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Although the Canadian Armed Forces (CAF) has had a storied history, its experience in the conduct of large-scale operations has been limited since the first half of the 20th century. Whilst there have admittedly been limited large-scale conflict between two near-peer or peer-to-peer adversaries, Canada has arguably not partaken in a large-scale conflict since the Korean War in the 1950s. Despite this, developments within recent times, particularly the Russo-Ukrainian conflict and the growing tensions between China and the West, highlight the potential for and growing risk of a return to large-scale conflicts.

Within a large-scale conflict, the role and importance of the artillery will remain paramount as it has throughout history. In particular, the Royal Regiment of Canadian Artillery (RCA) will undoubtedly be called upon to provide the necessary fire support to support friendly ground forces in its maneuvers. As such, this paper will seek to examine the landscape of the modern operating environment, its impacts on the RCA and contend that it is ill suited for the challenges it is likely to face in a large-scale conflict. In doing so, it will also propose changes that may enable the artillery to remain relevant and potentially enhance its effectiveness in a modern large scale conflict.

Firepower Capabilities

Since the conclusion of the Second World War, the likeliest opponent within a large-scale for the West, and by extension Canada, has been Russia and its predecessor, the Soviet Union. Although the arms race that occurred during the Cold War has largely abated, Russia has continued to invest significantly in its military in order to modernize its equipment and tactics. Within the context of the artillery, Russia's continuing investment and interest in what it considers the "God of War" suggests that massed fires will remain a critical feature in a large-scale conflict.

The importance of artillery to the Russian military cannot be understated given the significance it holds within their doctrine. Whereas Western militaries view artillery as a tool to support maneuvers, the Russian military has continually adopted the view that maneuver supports artillery (Asymmetric Warfare Group [AWG], 2016, p. 21). As such, artillery is perceived as "the finishing arm for the Russian Army" and is utilized to "deliver devastating indirect fires, while maintaining standoff" until sufficient fires have been delivered and the ground force is required to maneuver "to secure time and space for indirect fire … platforms to begin the cycle again" (AWG, 2016, p. 21).

Such emphasis on the role of artillery has resulted in its continuing ability to "cover an area greater than $1km^2$ with fire" and "destroy entire mechanized battalions caught in the open in a manner of minutes" (AWG, 2016, p. 23; Gentile et al., 2017, p. 62). The integration of artillery and its emphasis may further be seen within the structure of Russia's brigades as each motorized rifle or tank brigade is augmented by four artillery battalions; two of which are howitzer battalions supplemented by an multiple launch rocket system (MLRS) battalion and an antitank artillery battalion (Grau & Bartles, 2018, p. 235). Such a structure stands in stark contrast to a Canadian mechanized brigade which sees the coupling of an artillery regiment of eight guns to the formation and as a result possesses substantially less firepower at its disposal; in turn, limiting its effectiveness in contrast to Russian artillery.

In contrast to Russian artillery's focus on increasing the weight of fire it may bear on its targets, Canada and other Western nations also appear to have found itself "wedded to the idea that precision fires that minimize risk of … collateral damage are the beginning and end of indirect support" (Morgan, 2018). Although such a focus undoubtedly stems from a decade focused primarily on COIN operations, in which minimizing collateral damage was critical to

success, it will also likely place us at a disadvantage in a near-peer conflict where an adversary may outgun us in terms of mass of fire, range and speed (Morgan, 2018). As Jacobson and Scales (2016) states, the emphasis on precision is likely to produce reduced effectiveness in a large-scale and high intensity conflict as:

> "the ability and opportunity to employ precision are premised on a world of low-intensity conflict. In high-intensity conflict defined by combined-arms maneuver, the employment of artillery based on a precise point on the ground becomes a much harder proposition, especially when the enemy commands large formations of moving, armored vehicles, as Russia does" (para. 2).

