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FORMATION LEVEL**

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UNMANNED GROUND VEHICLES AS SENSOR SYSTEMS AT THE FORMATION LEVEL

AIM

1. The aim of this paper is to demonstrate to Director General Land Capability Development that integration of unmanned ground vehicles (UGV) as sensor systems would benefit formation level operations. This service paper provides reflection on incorporation of this technology toward successful adaptation to conduct Adaptive Dispersed Operations (ADO). It considers the role of this developing technology deployed at the operational level as a sense asset to aid in decision making and to produce precision lethality.

INTRODUCTION

2. The Canadian Army (CA) continues moving forward with the concepts outlined in *Advancing With Purpose: The Army Strategy 3rd edition* to remain combat-effective and multi-purpose. As part of the CA strategy, the Canadian Mechanised Brigade Group Headquarters (CMBG HQ) at formation level is responsible for the command and control of tactical assets to synchronize effects in combat.¹ As outlined in *Waypoint 2018*, as the CA enters the second build phase of the force employment concept, a key enabler to successfully conduct of ADO will be command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) capabilities.² As the CMBG HQ continues to adapt, more emphasis will be placed on C4ISR as the mechanism to enhance formation level command and control.³ In turn, focus must also be placed on the ability of the Brigade's (Bde) organic sense assets, particularly the

¹ Canada. Department of National Defence, B-GL-005-000/AC-001, *Advancing With Purpose: The Army Strategy 3rd Edition*. (Ottawa: Director Army Staff, 2014), 11.

² Canada, Department of National Defence, B-GL-300-000/AG-003 *Waypoint 2018: The Canadian Army Advancing Toward Land Operations 2021*. Kingston: Canadian Army Land Warfare Centre, 2015, 43.

³ *Waypoint 2018*, 65.

Armoured Reconnaissance Squadron (Armd Recce Sqn) and the Artillery Target Acquisition Battery (Arty TA Bty), to gather and interpret information necessary for commanders to plan and make critical decisions on how they will influence the battlespace.

3. Considering the issue within the context of risk mitigation and the expectation of precision effects that has been observed in recent conflict, the trend in land warfare will continue moving toward capabilities that provide remote functions. Technological innovation brought the inclusion of long range remote sensor suites in units that are organic to the formation level; including target acquisition radars, remote electro-optical and thermal imagery (EO/TI) sensor equipment and unattended ground sensors (UGS). As technology has improved the latest evolution has seen inclusion of Unmanned Aerial Vehicles (UAV) within Armd Recce Sqn and Arty TA Bty in the CMBG. As technology continues to evolve, the next natural progression is inclusion of UGV equipped with remote sensors.

DISCUSSION

4. The trend in ongoing conflict points toward asymmetrical attack, combatants intermixed with civilian populations and fighting in an urban landscape. Non-state actors are closing the technological gap and, although less likely, the prospect of conflict with a near-peer enemy remains a possibility for future land warfare. Experience in the Ukraine and Syria have exposed an ambiguous and unpredictable hybrid warfare environment that includes state and non-state actors.⁴ Operational success in this environment will depend on highly developed network capabilities to collect, process and disseminate information in order to enable smaller, mobile forces to react with precision. In the non-contiguous and dispersed ADO environment the CA

⁴ Robert Killebrew. "Good advice: Hybrid warfare demands an indirect approach." *Armed Forces Journal* 34:1 (June 2008).

must also recognize indicators to predict the requirement to mass and bring overwhelming firepower to bear on the enemy.⁵

5. Recent experimentation in Canada and among Allies has seen successful use of small, man-portable UGV in tactical urban operations.⁶ Dismounted military patrols have shown they are able to use a lightweight, portable remote vehicle to maneuver in the urban landscape helping to avoid ambush and inspect potential threats such as improvised explosive devices (IED). In this setting, the UGV has proven its worth in providing tactical decision makers with vital information before exposing soldiers to harm.⁷ These successes should certainly be built upon. As a result of proof of concept at the tactical level, additional thought should be given to the use of UGV to augment existing target acquisition and manoeuvre reconnaissance capabilities that are already present in the CMBG and responsive to the needs of the operational level commander.

