Loitering Munitions

The Soldiers' Hand Held Cruise Missiles

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Loitering munitions (LMs) are low-cost guided precision munitions which can be maintained in a holding pattern in the air for a certain time and rapidly attack, land or sea, non-line-of-sight (NLOS) targets. LMs are under the control of an operator who sees a real-time image of the target and its surrounding area, giving the capacity to control the exact time, attitude and direction of the attack of a static, re-locatable or moving target, including providing a contribution to the formal target identification and confirmation process[1].

Whether labelled as hand held cruise missiles, pocket artillery or miniature air force, loitering munitions will be – and in some instances already are – part of the toolbox of the modern warfighter. This is a logical add-on to the way unmanned systems are becoming preponderant in contemporary warfare.

There is no need to demonstrate any longer the fact that unmanned systems[2] are part of the everyday life of the warfighter, whether in the air, on the ground, and above or under the water. Unmanned aerial vehicles, the well-known UAVs, represent the largest subset of the unmanned systems. A rather new subclass of UAVs are the weaponised unmanned air vehicles. Loitering munitions are part of this family.

This article will focus mainly on short range man-portable loitering munitions used by small tactical units.

Two main options exist to create a small weaponised UAV. The first option is to produce miniature munitions to be attached to existing standard ISR drones. For examples, Raytheon developed Pyros, a 12 pounds air-launched precision bomb, and MBDA's Saber, a 13 pounds glide weapon. Development in nanoenergetics would allow the production of even smaller, but still powerful mini bombs. The second option is to blend a drone with a bomb. The resulting image sensor-guided miniature missile can be flown in a one-way mission to a selected target. As of now, almost all of the initiatives launched by the industry followed the latter model.

Background

The concept of loitering munitions and their usage by the modern warfighter stand at the convergence of several trends.

Change in the Nature of Warfare

Warfare has evolved from being described as human centric, to platform centric, and now network centric. Having said that, the combats (so far) are more often individuals and – far from involving mechanised hordes being challenged by swarms of A-10 Warthog tank busters – rely on sections/squads engaging combats in hostile surroundings, frequently urban environment and population centres. So, whatever shape warfare is taking, there is a need to give greater fire power to the small tactical units (often the most at risk on the battlefield), instead of having them call-in division-level assets. "*In the past the small unit was built around the fighting system. Today and for the future, the fighting system must be built around the small combat team*"[3]

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[1] UK MoD, *The Major Projects Report 2011*, National Audit Office, 16 November 2011.

[2] We used the current terminology "unmanned systems", meaning there is no "man" on-board the platform; the previous term of "remotely piloted vehicle" (RPV) was probably more explicit, and could hold true for most systems except for the ones that are autonomous.

[3] Cornelius, Stephen C., *Missile Science and Technology, We've been at War for 10 Years; What Have We Learned?* 13th Annual AUSA Missile Conference, 26 April 2011

Lessons from the Battlefield

One of the key lessons learnt from the 2006 Israel-Hezbollah war in Lebanon was the infantry use of guided anti-tank weapons as immediately-available precision artillery fire[4]. For such purpose, Israeli forces used the Rafael's Spike missiles, while Hezbollah used the 1960s Russian-made 9K11/AT-3 missiles (Malyutka)[5].The targets of such attacks were mostly fortified outposts and rooms in buildings.

Similar trends have been observed among American and British forces in Afghanistan who used expensive FGM-148 Javelin missiles (at around USD 100,000 per shot); demonstrating that there was nothing suitable and cheaper available.

Need for Precision Strike

The trend in artillery is undeniably heading for precision strike and precision weapons. A small, surgically precise effect has far larger utility than unguided artillery shells or bombs. *"One-shot, one-target"* accuracy has become the leitmotiv of the various stakeholders, whether it is to avoid collateral damages or to reduce costs (however under certain circumstances, speculative fire or *"heavy pounding"* may still be needed).

During the Gulf War, it has been found that "*a tonne of PGMs* [precision guided munitions] *typically replaces 12-20 tonnes of unguided munitions on a tonnage per target kill basis*"[6] .

