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Scientific Letter

On the Canadian Army Infantry Anti-Armour Capability

Aim

This Scientific Letter provides the details and results of the FUSILIER RECIPROQUE exercise held at Canadian Forces Base (CFB) Petawawa on 12–14 April 2016. This exercise was designed to test the current infantry anti-armour capability when air support and Main Battle Tank (MBT) support are not available. The results of the exercise confirm that a significant anti-armour capability gap exists within the Canadian Army (CA).

Background

The possibility of anti-armour engagements exists through a spectrum of operations, from stability or peace support operations to major combat operations [1]. Anti-armour combat is based on a layered defence approach: long range engagements of enemy armoured forces are made possible by attack aircraft and long range indirect fires. At medium range, MBTs and artillery can be used, as well as infantry fielded medium range anti-armour missile systems. At close range, anti-armour combat becomes the sole responsibility of the infantry [2].

The current CA approach to anti-armour combat is based on the assumptions that the infantry will always be supported by MBTs, considered to be the best anti-armour systems, and that air support will always be present to deal with any armour threat [1, 3]. These two assumptions are a result of decades of NATO supremacy [3] and might no longer always be valid due to the rise of near-peer adversaries and the prevalence of asymmetric warfare in multiple conflict zones. An infantry company facing a near-peer enemy having comparable fighting capabilities could find itself separated from any MBT support and unable to receive air support due to the enemy's ability to prevent the friendly forces from achieving air superiority [2–3]. A similar situation could happen during asymmetric engagements where enemies could have access to armoured vehicles and the dispersion of friendly troops could lead to isolated infantry facing an armoured threat without timely air support [1].

Without support from MBTs and air assets, the task to stop enemy armoured vehicles falls to the infantry and an organic infantry anti-armour capability becomes essential to mission success. Recent publications argued that the current CA infantry anti-armour capability is deficient and unable to face modern armoured threats [1–4]. To test this assertion, the exercise FUSILIER RECIPROQUE was held to assess the current CA infantry anti-armour capability under controlled conditions. This Scientific Letter documents the details and results of this exercise and provides lessons learned and recommendations.

Exercise Design

Hypothesis

The exercise FUSILIER RECIPROQUE was designed to test the following hypothesis: a CA dismounted infantry company is capable of defeating an enemy force equipped with modern MBTs during defensive operations with a ratio of 1 (friendly) to 3 (enemy), without support from MBTs or air assets [5].

Location

The exercise was held in the infantry training area of CFB Petawawa. The anti-armour engagements took place in two different environments: a small village provided an urban environment, while the approaches to this village provided a terrain characterized by a mix of forests, open areas covered in shrubs with good visibility and small hills. A total of eight iterations were conducted over the 3-day exercise. Five iterations involved operations in both the forest approaches to the village and the village itself. Two iterations were conducted solely in the forest approaches and one iteration was based solely in the village.

Troops

The defending infantry forces involved Company B of the 2nd Battalion of the Royal 22e Régiment and a Tube Launched, Optically Tracked, Wire-command Link Missile System (TOW) detachment from the 1st Battalion of the Royal 22e Régiment. The enemy armoured forces were provided by seven Light Armoured Vehicles (LAV) from the 1st Battalion of the Royal Canadian Regiment representing modern MBTs assumed to be T80s.

Data Collection

Both qualitative and quantitative data were collected during the exercise. Qualitative data were obtained through observations and after-action discussions held at the completion of each iteration and involving the infantry Tank Hunting Teams (THT), the enemy forces and representatives from Exercise Control (EXCON). Quantitative data were collected through engagement results focusing on the survival rate of the THTs and the success rate of the anti-armour engagements. An exercise logbook was kept by EXCON and documented most of the exercise events chronologically. In addition to the data collected during the exercise, the CFB Valcartier Small Arms Training Simulator (SATS) was used prior to the exercise to generate simulated unclassified hit probabilities of different anti-armour weapon systems against static and mobile targets [5].

Weapons

The FUSILIER RECIPROQUE exercise focused on the anti-armour capability of a dismounted infantry company. As such, three weapon systems currently fielded by the infantry were the primary weapons used during the exercise: the medium range TOW system, and the short range M72 and 84 mm Carl Gustav weapon systems. A detailed review of all anti-armour weapons available to the CA can be found in [1]. Additional information on each weapon system used during FUSILIER RECIPROQUE and details of the performance estimation process for each system are provided in Annex A.

