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VERTICAL TAKE OFF AND LAND REMOTELY PILOTED AIR SYSTEMS FOR BATTLEFIELD AEROMEDICAL EVACUATION

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AIM

1. The purpose of this paper is to highlight the opportunity presented by Vertical Take Off and Land (VTOL) Remotely Piloted Air Systems (RPAS) for the Canadian Armed Forces (CAF) future battlefield Aero Medical Evacuation (Aeromed) requirement.[1] The current status of this technology and developmental constraints for Aeromed applications will be outlined with a view to proposing operational use cases for CAF in the 2025-2035 timeframe. Possible use cases will be examined to establish the feasibility of employment of this capability within the domestic and contingency Operations Other Than War (OOTW) context. Three recommendations will be made to aid progression of this capability for future CAF employment. Proposed further areas of study include the expansion of use cases to address high intensity warfare opportunities and, the evolution of this capability longer term, to incorporate the use of autonomous Unmanned Air Systems (UAS).[2]

[1] In a military context use of the term RPAS is frequently favoured over Unmanned Air System as it reassures the public of the involvement of a human pilot. However both terms are widely accepted.

[2] Autonomy refers to the evolution of UAS to be capable of undertaking self led missions, enabled by artificial intelligence without the need for a remote human pilot.

INTRODUCTION

2. The vision presented in Strong Secure Engaged (SSE)[3] 2017 is for an adaptable force capable of full spectrum operations and a continuing Canadian commitment to humanitarian and peace support operations. The United Kingdom (UK) Ministry of Defence (MOD) Future Operating Environment 2035 (FOE 35) describes the projected characteristics of the future battle-space environment as increasingly contested and congested. The FOE is forecast to have up to 80% of the population living in urban mega-cities within 100 miles of the coast.[4] The appetite for NATO nations' acceptance of casualties, especially in Peace Support Operations (PSO) is likely to continue its decline, making unmanned air and ground systems an attractive prospect.[5] Climate change is expected to increase the risk of flooding in coastal areas, desertification in arable areas and competition for resources, specifically water.[6] An increasing proliferation of inter and intrastate resource wars driving mass migration will likely require intervention by the International Community. It is therefore anticipated that PSO complexity will increase with operations taking place in megacities as populations migrate to the perceived safety of the cities. The challenge of gaining access to both conduct missions and extract casualties, especially in built up and contested areas will be an increasing constraint. Given this context, the availability of unmanned and therefore smaller, more maneuverable medevac aircraft capable of extracting casualties from complex terrain or areas of congested airspace would enable agility in mission planning and conduct.

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[3] Canada Dept of National Defence, *Strong, Secure, Engaged: Canada's Defence Policy* (Ottawa, Ont.: National Defence, 2017), 113.

[4] UK MOD, *Strategic Trends Programme: Future Operating Environment 2035*, Doctrine Concepts Centre, 2017, pp 2, 5.

[5] The lack of International Community political will to intervene and take casualties was seen in UN peace keeping missions to Somalia (1993), Rwanda (1993-94), the Balkans (1992-95), Rohingya (2017). www.UN.org

[6] UK MOD, "Strategic Trends Programme: Future Operating Environment 2035," Doctrine Concepts Centre, 2015, pp 17.

DISCUSSION

3. Background of RPAS. The use of RPAS on the battlefield is a concept that has gained significant traction over the previous two decades. Low and medium[7] altitude UAS came to prominence initially with Intelligence Surveillance Target Acquisition and Reconnaissance (ISTAR) platforms and later with an armed role in the Iraq and Afghan conflicts. These platforms have proven their value as force multipliers on the battlefield. With the recent explosion of commercial 'drone'[8] technology and decreasing risk appetite for battlefield casualties, UAS are primed for greater proliferation in the future battle-space.

4. The CAF does not possess a dedicated Aeromed VTOL aircraft. Other battlefield helicopters currently fulfill this function on an ad hoc basis dependent upon availability. This status is sub optimal in the longer term, as it means that air assets required for critical mission support tasks including air support, may be diverted at short notice for Aeromed. The development of dedicated medical VTOL RPAS would free up crewed assets for mission critical support tasks. CAF currently possesses only small tactical ISTAR UAS, no larger strategic assets such as Reaper. The use of RPAS in a medical context versus as a strike platform is a much better fit with Canadian ideals and values and as such is more likely to gain support and formal acceptance at the strategic level.

[7] The Predator RPAS was initially fielded by the USAF in 2002 and later variants (Reaper) were procured by other allied nations including the UK MOD. It was used extensively in the Iraq and Afghan conflicts.

[8] Mainly civilian term for remotely operated or autonomous unmanned air system. This term is not favoured by military organisations due to the implication there is no human in the loop.