6. Ongoing research into remote controlled weapons systems is extremely diverse ranging in size from 90 kg robots armed with small arms to tank sized robots with 30mm turret mounted main armament.⁸ For the purposes of this discussion the subject will be limited to UGV employed as remote controlled or semi-autonomous surveillance systems. Discussion will focus on the advantages and challenges of considering UGV within the existing concept of operation for medium weight forces. In considering incorporation of UGV as sensor systems at the

⁵ *Advancing with Purpose*, 15.

⁶ See Patrik Lif, Hans Jander and Jonathan Borgvall. "Tactical Evaluation of Unmanned Ground Vehicle Suring a MOUT Exercise" *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*, Linköping, Sweden: Swedish Defence Research Agency, 2006, 2557-2561. and D.L. Lynk, J.C.M Coulombe and R.R. Kollman. "Sensor Equipment and the Urban Battlespace" *The Canadian Army Journal*, 13.1, (2010): 12-34.

⁷ Lif, Jander and Borgvall, *Tactical Evaluation*, 2558.

⁸ Gary Martinic, "The Proliferation, Diversity and Utility of Ground-based Robotic Technologies" *Canadian Military Journal*, 14:4 (Autumn 2014): 50.

formation level the framework for discussion will be provided by the ‘Core Elements’⁹ of the Future Army:

- a. Knowledge Based,
- b. Strategically Relevant,
- c. Sustainable, and
- d. Tactically Decisive.

Knowledge Based

7. The CMBG HQ is the lowest command in the CA capable of fully integrating the effect of all arms teams and enablers.¹⁰ Sense is the fundamental enabler to command but increasing capacity to gain and distribute information is not a capability in itself.¹¹ Collection and fusion lead to information dominance, improved decision making and better responsiveness in synchronizing tactical actions. Recently information dominance at CMBG level has been realized through access to airborne or space based sensor systems that have changed the face of the battlefield providing significant advantage to the CA. The enemy has responded by dispersing and hiding among the population. The utility of overhead sensors is undeniable, but based on the evolution of enemy tactics, systems such as UAV will continue to need to be augmented by ground based sensors, particularly in complex terrain or to provide persistent surveillance across a non-contiguous Area of Operations (AO).

8. Simultaneous operations in a non-contiguous battlespace will severely tax existing ISR resources. Limited ISR is already competed for at varying levels, particularly in a joint inter-

⁹ Canada, Department of National Defence. *Future Force: Concepts for Future Army Capabilities*. Kingston: Director of Land Strategic Concepts, 2003, 182.

¹⁰ *Waypoint 2018*, 36.

¹¹ Mike Jackson, "The Future of Land Warfare." *RUSI Journal* (Royal United Services Institute for Defence Studies) 155:4 (Aug 2003): 57.

agency, multi-national coalition context. Persistent surveillance cannot be guaranteed with airborne sensors that are negatively impacted by weather and limitations on endurance. In ADO this means that commanders are blind to areas of the battlefield for periods of time.¹² UGV would provide a responsive, networked sensor working directly under the Bde to cover the gaps between AOs and maintain persistent surveillance in the Area of Interest (AI).¹³ Flexibility would be gained from mixing assets and providing depth for sensor mission tasking, coordination and re-tasking efforts in support of operations and planning or economy of effort for persistent tasks.¹⁴

Strategically Relevant

9. Resource limitations highlight the necessity for the CA to limit equipment purchases to systems that are relevant to all types of missions across the spectrum of operations. Surveillance technology has been proven to be employable in a range of tasks from peacetime military engagement to conflict. UGV simply represents an innovative way to deliver the sensor package to the AI and improve reach. Similar to UAV, UGV are rapidly deployable, agile and contribute to precision lethality against both near-peer and asymmetric threats. Multi-purpose in nature, the role of UGV is not limited to warfighting and could be employed as a Bde enabler in peace-support operations (PSO), stability operations or counter-insurgency operations (COIN).

