the technology of war. And this changed the way that they planned to fight in the future.8 Over the next 70 years, western military powers have sought to lead the way in aerospace and weapons research and development (R&D). Consequently, the US and other western powers made sure that they held a clear advantage with respect to tactics and technology, often a generation ahead of potential adversaries, by replacing the focus from quantity to quality, so that they could deter any adversary.9 Today, this race to maintain military supremacy has been extended into R&D pertaining to unmanned weapons systems (UWS) with air, land, and sea applications. Indeed, the world's most advanced militaries continue to develop Unmanned Weapons Systems because of the significant tactical advantages that they provide. While these robotic technologies have advanced significantly across all three environments, they arguably have been the most pronounced in the air, with unmanned combat aerial vehicles (UCAVs). The logical extension of this technology is its applicability to UAV swarming, where, just as in nature, swarming systems have individual agents that interact with one another and their environment. These agents follow simple rules, but the collective interactions between the agents can lead to quite complicated and sophisticated collective behaviours, including emergent behaviours, and even intelligence aspects. For example, a swarm may stay in formation while changing direction several times.20 In order for this to be achieved, individual units must be physically-homogenous with the same programming and the same sensors, which enables an autonomous swarm to communicate with each other, noting that the sensors are used to disguise swarm behaviour, which are often based upon environmental factors outside the swarm.

Currently, medium-size UAVs are optimised for ISR and light strike operations in non-contested or relatively permissive environments. However, significant advances have been made in developing the next generation of smaller UAVs with the ability to swarm, in order to attack specific military targets. This has the added advantage that they waste enemy resources by drawing fire, or alternatively, they could be equipped to jam enemy communications via on-board sensors. This generation of small UAVs has been developed to be modular, adaptable, and inexpensive, given that the payload they carry determines the type of mission they can execute. Such small UAVs have been found to be a cheaper and more cost-effective all-round military technology when one compares the costs to, for example, the F35 Joint Strike Fighter programme, which has cost approximately 1.5 trillion US dollars, to date. With most naval anti-ship and air to ground missiles costing upwards of a million dollars each, the goal has been to cost effectively produce an entire swarm of small UAVs costing less than a single missile. This goal has already been achieved with Raytheon's Coyote small folding wing UAV (see Figures 1 and 2), which cost around $15,000 USD per unit, with the challenge being to reduce the costs even further to somewhere between $5,000-$7,000 USD per unit. Indeed, UAVs of all classes have taken on offensive capabilities with the integration of adapted and purpose-built munitions, and look set to take on more roles as their capabilities are expanded and improved. For example, Defence Advanced Research Projects Agency (DARPA) are

currently working on armed 'deploy and recover' UAVs, which can also be launched from a 'mothership,' as shown at Figure 3, and which are recovered post-mission.

A significant milestone in the future of air warfare was achieved in late-2016, when the US Navy successfully demonstrated that a flight of around 30 Coyote UAVs could be fused into operating as a single swarm, above the ocean, and at an undisclosed location. The mission was intended to show that the swarm could be self-configuring, so that if one UAV was destroyed, others in the swarm could autonomously change their behaviour and complete the mission. Thus, small UAV swarm systems, which are aware of each other's position and movements, have been an incredible advance, meaning that UAV swarms can be much harder to stop.

In these tests, the UAVs also demonstrated that they could position themselves autonomously, flying in formation without being directed where to go, which, as opposed to remotely controlled operation, represents a major evolutionary leap forward, since the swarm effectively displayed 'collaborative behaviour.' The Coyote UAVs are a metre-long tube-launched, electrically-powered small UAV. Designed to be an expendable asset used for reconnaissance, this UAV has folding wings, so it can be fired from the tubes used for dropping sonobuoys on anti-submarine aircraft, or from a pneumatic launcher on a navy ship. Weighing around 6 kilograms, once launched, the Coyote's wings flick out and it can fly for up to 1.5 hours on battery power, while at the same time beaming back video messages from 30 kilometres away. Coyotes were also used by the US Office of Naval Research (ONR) in a programme known as 'Low-Cost UAV Swarming Technology' (LOCUST), which was designed to demonstrate whether autonomous, swarming small UAVs can overwhelm an adversary more cost-effectively than conventional weapons systems.