In light of the substantial differences in firepower available between Russian and Canadian units, any engagement in a large-scale conflict will likely see friendly forces significantly outgunned and subject to the devastating effects of Russian artillery. Although Canada and its allies have traditionally reduced the gap in firepower through its employment of air assets, as it has enjoyed the benefits of air superiority during its past conflicts, such a luxury likely will not be afforded in a large-scale conflict against a peer-to-peer adversary. In recognition of the reliance on air superiority within the West, Russia has significantly invested in its air defence capabilities and established an "intricate web of deadly anti-access/area denial weapon systems" that will limit the ability of an air force to engage targets (Morgan, 2018). As a result, most of the firepower available to Canada and its allies will likely be reduced to the capabilities it possesses on the surface.

UAS Integration and Counter-Battery Threats

In addition to the significant numerical and firepower advantages held by their artillery, the Russian military's growing usage and integration of unmanned aerial systems (UAS) and other surveillance and target acquisition equipment has further increased their effectiveness. The expansion of its use of both military and commercial off the shelf drones provides Russia with a multitude of sensors it may utilize to identify targets of opportunity and hostile artillery assets (AWG, 2016, p. 27). Such prolific usage of UAS coupled with the Russian artillery's ability to devote a number of assets for counter-battery fires poses a significant challenge to the RCA as "against adversaries such as the Russians, if you can be seen, you can be targeted; if you can be targeted, you can be hit; if you can be hit, you will be killed" (Gentile et al., 2017, p. 158). This integration of Russian UAS and artillery and its devastating effects may be seen in the 2014 Zelenopillya rocket attack as unmanned aerial vehicles located two Ukrainian brigades and subsequently utilized multiple launch rocket system (MLRS) rockets to destroy the units within the span of two to three minutes (Collins & Morgan, 2019, para. 1).

Irrespective of exactly how friendly artillery is detected, the equipment utilized by Russia ensures that a timer begins from the moment that the first round fired lands and when the gunline can expect to receive rounds in return. Given the rapid sensor to shooter link coupled with the massive firepower available to the Russian artillery, friendly artillery must remain constantly on the move as static positions are likely to result in the destruction of the guns (AWG, 2016, p. 27). As a result, friendly artillery must adopt measures such as dispersion and maneuver deployments in order to enhance its survivability. However, in doing so, friendly artillery must accept the tradeoff that constant motion may limit its ability to provide sufficient weights of fire. Given the extended duration of time required by towed artillery to move off its position and relocate, the amount of time it may remain static and engage may be severely limited.

Electronic Warfare Disruptions

In recognition of counter battery threats and the need for reduced response times for fires, the RCA has become increasingly reliant on technological aids such as the Global Positioning System (GPS) and Enhanced Position Location Reporting System (EPLRS). Although such efforts have proven highly beneficial in such respects, it also poses a new risk for which the RCA must recognize and respond.

Russia, in recognition of NATO's adoption of maneuver warfare and the growing reliance on technology, has already invested significant resources into its electronic warfare (EW) capabilities such that is now "capable of shutting down communications and signals across a broad spectrum" and possesses "a suite of platforms, each designed to counter a US communications capability" (AWG, 2016, p. 17). In addition to offensive capabilities that enable it to spoof GPS signals, jam UAS or intercept electronic signals to identify targets for its artillery, certain platforms also provide protection as it emits "an EW signal designed to overload electronic fuses on incoming fires" (AWG, 2016, p. 17-18). As a result, guided and electronic fuses may "detonate early or change course once they come in contact with one of the EW bubbles" which may significantly reduce the usability of ammunition currently relied upon by the RCA such as precision guidance kit or C32A1 fuzes (AWG, 2016, p. 18).