10. Strategic relevance for the CA must also consider employability within a multi-national coalition. Done correctly, incorporation of UGV represents an opportunity to contribute to multi-national information sharing and dissemination through resource sharing and network

¹² *Future Force*, 71.

¹³ Department of National Defence, B-GL-310-001/AG-001 *Land Operations 2021: Adaptive Dispersed Operations The Force Employment concept for Canada's Army of Tomorrow*. Kingston: Director of Land Concepts and Design, 2007, 17.

¹⁴ *Ibid.*, 36.

compatibility. Use of UGV in the CA means bringing a technological capability to the multi-national AO that may be leveraged by Allies in an enabler sharing environment.¹⁵ Improving the CA capacity to share enablers and provide a meaningful contribution rather than being an enabler customer is an additional benefit.

Sustainable¹⁶

11. Upgrades to CA surveillance equipment must not impose undue strain on existing support and force generation lines of operation. To assure support for an initiative such as UGV, training, supply and maintenance chains must be minimally impacted. Distributed training and in service support similar to the model being used on the Raven UAV currently employed in Armd Recce Sqns and Arty TA Btys provides a model to be emulated in developing UGS capability.

12. Upgrades to surveillance equipment must not place additional burden on force employers. Imposing additional operational security constraints that would interfere with the ability of the Bde to conduct other sense tasks or to share information across multi-national lines must be avoided. Although within the capacity of existing technology, operational level use of UGV should carefully consider whether sensitive electronic warfare or signals intelligence technologies should form part of the sensor package. Although such equipment would help achieve the desired sense effect, the trade off in barriers on information sharing and the necessity to dedicate forces to protecting the sensor would preclude the system's full integration in a coalition environment or its use in missions with inherently higher risk. **Tactically Decisive**

¹⁵ *Waypoint 2018*, 18.

¹⁶ Within the context discussed in *Future Force*, sustainability includes both Army Sustainment (logistics and maintenance aspects) as well as Strategic Sustainability (long term impacts on force posture and readiness), see p. 184.

13. Tactical decisiveness rests on integration of CA capabilities in close combat to prevail in the battlespace.¹⁷ Collection, fusion and dissemination of information provide a continuously updated intelligence picture to decision makers to enable close combat. The characteristics of the tactically decisive CA are: lethality mobility, modularity and survivability.¹⁸

14. Lethality. Information dominance is central to integrating efforts toward precision lethal effects. Mixing sensors such as UGV with precision and multi-spectrum capabilities provides a collection method to cue attack assets. Adding UGV to existing force structures provides redundancy and capitalizes on Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) expertise. Adding range and accuracy to existing CA capabilities, increased use of remote sensors allows soldiers to be removed from the physical demands of information collection and more focussed on the tasks of target analysis. Under the right tactical conditions, interpreting available data at the lowest level helps speed the sense-shoot link and delivers precision lethal effects to the battlefield more quickly.

15. Mobility. Surveillance and patrolling UGV range in size and shape from 4x4 vehicles that are powerful enough to manoeuvre over difficult terrain to small vehicles the size of a remote controlled toy that are capable of gaining information in confined spaces. The only appreciable limitation to the mobility of UGV is power generation for mobility and sensor systems, however, once the system is emplaced a silent watch capability would greatly extend endurance. UGV grant freedom of movement in situations where the threat is assessed as too high to allow manned patrolling or vehicle movement.

¹⁷ *Ibid.*, 29

¹⁸ *Future Force*, 185.

16. UGV may be tasked to provide verification of contacts, to provide local force protection observation or to cover holes in a surveillance screen. UGV provide a resource to meet the needs of the commander in ADO by aiding in development of situations prior to contact and facilitating secure manoeuvre to positions of advantage. Employment of the UGS may be used to accomplish Route, Area, Point and Zone Reconnaissance (RAPZ) or Rear Area Security (RAS) tasks. Commanders would also have the option of using the UGV to conduct route reconnaissance, define obstacles and participate in patrolling.