Two additional anti-armour weapons, the C14 command detonated, rocket-propelled anti-tank weapon and magnetic anti-tank mines were also introduced during the later iterations of the exercise to evaluate their impact on the efficiency of the defending forces.

Conduct of the Exercise

Throughout the exercise, the dismounted infantry was composed of an infantry company made of three rifle platoons and augmented with one TOW platoon equipped with All-Terrain Vehicles (ATV) and open trailers. The defending infantry was given the objective to defend the village and prevent its seizure by the enemy. The defending troops were operating in THTs and were divided into covering forces with a destroy task on the approaches to the village and a main defensive force with an interdict task located in the village [5]. Success would be achieved if the enemy tank battalion was degraded to 25% or less of its original strength, effectively being incapacitated and no longer able to seize the village.

The enemy armoured forces were composed of a mechanized battalion of MBTs and in some cases heavy Infantry Fighting Vehicle (IFVs), both of which were supported by dismounted infantry. To represent the armoured battalion, seven LAVs were used as stand-ins. Having only seven vehicles to represent a battalion, if an armoured vehicle was destroyed, it would be reintroduced in the battle after a few minutes to simulate a larger number of enemy vehicles. For each iteration, the enemy conducted an offensive operation towards the village with hasty and deliberate attacks [5]. The enemy forces would achieve success if they seized the village within two hours, which included the time to reach the village through the forest approaches.

EXCON was located in the village and adjudicated all engagements. To facilitate this process, referees were attached to each THT and to each armoured vehicle. When an engagement happened, the referee attached to the troops having initiated the engagement would communicate with EXCON the result of the engagement and this information would then be shared by EXCON to the relevant referees of the opposing force informing them that they had been engaged and providing them the result of the engagement.

The enemy armoured forces engaged the friendly forces when they were detected and the assumption was made that if a THT was observed and engaged by the enemy, it would automatically be destroyed and removed from the iteration. Furthermore, if a THT engaged the armoured forces, it was given 10 seconds to retreat after having fired at the enemy. If the THT took more than 10 seconds to leave its position, it would be considered destroyed. This condition was introduced for greater realism as after having engaged a specific vehicle, the THT position becomes compromised and the remaining enemy forces can quickly locate and engage the THT.

The defending THT also engaged the enemy once it was observed. If the TOW system was used, the assumption was made that a catastrophic kill (i.e., complete destruction of the enemy vehicle) would be the result of the engagement if the target was tracked during the entire missile flight time. If the M72 or the Carl Gustav were used, the results of the engagements were randomly generated based on the hit probabilities provided in Tables 2 and 3 in Annex A. Based on these probabilities, random tables of engagement results were generated and provided to the referees accompanying the THT. For each engagement, the referee would obtain the result of the attack from the random table based on the weapon used, the state of the target (mobile or static) and the range at which the target was engaged. An example of such a table is provided in Table 4 in Annex A. In the case of the M72, given its limited capability against modern armoured vehicles, it was assumed that only a mobility kill would be possible if an enemy vehicle was hit (i.e., the vehicle would no longer be able to manoeuver, but would still be able to fire its main gun). In the case of the Carl Gustav, an additional engagement outcome, a turret kill, was introduced in which the damaged enemy vehicle could still manoeuver but without the ability to fire its main gun. Given a hit by a Carl Gustav, it was assumed that a catastrophic kill would occur in 50% of the cases and a turret or mobility kill would each occur in 25% of the cases.

Results

In all six urban iterations, the enemy armoured battalion was not depleted significantly and successfully seized the village. This result invalidates the original hypothesis postulating that a CA dismounted infantry company is capable of defeating an enemy force equipped with modern MBTs during defensive operations without support from MBTs or air assets.

Throughout all eight iterations conducted during exercise FUSILIER RECIPROQUE, the TOW system and the Carl Gustav were the primary weapons used by the defending forces as the M72 was never used against the enemy, defending troops knowing its limited capabilities. Table 1 summarizes the THT survival rates after an engagement and the hit rates for the TOW system and the Carl Gustav depending on the environment where they were used. When both environments (forest and village) are considered together, both the TOW system and the Carl Gustav achieved high hit rates making them capable anti-armour weapons able to defeat the enemy. The THTs equipped with the TOW system had a higher survival rate (73%) than the THTs using the Carl Gustav (53%). This is due to the longer engagement range of the TOW system allowing the defending troops to be less easily seen by the enemy and giving them more time to retreat. Most engagements with the Carl Gustav were at close range between 100 m and 150 m to maximize the probability of destroying the enemy but severely limiting the ability of the THTs to retreat successfully.