Precision is also very relative. Heavy artillery with a precision guidance kit (PGK) can achieve a CEP of between 30 to 50 meters at a range of 30 kilometres, against a CEP of circa 250 meters with an unguided 155 mm shell. However for the section fighting in urban terrain, none of these results is sufficient. When the enemy is on the other side of the street, 30 or 50 meters means the death of the good guys and of the bad guys. In these cases, precision must mean within a couple of meters from the target.

Fusion Surveillance and Strike[7]

So, why not use a GPS-guided mortar round[8] in coordination with an ISR UAV, instead of sending and parking above a loitering munition? For the reason that to precision must be added another attribute which is always decisive on any battlefield: *speed* – the attribute that allows to shorten the sensor-to-shooter timeline.

There are many instances where enemy forces are detected but move before they can be targeted: the "*hide and seek*" or time sensitive targets (TST). Mobile and manoeuvring, such targets frequently elude aerial or artillery strikes owing to the delay between detection and attack (most of these strike weapons being operated from places physically distant from the target area). Therefore, to reduce the response time, precision strike must be fused with rapid strike capability.

However, could not the same result be achieved by using a small UAV carrying separate munitions? Probably so, but not at the individual soldier level (at least not yet). Unless we get to an extreme level of bomb miniaturisation, any UAV capable of carrying droppable bombs will not be able to be carried inside a back pack by an individual soldier, and will instead need a catapult. Surveillance and strike become very effective when they are merged into the same vector.

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[4] Glenn, Russell W., *All Glory Is Fleeting: Insights from the Second Lebanon War*, RAND Corporation - National Defense Research Institute, 2012.

[5] The 9K11 Malyutka is a manual command to line-of-sight (MCLOS) wire-guided anti-tank guided missile (ATGM) system developed in the Soviet Union during the 1960s and 1970s.

[6] "*Report of the Defense Science Board Task Force on Tactical Air Warfare,*" Office of the Under Secretary of Defense for Acquisition and Technology, Washington, DC, November 1993.

[7] A concept also referred to as "*reconnaissance-strike complex*"

[8] Weapons such as laser-guided missiles, "*smart*" bombs and GPS-guided artillery shells have already improved the accuracy of attacks against hostile targets.

Advances in Enabling Technologies

The progress of electronic microsystems and robotic has enabled loitering munitions to fuse surveillance and strike, to get smaller and to push their costs down. The same progress has enabled the design of completely autonomous lethal systems (e.g. the Harpy, which is mostly autonomous). However, despite the progress in developing automated target recognition using ladar sensors for example, man-in-the-loop is more than often still part of the *"kill"* decision.

Game Changer

Loitering munitions bring additional lethality to the section/squad, improve situational awareness and survivability by providing technology-enabled, direct fire, aerial precision capabilities, which allow soldiers and tactical small units to engage NLOS targets. LMs give the warfighter the capability to observe and identify an enemy target before delivering a rapid precision airstrike.

In addition, the soldiers are not exposed to detection or enemy fire while guiding the LMs to their targets. Man-portable LMs are rapidly deployable and reduce the logistics burden.

In the words of MBDA "*this revolutionary new concept has been designed to provide the military land component with a flexible capability to provide organic, timely, enduring and precise support at appropriate ranges, allowing simultaneous attack in deep, close and rear operations throughout the spectrum of conflict*[9]".

Loitering munitions can be used in a diversity of battle situations, high and low intensity conflicts, military operations in urban terrain (MOUT), close combat or counter-terror operations where terrorists/snipers hiding in built-up areas need to be attacked with precision and often through the top of their hideouts. LMs allow the strike to be executed from any direction and at any attack angle, from flat to vertical – a capability which is highly indispensable in urban areas.

LMs can track insurgents placing IEDs or fleeing from the scene, provide protection to small forward outposts, patrols or convoys, and could act as a deterrent when visibly deployed.

LMs reduce risks of collateral damages and friendly fire.

Another advantage of loitering munitions is their flexible range. Loitering munitions, depending on the models, are capable of attack in long, medium and close-range.

Unless the enemy has proper air defence systems[10] in place, small loitering munitions will be quite immune to enemy fire since they present a small signature (small size and quiet motor).