17. Modularity. A task-tailored formation operating in complex terrain or during asymmetrical conflicts will require sophisticated sensor equipment alongside the ability to send skilled soldiers forward to visually verify information. To meet the mission-specific requirements to achieve information dominance several modular approaches could be adopted.

- a. Within the sensor system itself, modularity could provide different sensor configurations based on the nature of the observation task.
- b. Within the sub-unit agility is attained through tactical self-sufficiency and adaptations. Fluid force structures that allow attachment and detachment of troops or patrols provide a more dispersed sensor footprint on the battlefield and a method of providing sensor support to flanking formations and subordinate units.¹⁹
- c. Within the formation, employment of UGV in sub-units that already benefit from the use of battlefield radars, acoustic detection systems, UGS and UAV

¹⁹ Department of National Defence, B-GL-394-002/FP-001 *Reconnaissance and Surveillance Operations*. (Kingston: Canadian Army Doctrine Training Centre, 2004), 28-29.

capabilities provides added flexibility in sensor employment and deepens existing capabilities.

18. Survivability. The predominant threat to soldiers on operation will remain asymmetric or terrorist attack but may be supplanted by organized militia or warlord forces. Either may be supported directly or indirectly by state-actors. Characterized by nebulous organisation and aversion to concentrating forces, the enemy will hide his movement among the population. Reducing risk to CA soldiers in this environment requires persistent observation at the edges of secure bubbles within the AO. Combined with other collection efforts, constant patrolling and observation help deter asymmetric attackers and cue assets to pre-empt massing of more conventional forces.

19. As much as prevention is desirable, survivability is also a product of tactical overmatch created by knowing when and where to strike the enemy. UGVs offer a proven capability to forces operating in an urban environment and could be further developed to provide essential tactical information which would reduce risk to soldiers and allow them to develop the situation or manoeuvre to position of advantage before contact.²⁰ It is also recognized that there is a significant possibility that hostile forces could employ Chemical, Biological, Radiological or Nuclear (CBRN) weapons. UGV offers an effective solution to mitigate risk in maintaining observation in and around a contaminated area.

20. Like UGS, a key facet of planning for employment of UGV will be prevention of assets from compromise or capture. Use of passive sensors on a silent platform mitigates a great deal of risk of detection but does not eliminate it altogether. A range of options exist to prevent

²⁰ *Future Force*, 114.

compromise including anti-tamper counter-measures that disable sensitive equipment or limiting UGS mounted surveillance systems to commercially available technology that is less sensitive to exploitation if captured. Generally the counter-ISTAR threat will need to be considered in a similar manner as with employment of UGS and must include both coordinated response to neutralize a threat and acceptance of the risk that an unmanned system is subject to capture.

CONCLUSION

21. This paper set out to highlight the advantages in considering employment of UGV as an operational level sense asset. It reasoned that employment of UGV as a sensor platform that is organic to the CMBG will enable ADO by covering gaps between AOs, providing flexibility to augment traditional tasks with remote sensors and ultimately contributing to more persistent surveillance across the AI. To demonstrate this potential operating concept, employment of UGV at formation level was examined using the ‘Core Elements’ of the Future Army. To give a better understanding of the potential for success offered by UGV, examples of tactical use in urban settings and similarities between UGV and UAV were highlighted.

22. In order to stay ahead of the technology curve, further mitigate risk to soldiers and deliver lethal effect on the battlefield, the CA must continue to explore and develop technological tools that bring information to decision makers. Without a dedicated effort to experiment and incorporate developing technology, the CA runs the risk of being left behind and losing the ISTAR advantage enjoyed in recent conflicts. UGV offer a low-signature, network integrated, CBRN capable sensor asset which could be incorporated into existing structures, aiding in alignment of capabilities within the formation toward operations in the ADO context.²¹

²¹ *Waypoint 2018*, 65.

RECOMMENDATION

23. It is recommended that the CA consider developing a concept of operations for incorporation of UGV as sensor systems responsive to the formation level commander. Incorporation of this technology should begin with experimentation with equipment in both the Armd Recce Sqn and Arty TA Bty.

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