The impressive thing about the LOCUST testing by ONR is that they launched 30 UAVs within 40 seconds, upon which the UAVs rapidly formed into a swarm, and then flew autonomously in formation to carry out the mission, communicating by using a low-power radio–frequency network, which enabled position sharing and other data. As endurance is limited to 90 minutes of operation, rapid launch was crucial for the battery-powered UAVs, which were designed to be platform, payload and mission agonistic. The swarming mechanism used was a 'parent/child' relationship, in which one of the UAVs acts as the lead, and the other UAVs follow. However, the 'leader' can also be changed in case it is destroyed during the mission. Interestingly, using certain electronic commands, the operator can redirect individual UAVs to perform other missions, and the swarm can also be broken up into smaller groups for alternative manoeuvres, or a single UAV might break formation to get a closer look at a target, and then return to carry out an attack. These scenarios indicate that a significant degree of formation control has been achieved, along with other vital data collected, which included how tight the formation could fly as a swarm, at what altitude, and what type of manoeuvres it could perform.

In October 2016, the USN also successfully launched 103 miniature swarming drones from F/A-18 fighter jets, which was carried out at an undisclosed location. Then, in early-2017, the USN carried out similar tests at the Naval Air Weapons Station China Lake Test Range Facility in California. In both tests, Perdix micro-UAVs successfully demonstrated advanced swarming behaviours, such as '…collective decision making and adaptive formation flying.' These Perdix low-altitude micro-drones were not pre-programmed, synchronised individual units. They were a collective 'organism,' sharing one distributed brain for decision-making and adapting to each other like swarms in nature. As every Perdix communicates and collaborates with every other Perdix, the swarm has no leader, and can gracefully adapt to drones entering or exiting the team.

Previous successful demonstrations have included an airdrop from F-16 fighter jet flare canisters by the US Air Force Test Pilot School at Edwards Air Force Base in 2014. The US Navy have also successfully

launched X-wing-shaped small drones vertically into the air, after being fired from the torpedo launch tube of a submerged US submarine, the USS Providence, in December 2013.

While these demonstrations by ONR and others have been impressive, there are still hurdles needing to be overcome before these new capabilities become fully established. Firstly, autonomous 'sense-and-avoid' technologies in small UAVs are still in their early developmental stages, and solutions will need to be found, although as processors are getting more powerful and reliable, this issue is likely to be resolved via the use of deep learning and neural networks as technology advances. This is important, because it's one thing to fly a swarm above open water, but then it's quite something else when that swarm needs to be flown above land where there are numerous obstacles to avoid, such as buildings, power lines and trees, let alone a land warfare scenario, where there may be adversary weaponry with which to contend

Secondly, there are two other issues in establishing trust with respect to completely autonomous systems, which again, are likely to be overcome eventually as more tests are safely completed. Thirdly, there is the issue that a swarm's endurance is limited by the duration of its battery life. Again, a potential solution to this problem is to establish a 'hive' or base station, where individual UAVs can return for recharging while the rest continue with their mission.

Lastly, public safety policies predominantly treat unmanned aircraft as if they are manned, meaning that they are highly regulated if they endanger public safety, or enter civilian airspace. The issue here being that policy makers will be more cautious as they are dealing with UAVs being operated fully autonomously, as opposed to being remotely piloted, which is still preferable from a flying safety standpoint. It is important to compare the differences between the two systems at this juncture. An RPA is the acronym for a Remotely Piloted Aircraft, which is a form of an unmanned aerial system (earlier acronyms for this were UAS), which is non-autonomous in its capacities, the aircraft being subject to direct pilot control at all stages of flight despite operating remotely from that pilot. Swarming UAVs are flocks or groups of small UAVs that can move and act as a group with only limited (semi-autonomous) or no (autonomous) human intervention. These systems also differ in that RPAs usually have a much longer flight duration (or loiter times), whereas swarming UAVs, currently have a limited flight duration of up to 1.5 hours maximum (although R&D continues into methods which may keep them in the air for longer periods). Lastly, RPAs should be considered as a safety critical system, as they often fly in and out of civilian airspace. Some authorities consider the risks posed by swarming UAVs as being too great, and advise that those risks should be considered sooner rather than later before their destructive potential reaches maturity. Swarming UAVs can be considered both safety critical and mission critical systems, although they are primarily a mission critical system (as indeed are weapons), and it is for this reason that they should not be released into civilian airspace other than for the purpose of an authorised military mission. In this interesting new source, future human decision-making regarding complex military and safety critical systems is analysed in detail. It addresses the likely changes to weapons, cyber warfare and artificial intelligence (intelligent and autonomous systems) to emphasize that these new capabilities need to be thoroughly tested before being fielded, in order to ensure they are safe and operationally effective, while at the same time, mitigating unintended hazards and adverse effects. They also provide detailed explanations with respect to meaningful human control during the Find, Fix, Track, Target, Engage, Assess (F2T2EA) 'kill chain,' with recommendations for ethically-aligned design of AI and autonomous weapons.

