General

A seminar on UAVs and UCAVs as force multipliers was held in the CLAWS Seminar Hall on 09 Feb 2012. The Seminar was chaired by Lt Gen PC Katoch, PVSM, UYSM, AVSM, SC (Retd). The panelists were Col JB Singh, Director, Artillery Directorate, Maj Gen P K Chakravorty, VSM (Retd), Consultant, BrahMos, Dr Krishnan, Director, Aero Development Establishment, DRDO. The seminar was attended by a large number of serving and retired officers and members from the strategic community.

Welcome Remarks: Brig Gurmeet Kanwal (Retd), Director, CLAWS

The Director welcomed all present at the Seminar. On this occasion, a book written by Dr Shah Alam, former Research Fellow, CLAWS, titled 'Pakistan's Military Role in Governance', was released by the Chairperson.

Lt Gen PC Katoch, PVSM, UYSM, AVSM, SC (Retd), former DGIS

The concept of employing UAVs has been in vogue ever since 1940. The first use of this equipment was made by the Iranians. The Indian Army has been giving due importance to this concept so that adequate system integration can be carried out. The problem with respect to reliability however exists. One third of the UAVs used by the USAF have been hit by enemy action or have crashed, the latest being the UAV downed by the Iranians. There may soon be a thinking UAV which is autonomous in nature.

Col J B Singh, Director, Project Pushpak

The UAV is capable of accomplishing tasks which are difficult for manned aircraft to accomplish. The overall expenditure on UAVs by the US has gone up from 5.3 million to 11 million USD.Countries like the US who are decreasing the size of their armed forces are in need of a greater number of force multipliers if they wish to continue with their worldwide commitments. The armed forces over the years have developed a variety of force multipliers like AWACS, J-STARS and multi role aircrafts. Besides being expensive, as these aircraft are manned, their loss is unacceptable. Also, as most manned airborne force multipliers are invariably employed in standoff role there coverage and capability during peace time is limited. This leads us to the importance of maintaining UAVs for real time reconnaissance and allied tasks.

The evolution and development of remotely piloted vehicles / UAVs by countries is as follows:-

· 1911 - First Aerial Warfare by Turkish troops.

· 1914 - First Attempt on Remote Control by Prof AM Low.

· 1915 - First Experiment on UAVs in Britain.

· 1917 - First Unmanned Flight.

· 1927 - ‘LARYNX ’ the First Successful RPV.

· 1934 - ‘Queen Bee’ the Drone for British Army & Navy

· RP- 4 by United States (also used by the Israelis in 1973).

Between 1985 to 2015 saw the US Navy acquiring the ‘Pioneer’ and ‘Firescout’, the Army acquiring ‘Raven’, ’Hunter’ and the ’Grey Eagle’ and the ‘Predator’ and ’Global Hawk’ class of UCAVs being acquired by the USAF. Some successful operations as carried out with the employment of UAVs are as follows:-

· Vietnam - Teledyne (Firebee)

· 1973 Arab - Israel - Ryan 124, Scout, Mastiff.

· 1982 Bekka valley - Mastiff, Scout.

· Gulf War - I - BQM-74, Pioneers, Pointers.

· Bosnia - Tier-2 Predator.

· Kosovo - Predator, Hunter.

· Afghanistan- Global Hawk, Predator.

· Gulf War-II - Hunter, Pointer , Dragon Eye, Global Hawk and Predator.

Smartly employed UAVs can help a modern armed force achieve its objective. Some examples are as under: -

· 1973 Yom Kippur, Israel learnt the true value of UAVs.

· 1982 - Operation Peace for Galilee campaign.

· Israeli strikes against Syrian missile batteries in Bekaa valley. Months before attack, Israeli UAVs fingerprinted Syrian surface to air radars - Anti radiation missiles were used during attack. UAVs flew over battlefield emitting dummy signals - causing Syrians to open up SAMs and tipping off their radar sites. Accuracy of artillery barrage on SAM sites was facilitated by UAVs. UAVs were also used for surveillance of major airfields deep within Syria – the information was relayed to AWACS - which vectored Israeli fighters against Syrian MiGs.

The overall result achieved by the Israelis from the above was evident as 19 sophisticated Syrian SAM batteries in Bekka valley were destroyed. The Syrian fighters defending SAMs were shot down and Israel achieved complete air superiority in a single afternoon.

UAVs are employed jointly and separately in both ISR and strike spectrum role. In ISR, the seekers are employed for intelligence preparation of the battlefield, target acquisition and reconnaissance. In Strike roles, shooters are employed to provide CAS in the form of UAV strike coordination, direct fire support and dynamic targeting. In the joint role UAV command systems are employed. The employment concept is as under: -

· UAVs should be used during the initial critical days of conflict.