The THTs equipped with the TOW system achieved significantly higher survival rate and hit rate when attacking the enemy in the urban environment compared to the forest approaches to the village. This was due to the range of the TOW system allowing the THT to be well camouflaged on the outskirts of the village and attacking the enemy once it was distracted by the urban fight with dismounted infantry.

The THTs using the 84 mm Carl Gustav achieved a higher hit rate when facing the enemy inside the village due to the shorter engagement ranges. This however came at a significant cost, the THT survival rate being significantly lower in the urban environment (46%) compared to the less exposed forest approaches (75%).

Starting at the sixth iteration, additional anti-armour weapons were introduced to support the defending forces: the C14 command detonated, rocket-propelled anti-tank weapon and magnetic anti-tank mines. The C14 was only used during the sixth iteration, while anti-tank mines were used for the remaining three iterations. These additional weapons increased the anti-armour capability of the defending forces and were responsible for the destruction of a few enemy vehicles. Anti-tank mines proved especially useful in the urban environment to interdict streets and funnel the enemy towards the THTs. These results are however anecdotal and more iterations with these additional weapons would be needed to accurately quantify their impact on the battlefield.

Table 1: *Exercise FUSILIER RECIPROQUE results: the THT survival rates are based on a successful withdrawal within 10 seconds, the hit rates are over all ranges and do not differentiate between mobility, turret and catastrophic kills.*

	Weapon	Number of Engagements	THT Survival Rate	Hit Rate
Urban Environment	TOW	4	100%	100%
	84 mm	13	46%	100%
Forest Environment	TOW	7	57%	71%
	84 mm	4	75%	75%
Combined Environments	TOW	11	73%	82%
	84 mm	17	53%	94%

Lessons Learned

The exercise FUSILIER RECIPROQUE yielded valuable observations and lessons learned related to both infantry anti-armour combat and exercise design. These lessons learned are documented below for completeness and to support the development and further testing of the CA infantry anti-armour capability.

On Infantry Anti-Armour Combat

Tactics

In the absence of support from MBTs and air assets, a CA infantry company is insufficient to defend a small village against a battalion of armoured vehicles. A significant anti-armour capability gap therefore exists within the CA.

The most adequate tactic to stop an enemy armoured battalion trying to seize a village is to create the conditions allowing the infantry company to engage the enemy as far away from the village as possible conducting a mobile defence and engaging the enemy column multiple times before its arrival to the village to maximize its casualties.

It was observed during FUSILIER RECIPROQUE that some of the terrain leading to the village was not favorable to the TOW system. Small bushes could entangle the guidance cable and the rolling hills created tracking difficulties as the enemy could quickly disappear behind the hills as it moved.

In the forest zones leading to the village, a platoon might be responsible for a large area making it difficult to always find the enemy. This is compounded by the fact that the enemy can move fast and rapidly cross an area undetected. Therefore, over a large area, coordination between THTs is crucial to identify the enemy position and maximize the number of engagements. Tactically, the use of a screen to locate the enemy armoured column can have a significant impact.

During the enemy approach towards the village, open ground should not be dismissed as it can still be used to hide and observe the enemy to provide increased situational awareness to the THTs waiting to engage in covered areas.

Upon reaching an urban environment, an armoured enemy battalion dismounts and disperses in the village. As such, the anti-armour engagement turns into an infantry battle. During the iterations in the village, the enemy would dismount and wait for its infantry to clear the village before moving the armoured vehicles deeper in the village. It was suggested that at least two platoons would be needed for urban combat in a small village to deal with an armoured threat: one platoon to engage the dismounted infantry and the other to engage the armoured vehicles.

In an urban environment, the probability of survival of a THT depends on the configuration of the village or city. The village used during FUSILIER RECIPROQUE was a small village with very few roads. A larger city would have houses hidden from view, taller buildings, and the enemy would not be able to see if all the streets are passable or not. This would be beneficial for THTs by providing a tactical advantage and increasing their survival rate.

Weapons

In the context of this exercise, the TOW system proved to be a very capable weapon. It is believed that the recent fielding of the TOW system to the CA infantry constitutes a positive measure as previously argued in [6]. It must be emphasized that the TOW system in its dismounted configuration is cumbersome and highly vulnerable [3]. It should therefore be mounted on a mobile platform or be limited to tactical situations where mobility is not critical.

THTs equipped with the Carl Gustav have overall a low probability of survival due to the need to engage the enemy at very short range. This situation could be improved by acquiring new anti-armour weapons having a larger engagement range.