5. Capability Development Status. This capability has been in development with the United States Army since 2012 and with the Israeli Defence Force (IDF) since 2008. They have both demonstrated proofs of concept with differing solutions for delivering lift. The US Army identified a capability gap in 2012 in their Initial Capabilities Document for Unmanned Systems as follows, "…the inability to safely diagnose, recover and transport casualties with en-route care from areas where manned systems are denied entry or [are] unavailable…"[9] As a result, the US Army Medical Research and Material Command's (USAMRMC) Telemedicine and Advanced Technology Research Centre (TATRC) has conducted research into the future use of unmanned systems for combat medical missions including "critical item resupply, casualty extraction, casualty evacuation and contaminated human remains recovery."[10] The latest prototype released in 2016, is the DP-14 Hawk, a dual rotor UAS which looks like a miniaturized Chinook helicopter. It has a patient compartment of around 6 feet with a 430lb payload and can fit in the back of a long wheelbase utility van (~10 foot).[11] There are still significant cultural challenges to overcome in terms of acceptance of the transport of critically ill patients in unmanned aircraft, however as a proof of concept this capability has demonstrated great potential.

6. The IDF has also been developing UAS for operations in urban and other environments that would be prohibitive for traditional helicopters. Their prototype, the Tactical Robotics AirMule, initially designed for search and rescue operations has a 1000lb, two-person transport

[9] Beebe, M, Lam, D, "Unmanned Aircraft Systems for Casualty Evacuation: What needs to be done," US Army TATRC, 2013, 4 *Accessed online 1 February 2018.*

[10] *Ibid,.*

[11] Dragonfly Pictures Inc 14 Hawk (DP-14 Hawk). DefenseTech, "Army Eyes Dual-Rotor Drone for Casualty-Evacuation," Military.com, 27 March 2017, Accessed online 1 February 2018. https://www.military.com/defensetech/2017/03/23/dp14-hawk

capacity.[12] The AirMule looks akin to a flying car and uses twin ducted fan, shielded rotor blades (encased within a circular housing) to protect the fragile blades from impact with buildings in confined spaces. This construct mitigates the constraints of traditional rotary wing systems, which cannot operate in close proximity to structures and require greater space for takeoff and landing. The IDFs capability development was driven by a requirement identified in the 2006 Lebanon war to extract casualties from heavily built up and contested areas.[13] The AirMule is designed to navigate narrow creeks, city streets, compact alleyways and refugee camp mazes. The manufacturer also claims the AirMule to be the only VTOL UAS that is compliant with the North Atlantic Treaty Organisation (NATO) UAS Casualty Evacuation standards as published in 2012.[14]

7. Other UAS Medical Capabilities. A separate area of civilian medical capability development which seeks to use UAS, albeit much smaller than the Aeromed variant discussed, is the delivery of medical supplies to remote locations. This concept is fairly advanced in Costa Rica where eight remote communities were due to start receiving regular medication deliveries from 2017 via a government-funded initiative.[15] Another civilian UAS application with great potential is in the emergency delivery of Automated External Defibrillator's (AED) for immediate response to cardiac arrest in urban as well as rural areas. One proposal from a

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[12] Gibbs, S, "Airmule drone ambulance makes maiden flight," *The Guardian*, 13 January 2016, Accessed online 31 January 2018. https://www.theguardian.com/technology/2016/jan/13/airmule-first-autonomous-ambulance-drone-takes-flight

[13] Swartz, K, "Compact Vertical Flight: Urban Aeronautics Advances," AHS International, Vertiflight, Jan/Feb 2018, 1, Accessed online 31 January 2018. http://www.tactical-robotics.com/userfiles/files/Press/UrbanAero_VF-JF18%2Bcover%2BIndex.pdf

[14] NATO, "Safe Ride Standards for Casualty Evacuation Using Unmanned Aerial Vehicles," Science & Technology Organisation Report, December 2012, Accessed online 1 February 2018. www.Sto.NATO.Int

[15] "Drones to Deliver Drugs in Remote Costa Rica," *Appropriate Technology* 43-4, 2016, 7.

University of Utah post graduate thesis is for the forward basing of AED carrying drones across a city grid to cut down on response times and through this, associated fatalities.[16] Centrally dispatched, these automated drones would fly towards the GPS signal emitted by the 911 caller's cell phone. Both of these applications have great potential for use on future operations both on humanitarian and high intensity war-fighting missions. Smaller utility aircraft could be paired with the larger Aeromed solution proposed as part of a suite of medical UAS providing a holistic, scalable capability.

8. Advantages / Benefits. There are numerous benefits to be derived from the development of this capability within the CAF, the principal of which are outlined below:

a. Risk reduction to air and medical crews in high-risk environments including high intensity warfare and natural disaster zones;

b. Casualty recovery in contaminated areas including Chemical Biological Radiological Nuclear (CBRN) high threat areas;

c. Casualty recovery in built up areas, which would otherwise prove non-permissive for standard military rotary wing due to building density and non-availability of adequate Helicopter Landing Sites (HLS); and

[16] Pulver, AT. "Locating Automated External Defibrillator Enabled Medical Drones to Reduce Response Times to Out-of-Hospital Cardiac Arrests," M.S., The University of Utah, 2017, 3.

d. Enhanced response time (due to dedicated assets and high threat environment access) and extraction of critically ill patients back to role three hospital for life saving treatment within the golden hour.[17]

9. Concept of Use - OOTW. For the purpose of this paper, the use cases proposed will be limited to Operations OOTW. However this could be expanded in further study to incorporate high intensity warfare as there is significant potential in that environment. VTOL RPAS can be designed in varying sizes, the smallest of which would accommodate only the casualty, their injuries having been stabilized for transport by the field medic. The RPAS size however could be scaled up to incorporate room for a medic to travel with critically wounded patients for example as with the IDF AirMule. It is advised that the use of autonomous UAS for Aeromed should only occur as an evolution to initial fielding of remotely human piloted systems. This is to allow the necessary cultural progression of legal, safety and human factors considerations of placing patients in unmanned transport.