A similar emphasis on EW capabilities may be seen in the East given the Chinese military's investments into the same domain. In response to the growing reliance and usage of technology, the PLA has deemed EW to be "an integral component of modern warfare" and has developed a strategy that emphasizes reducing its enemy's abilities to utilize the full spectrum of frequencies as well as its computer and information systems (Office of the Secretary of Defense [OSD], 2021, p. 87). Such developments may already be seen in practice as the PLA's EW units

"routinely train to conduct jamming and anti-jamming operations against multiple communications and radar systems and GPS satellite systems during force-on-force exercises" (OSD, 2021, p. 87). In light of the growing tensions between China and the West and the reality that its leaders have increasingly pushed for its military to "think about how it will operate beyond China's borders and its immediate periphery to advance and defence these [foreign] interests," the potential that the RCA is required to operate in an environment dominated by significant EW interference is significant (OSD, 2021, p. 127).

As a result, the RCA must prepare to conduct its duties within environments that suppress or deny the technological tools it has traditionally relied upon to enhance its response to calls for fire. Furthermore, gunners must remain cognizant that reliance of technological tools such as GPS may not provide the accurate information that it generally provides.

Artillery Operations in Urban Environments

In 2017, approximately 55% of the world's population resided in urban areas with the figures likely to increase to 66% by 2050 (Ministry of Defence [MoD], 2018, p. 64). As a result, the number of megacities, defined as urban areas with a population greater than ten million, is expected to increase to forty-one by 2030 and 50 by 2050 (MoD, 2018, p. 65). Given that the growing number of urban areas is likely to limit one's ability to simply bypass it, coupled with the reality that adversaries are likely to utilize complex environments such as cities to limit technological advantages, it is increasingly likely that a future large-scale conflict will require the RCA to operate within large built-up areas; a task that it is ill suited for at this time.

The usage of artillery within urban environments (UE) is not a novel concept particularly as evidenced by its employment during the Battle of Grozny. In that instance, Russian artillery

was utilized to establish a perimeter around the city and was also utilized in a direct fire capacity, often within ranges of 150-200m, as the main guns of its armoured vehicles were incapable of engaging targets within the upper floors of buildings (Department of National Defence [DND], 2006, p. 21). Given the limited elevation available on the LAV 6 and Leopard 2A6, it is not beyond the realm of possibility that Canadian artillery may be called into a similar role.

Despite this realm of growing likelihood, much of Canadian and NATO doctrine and training remains focused on operations within open fields as opposed to the growing number of built-up areas (North Atlantic Treaty Organization [NATO] Research and Technology Organization, 2003, p. 9). It should be noted that Canadian doctrinal publications on urban operations do exist, albeit largely copied from US doctrine, in the form of B-GL-322-007/FP-001 Unique Operations – Urban and its sister publication B-GL-322-008/FP-001 Unique Operations – A Tactical Guide to Urban Operations. However, and despite the unique considerations and challenges identified, limited references to it and training based upon the publications exist within the RCA. As a result, leaders and gunners are arguably ill prepared for the differences in demands required during artillery operations within urban settings in contrast to the open terrain that is often utilized for training. Whether it involves differences in deployment of the guns, preparation for a local defence battle, or simply securing the immediate gun area, minimal training and considerations are provided to gunners ahead of time.

In spite of its limited usage, important insights may still be gleaned from the publications as it highlights the limited preparedness of the RCA for the duties it may be called upon within urban operations. As B-GL-322-008/FP-001 highlights, “weapons of at least 155 mm are required against thick reinforced concrete, stone or brick walls” (DND, 2010, p. 4-23). Given

that the RCA possesses limited quantities of the 155 mm M777 howitzer, its ability to provide the fire support required to penetrate and destroy buildings is, in turn, extremely limited.

Beyond the limited quantities of fire assets available to assist in the conduct of urban operations, the M777 in itself poses significant deficiencies that limit its ability to be utilized. Given that the howitzer is a towed artillery piece and requires a gun tractor for movement, its employability within built-up areas is significantly limited as its long length and large turn radius poses a major complication on its maneuverability. The lack of armour and protection within the existing equipment further complicates matters as the exposed nature of the gun results in increased risk of detachment members to the effects of enemy fires.