During an anti-armour battle within an urban environment, the Carl Gustav can be difficult to manage inside a building due to the weapon's back blast. The Carl Gustav is easier to use in open environments.

Currently, the C14 can only be used by engineers. It is believed that this anti-armour weapon should be assigned to the infantry for maximum impact. The C14 being remotely operated can increase the probability of survival of the THTs.

On Exercise Design

A sufficient number of referees needs to be used to account for all engagements during an anti-armour exercise. In some instances during FUSILIER RECIPROQUE, no referees were attached to some THTs and therefore no information could be relayed if they were engaged or if they engaged the enemy.

It sometimes proved difficult to pass the information from EXCON to the referees attached to the enemy to let them know that the vehicle they were in was being engaged. The time delay between the attack being communicated to EXCON and the results being relayed to the enemy target resulted in cases where the enemy kept advancing even if the result of the attack was a catastrophic or mobility kill.

Accurate and complete log keeping is important to record the details of all the engagements and obtain relevant statistics. This however can be difficult due to the fast pace and inherent confusion of military engagements.

In some instances, the enemy could not see from where they were being engaged as the anti-armour weapons did not make noise or create smoke. The use of pyrotechnics would solve this issue and provide increased realism.

In an urban environment, armoured vehicles must operate with their hatch down as would be the case under real combat conditions. This is needed to replicate the limited situational awareness resulting from an armoured vehicle operating with its hatch closed.

During engagements, destroyed or immobilized vehicles need to be left in place to create realistic obstructions impeding the progress of the armoured column and creating engagement opportunities for the THTs.

Conclusions

The evidence collected during exercise FUSILIER RECIPROQUE confirms that a significant CA infantry anti-armour capability gap exists, as was previously argued in [1–4]. Without support from MBTs or air assets, an infantry company cannot defeat an enemy force equipped with modern MBTs during defensive operations with a ratio of 1 (friendly) to 3 (enemy). The lessons learned during the exercise also support previous recommendations provided in [1–4, 6] and addressing this capability gap. Based on the observations and data collected during FUSILIER RECIPROQUE, this report recommends the following:

1) The current CA short range anti-armour weapons need to be upgraded or replaced by more modern and effective weapon systems. In particular, the M72 should be phased out and the Carl Gustav should be maintained until a better replacement is identified.

2) The survival rate of THTs can be improved by increasing the infantry capability to engage an armoured opponent at medium range. This can be achieved by acquiring new portable medium-range weapon systems covering the 500–1500 m gap.

3) Additional weapon systems such as the C14 and magnetic anti-tank mines have the potential to significantly increase the CA infantry anti-armour capability. As such, it is believed that the C14 should be assigned to the infantry for maximum impact.

4) In addition to upgraded or new anti-armour weapon systems, dedicated anti-armour tactical training at the company and platoon levels is necessary to ensure readiness and close the existing capability gap.

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Annex A Anti-Armour Weapon Systems - Supplementary Information

For completeness, this Annex provides additional information on the anti-armour weapon systems used during the FUSILIER RECIPROQUE exercise.

TOW missile system

The TOW missile system (Tube launched, Optically tracked, Wire-command link) has been in service within the CA since 1975. It is a medium range weapon with a maximum range of 3750 m. The TOW is a Semi-Automatic Command to Line-Of-Sight (SACLOS) system, meaning that the TOW gunner must maintain his reticule on target throughout the missile flight to successfully hit the target [1]. The TOW has proven to be an effective weapon against MBTs [1]. However, because of its weight (launcher: 111.5 kg, missiles: 21 to 23 kg each) the TOW system cannot be carried for long distances by dismounted infantry and is mostly used in static defensive positions. The future of the TOW system in the CA is currently unclear as new concepts of employment are being considered [2, 6]. For the purpose of the FUSILIER RECIPROQUE exercise, it was assumed that the TOW would achieve a 100% hit probability if the target was tracked during the entire flight time. A miss would happen if at any point tracking was lost. The missile flight time was estimated by the THT based on the range to target.