Systems

There are several loitering munitions systems that could be branded as long- or middle-range and which required catapult launches. Amongst the most known are the Harpy (IAI) dedicated to the suppression of enemy air defence (SEAD) missions; Harop (IAI) a long endurance LM; Hero-400 (ex-Blade Arrow from UVision) a long range precision attack munition; and Fire Shadow (MBDA) developed with the UK MoD as part of their IFPA (Indirect Fire Precision Attack) programme.

As for man-portable loitering munitions, some of the key criteria are low weight, quick deployment/quick launch (most likely foldable wings), endurance (the system must be able to scout for at least 30 minutes), substantial lethal payload, ability to attack from any angle (flat to vertical), hit with accuracy (circa one-metre), controllable from a simple device (e.g. Android tablet), secure communication links, real-time video display (day/night video sensor) and low-cost (conveying high value for money).

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[9] MBDA, Press Release, March 2013

[10] Such as radio jamming to interrupt remote-control signals (for non-autonomous or non-GPS guided platforms), small missiles with adequate guidance systems, rapid fire guns or direct energy weapons.

Only a few man-portable LM systems have been offered by the industry and more systems are expected to come out (thus a suggestion we are making to a manufacturer).

Switchblade (AeroVironment), a 2ft, 6-pound (including the carrying case and launcher), with foldable wings, expandable LM which can be controlled up to 10Km, with an electric engine displaying an endurance of 10-15 minutes and a warhead equivalent to a 40mm grenade. The Switchblade has been fielded with the US Army in Afghanistan and reports claim that they have been very successful despite their rather short loitering time.

BattleHawk (Textron), a 5.5-pound (10-pound including launcher and control unit), tube launched, loitering munition that can be controlled from a tablet or smartphone device (Android-based), electric propulsion, 30-minute endurance, 40mm fragmenting grenade warhead, flexible carbon fibre wing, and 5 km reach.

Tactical Grenade Extended Range or ***TiGER*** (MBDA), a loitering weapon with a warhead of two 40mm grenades packed in tandem, with inflatable wings, carried in a small tube, electric propulsion, can fly to a distance of up to two miles, and loiter over the target for several minutes.

Hero-30, formerly WASP (UVision) is presented as a mini ISR UAV and not as a loitering munition, however it has all the attributes of being a very successful and effective LM. Its shape with cruciform wings is highly manoeuvrable and perfectly adapted to attacks from all angles, it loiters for 30 minutes, it has a data link range of 10 km, it can carry a 2.2-pound payload, it weighs 6.5 pounds, and is launched from a launch canister (all eight wings are foldable).

If we may give an advice to the manufacturer, we would suggest UVision to use their Hero-30 as a loitering munition.

Next

Looking a little further into the future of the technology, we believe that researchers should explore "*perch and stare*" loitering munitions (e.g. small quadcopters with a mini warhead waiting for a wake-up signal or acting autonomously in response to a given event), semi-autonomous or autonomous small LMs (e.g. penetrating into a facility with the knowledge of the plan and looking for a specific area/target), swarming LMs (e.g. to saturate an area), LMs with morphing wings or shape-changing LMs (e.g. an aerial LM able to crawl on the ground or enter through vent shafts).

Conclusion

Loitering munitions are enhancing the current force and enabling the future force. Loitering munitions are moving into the combat zone, and man-portable LMs are and will be indispensable devices in the tool-box of the soldier.

LMAMS, a recent RFI from the US Army[11] shows the importance of the LM concept since their successful fielding in Afghanistan.

India has been at the forefront of the usage of medium range loitering munitions when purchasing the Harop from IAI. Now, with the prevalence of current low intensity conflicts and terrorism/insurgent activities (and the presence of training camps in remote areas) and the risk of high intensity conflicts, Indian Armed Forces should consider acquiring man-portable loitering munitions.

[11] The Lethal Miniature Aerial Munition System (LMAMS) programme, pursued by the US Special Operations Command, is designed to provide a soldier carried, ground launched Non-Line-Of-Sight (NLOS) loitering precision guided system organic at the small unit level.