The advantage of robotic swarms is that they are not limited to one particular military domain only, as they will likely prove be equally effective across all domains, particularly when used in combination with the advanced tactics that they were designed to undertake, whether they may be offensive or defensive in nature. To this end, drone swarms could be used to blanket enemy areas with ISR assets, to jam enemy air defences, and to overwhelm enemy targets with firepower. They would likely be particularly useful in all phases of the F2T2EA targeting cycle, and as an alternative to precision-guided munitions (PGMs), because even the most advanced PGMs become useless if targets cannot be located and designated for

attack. UAV swarming technologies and tactics bring significant changes to warfighting capabilities, including the ability for 'kamikaze-style' attacks to overwhelm adversarial assets, which can include neutralising enemy missile batteries, radar stations and other systems, or by rendering same sites vulnerable to attacks by more heavily-armed manned aircraft. They can also be deployed to conduct important ISR and other imagery missions deemed too heavily defended to be carried out by manned aircraft. UAV swarms can also be employed in defensive roles where they can protect larger navy ships, heavy armour and artillery, or large aircraft assets from attack by establishing defensive barriers. Indeed, LOCUST is part of an effort to develop autonomous technologies that can be applied across surface, undersea and air domains.

Conclusions

The growing importance of unmanned vehicles stands as a testament to the evolution of military technology. It is the author's view that UWS, including swarming UAVs, are the future of warfare. The ISR-gathering value of unmanned vehicles is well-demonstrated, as UAVs can remain on station over areas of interest sometimes for days at a time, making them one of the most valuable persistent-surveillance platforms available. As a weapons platform, UAVs with light missile armaments have taken out attacking forces, and have killed many terrorist leaders in the Middle East in precision surgical strikes. Furthermore, unmanned vehicles help keep humans out of harm's way. As a result, battlefield casualties can be reduced, and UAVs cut down on the possibility that a human aircraft pilot will be shot down, taken captive and remain in the headlines for months, if not years.

Research into swarming UAVs is one of the fastest and most promising areas of military R&D today, as swarms have essentially advanced the capabilities of UAVs even further. These has been possible mostly because of algorithms, in that their application is that which governs swarm behaviour, making communication and cooperation possible within the swarm. Essentially, UAV swarms are low-technology hardware knitted together with high-technology artificial intelligence (AI). This combination will likely become a powerful weapon of the future, including both lethal and non-lethal applications, enabling essentially a light attack force to defeat more powerful and sophisticated opponents. Such algorithms will enable UAVs and UAV swarms to conduct a much wider range of functions without needing human intervention, such as sensing, targeting, weapons adjustments and sensor payloads, range and capabilities. Developments with respect to AI will better enable unmanned platforms to organise, interpret and integrate functions independently, such as ISR filtering, sensor manipulation, manoeuvring and navigation; hence emerging computer technology will better enable UAVs to make more decisions and to perform more functions by themselves. The advent of swarm technology heralds a period that could reverse the trend of the past quarter of a century of US military dominance, which has seen the deployment of fewer but more advanced – and expensive- weapons platforms. The next generation of weapons may see sophisticated technology systems outdone by the sheer numbers of autonomous swarms.

Just when the US achieves its goal in developing these new UAV swarming capabilities ready for acquisition and deployment as front-line weapons systems remains to be seen. The results so far have demonstrated that it is well on track to meeting research goals in the near-future, as it continues development and testing on a range of systems and levels of autonomy. The creativity and innovation of these projects represents an unprecedented paradigm shift in small UAV launch systems, strategy and tactics with the myriad modes of operation, and the technology certainly has the characteristics to be a 'game-changer' for the US and its Allies.

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Link to Canadian Military Journal and this article where references and pictures can be seen.
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