M72

The M72 is a lightweight (3.45 kg) anti-armour rocket launcher system having an effective range of 150 m and using an unguided projectile [1]. The M72 is used in the CA, but mainly by soldiers not equipped with the 84 mm Carl Gustav. The M72's anti-armour destructive capability is limited to older Infantry Fighting Vehicles (IFV) and is considered ineffective against the most modern MBTs and IFVs. As such, the M72 is no longer viewed by the CA as an effective anti-armour weapon [1]. Nonetheless, as this weapon is still in service, it was included in the FUSILIER RECIPROQUE exercise. Simulated unclassified probabilities of hitting a static or mobile target with an M72 at various ranges were estimated prior to the exercise by THTs of Company A of the 2nd Battalion of the Royal 22e Régiment. The CFB Valcartier Small Arms Training Simulator (SATS) was used to simulate multiple engagements against generic unclassified targets and estimate the hit probabilities. These hit probabilities and their associated standard deviations [7] are provided in Table 2. To note, to ensure that the data remained unclassified, the aspect of the target (i.e., the angle at which the target was presenting itself) and the target type (i.e., generic MBTs, IFVs and trucks) were not considered during the data collection and therefore the hit probabilities are averaged over all possible aspects of a target and over all target types used. Also, no real ammunition was used and the trajectories of the projectiles were computer generated under optimal conditions. Furthermore, the impact of stress and fatigue was not considered during the estimation of the hit probabilities. As such, these unclassified probabilities represent an averaged best-case scenario and are likely higher than would be observed under realistic fighting conditions.

Table 2: *Averaged unclassified hit probabilities and associated standard deviations for the M72 against static and mobile targets at various ranges (each probability estimate for a given range and type of target is based on 310 simulated engagements and averaged over the target aspect angles and target types).*

M72				
Distance (m)	Static Target		Mobile Target	
	Hit Probability Estimate	Hit Probability Standard Deviation	Hit Probability Estimate	Hit Probability Standard Deviation
50	95%	1.3%	89%	1.7%
100	97%	0.9%	95%	1.2%
150	99%	0.6%	92%	1.6%
200	97%	1.0%	95%	1.3%
250	95%	1.2%	87%	1.9%

84 mm Carl Gustav

The 84 mm Carl Gustav is a lightweight (15 kg) two-person anti-armour tube artillery able to defeat MBTs [1]. The maximum range of the Carl Gustav is 700 m and its projectile is unguided. Its effective range is considered to be 500 m against a static target and 400 m against a moving target [2]. This weapon system is currently in service and constitutes the CA infantry primary anti-armour capability. Currently, an infantry company is assigned four Carl Gustavs. As was the case for the M72, the unclassified hit probabilities at various ranges against static or mobile targets for the Carl Gustav were estimated through repeated simulated engagements with the SATS. The hit probabilities for the Carl Gustav are summarized in Table 3.

Random engagement results

If the M72 or the Carl Gustav were used, the results of the engagements were randomly generated based on the hit probabilities provided in Tables 2 and 3. Based on these probabilities, random tables of engagement results were generated and provided to the referees accompanying the THT. For each engagement, the referee would obtain the result of the attack from the random table based on the weapon used, the state of the target (mobile or static) and the range at which the target was engaged. An example of such a table is provided in Table 4 for a Carl Gustav used against a static target.

Table 3: *Averaged unclassified hit probabilities and associated standard deviations for the 84 mm Carl Gustav against static and mobile targets at various ranges (each probability estimate for a given range and a static target is based on 310 simulated engagements, each probability estimate for a given range and a mobile target is based on 210 simulated engagements, all probability estimates are averaged over the target aspect angles and target types).*

84 mm Carl Gustav				
Distance (m)	Static Target		Mobile Target	
	Hit Probability Estimate	Hit Probability Standard Deviation	Hit Probability Estimate	Hit Probability Standard Deviation
50	96%	1.1%	82%	2.7%
100	94%	1.3%	92%	1.8%
150	92%	1.5%	75%	3.0%
200	87%	1.9%	73%	3.1%
250	77%	2.4%	71%	3.1%
300	58%	2.8%	54%	3.4%
400	67%	2.7%	53%	3.4%
500	60%	2.8%	50%	3.5%
600	47%	2.8%	29%	3.1%
700	32%	2.7%	19%	2.7%

Table 4: *Example of a randomly generated table of engagement results for a THT equipped with a 84 mm Carl Gustav and targeting a static target at various ranges (MS: miss, MK: mobility kill, TK: turret kill, CK: catastrophic kill).*

84 mm Carl Gustav, Static Target

	Engagements				
Distance (m)	1	2	3	4	5
50	MK	CK	CK	MK	MK
100	TK	CK	CK	TK	MK
150	CK	CK	MK	TK	TK
200	TK	TK	MS	TK	TK
250	TK	TK	CK	TK	CK
300	MS	TK	CK	MS	TK
400	MS	MK	TK	MK	MS
500	MK	MS	MS	MS	MS
600	CK	MS	MS	CK	MS
700	MS	MS	MS	CK	MS