Addressing the Capability Gaps

In light of the threats posed by contemporary adversaries and the limited match of the RCA's equipment and training for operations in a large-scale conflict, existing capability gaps should be addressed. Perhaps the simplest, and undoubtedly the most cost prohibitive, solution to many of the challenges faced by the RCA is to literally retool and adopt self-propelled guns (SPGs) or MLRS.

Self-propelled artillery provides many advantages over towed artillery such as a level of mobility that is difficult, if not impossible to match, which would reduce the threat of counter battery. In addition, the ability of modern SPGs to conduct multiple round simultaneous impact missions would increase the weight of fire that the RCA can deliver from the same number of systems prior to its detection. Given many of these systems require substantially less crew members per gun, the RCA could also increase its ability to mass fires as whole even further as its detachments may be dispersed to man more systems. The inclusion of armour compared to the

M777 would also increase the artillery's ability to operate within closer engagements without exposing detachments members to small arms fires and other effects. Irrespective of the specific system that is ultimately adopted, one certainty is that it must be a fully digitized platform that includes an integrated and networked sensor-shooter link so that technological aids such as EPLRS can continue to be utilized to reduce threats of counter battery and increase the speed at which fires may be provided.

In the absence of the ability to procure modern self-propelled artillery, additional tools and equipment may be implemented to enhance the RCA's ability to operate in certain environments encountered in a large-scale conflict. For example, new munitions based off air force ordnance designs such as the BLU-129/B, a low collateral damage bomb, may be explored to increase the artillery's utility within urban environments whilst maintaining a reduced risk of fratricide or undue harm to civilians. Given the ordnance is made of a carbon-fiber bomb body that disintegrates rather than fragmenting, while providing sufficient explosive force and overpressure to eliminate hostiles, its implementation in artillery rounds would increase the suitability of artillery to engage more liberally within an urban setting (Aerojet Rocketdyne, n.d., para. 2). Despite the potential implementation of such tools, the RCA must simultaneously remember that it cannot remain wedded to the concept of precision and low collateral munitions as it is ultimately an area of effect weapon. As such, the RCA and its guns must maintain a balanced mix of precision and area munitions so that it maintains a degree of flexibility and remains relevant across a spectrum of operating environments.

Beyond the realm of new equipment and ammunition, training must further emphasize the potential for disrupted communications within a technologically denied environment and prepare soldiers to operate without the aid of technology. Simultaneously, the RCA and CAF

must continue to pursue full integration of digital fire systems such as EPLRS and further explore, develop and invest in its ability to withstand and respond rapidly to cyber or electronic attacks that seek to degrade our abilities. Although the RCA has taken great strides in recognizing the counter battery threat posed by likely adversaries, the need to move quickly following an engagement and the importance of equipment such as EPLRS to facilitate dispersion, greater implementation must continue at all levels to ensure the guns remain on a position for as minimal time as possible. Furthermore, training should begin to educate and prepare gunners for the growing possibility that they may be required to operate in urban environments and the differing challenges and considerations that will arise from it. In doing so, the RCA can better prepare its soldiers overall to meet the demands and challenges it is likely to face within a near-peer or peer-to-peer conflict.

Conclusion

In the aftermath of the 9/11 terrorist attacks, the CAF became committed to the conduct of COIN operations and operating against a technologically inferior enemy within the confines of limited large-scale engagements. In light of the growing instability and changes within the geopolitical landscape however, the CAF and RCA must re-shift its focus on and prepare for a potential return to large scale conflicts with a near-peer or peer-to-peer adversary. The RCA in particular must identify solutions that will enable it to effectively operate in the face of the threats and challenges posed by adversaries such as Russia and China who have heavily invested in their capabilities. The reality that the Canadian artillery is ill suited to conduct certain operations and engage against peer-to-peer foes must be recognized so that relevant changes may be developed. In doing so, the RCA will better prepare itself for a potential return to large-scale conflict before it learns its lesson via the loss of its guns and personnel.

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