· UAVs perform the 3'D's - Dull, Dirty and Dangerous.

o Dull - Long Endurance Missions regularly for few days.

o Dirty - e.g. detecting chemical weapons.

o Dangerous - reconnoiter behind enemy lines and suppression of enemy air defence.

· UAVs can be used in politically sensitive areas – for limited objectives to eliminate the risk of hostages (in case of manned aircraft) which may be used as UAV. The UAV projects power without projecting vulnerability.

· For propaganda.

UAV echelons are subdivided into the contact battle and the depth battle stages, which are defined as below:-

· *Contact Battle.*

· Close range (25 km or less).

· Short Range (1-2 hours missions).

o Operate below coordinating altitude.

o Integrated with ground forces for tactical operations.

· *Depth Battle* - Operational Level.

· Extended range (100-200 kms).

· Long duration (24 hours).

· Missions in direct support/general support at tactical/ operational level.

· Airspace coordination.

The employment philosophy of the UAVs is perceived as under:-

· Pivot for reconnaissance, surveillance, target acquisition, destruction and PSDA.

· High value time critical mobile targets.

· Weapon of sustained battle presence.

· Disrupt enemy C4I2 network.

· Help own forces to operate within enemy OODA cycle.

· Immediate punitive strikes.

· Armed UAVs create space between LIC/Proxy war in spectrum of conflict.

· Reconnaissance, target acquisition, weapon release platform for monitoring move & deployment of enemy strategic weapon system.

· Air blockade on critical enemy air bases.

· Complementary weapons system along with missiles to strike strategic targets.

· Integrated with C4I2 - system network centric warfare at various levels.

· Lasing targets for aircrafts and guns.

· Surveillance and tracking of militant hideouts.

· Striking on communication nodes, Air Defence Radars and logistics infrastructure.

The future employment of UAVs in strategic and electronic warfare roles focuses on demonstrating increased combat capability by exploiting their unique characteristics. The following prospects are being considered for future employment of UAVs:-

· Missile Defence.

· Address Concerns of Fratricide.

· Target Geo-location.

· Weather estimation.

· Convoy protection and IED patrols.

· Communication relays and jammers.

· Deployment of UGS in hostile/difficult terrain.

UAVs are capable of augmenting missile defence as follows:-

· UAVs loiter for hours over suspected launch sites.

· Use of UAVs armed with on-board interceptors to intercept ballistic missiles and attack their launch systems during the boost phase of flight. Boost Phase Intercept (BPI).

Concerns over fratricide are addressed as under: -

· UAVs are employed to address concerns of fratricide by enhancing ability of fighter aircraft .

· A UAV situational awareness data link can connect the receivers to a network that will include connectivity to properly equipped ground forces.

· Resultantly, pilots of attack aircraft can receive information about locations of friendly troops.

· UAVs should migrate to IFF techniques in the near future.

Target geo-location by utilization of UAVs is possible as follows:-

· Simple geolocation, where accuracy is not defined, could be sufficient for general fixation and orientation but not suitable for targeting of GPS guided weapons.

· Research in SLAM (Simultaneous localisation and mapping) and use of improved sensors like IMU (Inertial measurement unit) have made accurate geo-location of targets using two or more UAVs a reality.

Weather Estimation by use of UAVs is an in vogue phenomena as given below:-

· Research in ‘Weather estimation using UAVs’ give UAVs the ability to perform periodic, automatic pilot requisitioned weather reporting.

· Weather information in denied and data-sparse areas would thus be available.

· Data inputs from onboard sensors is uploaded via satellites into classified networks, which allow access by meteorological and oceanographic centres, air operations centre’s and squadrons.

Convoy protection and IED patrols is being planned as part of UAV specific missions as follows:-

· Patrolling highways in hostile area & protecting convoys soon part of regular UAV missions.

· Relying on continuous communications, UAV can cover a convoy, controlled from GCS over large distances.

· More suitable solution is to use a small UAV loitering overhead, equipped with ground surveillance systems to monitor the area ahead of the convoy, forewarn of ambushes or of suspected IEDs.

UAVs are effective aerial communication relay platforms as given below:-

· UAVs used as Airborne Communication Nodes (ACN) for communication relays, transfer imagery and voice where communication is a problem due to terrain.

· An airborne communication relay package (CRP) can effectively connect units operating in mountains, where terrestrial radio communications are typically masked by the terrain.

· Tactical communication needs can be met much more effectively with ACNs than satellites. ACNs enhance intra-theatre and tactical communication connectivity.