10. Canada has a well-established history of involvement in Humanitarian and PSO, and SSE signals a continued commitment in this environment. The following use cases are proposed for the CAF future OOTW environment:

[17] In emergency medicine, the golden hour refers to the 1-hour window following trauma during which life saving treatment has the highest likelihood of success. Initially coined by Dr Adams Cowley in 1967 it has become the target response time for battlefield medevac by coalition nations.

a. Humanitarian Aid Disaster Relief (HADR). The compact nature of the proposed VTOL RPAS concept and the minimal remote crewing requirement make this solution ideally suited for rapid mobilization and inclusion within Disaster Assistance Response Team (DART) force packages. Recovery of wounded in high-risk environments such as mudslides, forest fires, earthquake or tsunami affected areas present unique threats for recovery by crewed rotary wing assets including Foreign Object Damage (FOD) and a lack of suitable landing sites. The risk of endangering further lives (air/med crew) could be mitigated and recovery times accelerated through the use of medevac RPAS. This capability could equally be expanded for used for CAF domestic support operations following resolution of existing cultural and legal constraints. Feasible applications for aid to the civil power tasks could include Search and Rescue (SAR), Aeromed support to fire and flood victims and cross governmental responses to terrorism and CBRN mass casualty events.

b. PSO. RPAS make an attractive solution for medevac, considering the aversion to acceptance of PSO casualties and the expectation that operations will increasingly take place in and around congested megacities. Dedicated HLS will not always be available and as such medevac assets may need to use small urban landing sites of opportunity. If in a contested area, rotary wing assets are at high risk of taking incoming fire when operating in dense urban areas. In this context the smaller, more agile VTOL RPAS would be uniquely suited with reduced rotor blade exclusion zones. Also as seen with the AirMule concept, an ability to navigate city streets to access casualties in situ would be a significant capability enhancement, increasing rates of extraction within the golden hour. Casualty recovery could therefore still take place without exposing further troops on

dangerous recovery missions and in environments for which traditional rotary wing assets would not receive flight authorization due to threats.

11. Challenges. There are a number of challenges most of which are non-technical in the legal, policy and doctrinal areas that must be overcome before a RPAS Aeromed capability can be effectively implemented in the future battle space. These include:

a. Cultural change to enable the acceptance of unmanned transport of trauma patients;

b. Continuity of care for wounded patients during transport;

c. Development of Canadian health and safety legislation to govern the transportation of military and civilian patients in RPAS;

d. Agreed NATO medical standards governing the transportation of casualties on RPAS to enable shared use of medevac assets by coalition / troop contributing nations; and

e. The development of coherent international treaties and individual nation / NATO doctrine and policies.[18]

[18] Beebe, M, Lam, D, "Unmanned Aircraft Systems for Casualty Evacuation: What needs to be done," US Army TATRC, 2013, 3. Accessed online 1 February 2018.

CONCLUSION

12. The proliferation of unmanned systems in the battlefield is a surety as western societies become increasingly intolerant of battlefield casualties, particularly on PSO. The anticipated future contested, congested battlefield with increasing operations in complex megacities presents an environment to which UAS are uniquely well suited. Canada remains committed to HADR and PSO missions in the medium term. The incorporation of VTOL RPAS medevac systems into the OOTW force mix would deliver a significant capability enhancement and the ability to rapidly deploy a medical capability at short notice, with minimal crewing constraints. A capability of this type is aligned with the Government's vision for Defence (SSE) and with Canadian societal ideals and values of providing assistance to those populations less able to help themselves. As such capability investment in this area is likely to be favourably received in terms of governmental and treasury approval. It would also allow Canada to make a valued contribution to future coalition or NATO operations in the medevac arena. There are as yet significant constraints in the technical and non-technical spheres, the most challenging of which exist in the cultural, legal and human-factors areas. The CAF should therefore seek involvement in cross governmental and international initiatives to address these challenges from a legal and doctrinal perspective now to ensure it is well situated to implement the capability once available.

RECOMMENDATION

13. Below are some recommendations to progress this capability development within the CAF.

a. That CAF commission a detailed capability investigation into the incorporation of VTOL RPAS medevac capability within its future medical procurement programme.

b. Develop a Government of Canada (GAC) working group to include defence and industrial partners to evolve the CAF doctrinal and legal position and to address wider societal preparedness for the acceptance of unmanned medevac capabilities.

c. Develop a coalition (5-Eyes) working group to begin addressing the necessary technological and non-technological challenges to the development and fielding of future RPAS Aeromed capabilities.

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