The UAV can be used to deploy UGS in Hostile/Difficult Terrain

· UAVs operating in an autonomous mode can be extensively employed for the deployment of Unattended Ground Sensors (UGS) in hostile/ difficult terrain to check infiltration bids.

· The same technology can also be used for delivery of mines in hostile territory to check enemy advances.

Detection of Nuclear /Chemical and Biological Plumes is possible by UAVs as follows:-

· The effectiveness of UAVs has been demonstrated in one of the most sinister scenarios of modern warfare: Biological threat.

· Boeing, in conjunction with the U.S. Defence Threat Reduction Agency (DTRA), has successfully developed the Scan Eagle UAV.

· This UAV can intercept, detect, and fly through simulated biological plumes or clouds to collect airborne agents.

Certain limitations of the UAV are as follows:-

· UAV survivability, data link technology and extensive manpower training.

· UAVs have reduced radar cross section, low infra red signature and reduce noise levels - but are relatively slow thus impacting on their survivability which is essential in combat.

· Lack redundant onboard systems.

· Operation of UAVs in bad weather is problematic.

· No counter measures exist against enemy air defence weapons.

· Data links are susceptible to jamming.

· Encryption requires large bandwidth.

· Operation of UAVs is manpower intensive.

Present day surveillance challenges while employing UAVs are as follows:-

· Limited coverage due to line of sight in mountains.

· Communication connectivity for lateral and rearward flow of information.

· 'Time gap' between intelligence collection, analysis and dissemination needs to be reduced.

· Airspace control resulting in safe and effective UAV operations.

· Sense and avoid techniques to be integrated in civil airspace.

· Air Defence architecture to achieve security without fratricide.

· Growth of UAV platforms requires significant frequency spectrum demand.

A Taliban fighter reportedly said, 'We pray to Allah we have American soldiers to kill… but these bombs from the sky we cannot fight'. UAVs are undoubtedly evolving rapidly to emerge as indispensable weapons of war. They are at cross roads where growing tech capabilities must be used to meet operational requirements. There is an inescapable requirement of controlling the asset at the appropriate headquarters which can ensure the shortening of the kill/destruction chain. There is a need for a common operating picture and unity of command. Needless to say the tracking of and striking targets requires patience - the UAV is only as persistent as those operating it. To stay ahead in the future unmanned battlefield, strategic technical areas must be identified early and built up as technology matures.

Dr PS Krishnan, Director, ADE, DRDO

Warfare and war fighting has undergone change and evolved since the days of Mahabharata, through the World Wars, the Kargil Wars and the present day asymmetric warfare. The intensity of warfare has been increasing, as also the complexity of the instruments used for same.

ISR Challenges of Present Day Warfare

There are a number of ISR challenges in current warfare:-

· Free access to radio spectrum to all.

· Command and Control centres are not always actual part of the forces in contact.

· Cam by adversaries is difficult to detect.

· Containing the damages.

· Time gap permissible to react has been reduced from '*months'* (as in Napoleon Wars) to '*hours'* in World Wars, to a matter of '*seconds'* in today's warfare.

Two features of ISR are precision and effectiveness.

UAV Usage

Usage of UAV is on increase. Even about three years back, it was said that

· '1 UAV was equivalent to 175 manned aircrafts' and

· '1 hour of UAV flight was equivalent to 300 hours of manned aircraft' in terms of cost effectiveness.

This ratio will only increase tremendously in future. Future operations will be highly network centric, where advance sensors on sophisticated aerial vehicles with interoperable platforms and distributed command and control centers will be employed in combined operations in both sea and land operations. Hence the spectrum in which we need to conduct ISR will be from biometric to SAR and in future it will also be in hyper spectrum as well. The range of operations will also increase when going for hyper spectrum. Similarly, the size of the aerial platform shall be from nano to micro to mini. The smaller ones are for short term ISR and the bigger ones for long term, thus both are important.

Aeronautical Development Establishment

The Aeronautical Development Establishment (ADE) is a laboratory of Defence Research and Development Organisation (DRDO). Located in Bangalore, its primary function is research and development in the field of military aviation. Its recent successful projects include LAKSHYA (an aerial target), NISHANT (a reconnaissance UAV), flight simulators (LCA, Ajit, Kiran, Mig-21) and avionics packages for Tejas-LCA (display and FCC). It earlier worked on Sparrow (mini-UAV) and Ulka (aerial target). Many new projects are being planned there. The website of ADE, as available in public domain is on link

http://drdo.gov.in/drdo/labs/ADE/English/index.jsp?pg=homebody.jsp&labhits=18080. The past, current and future Areas of Work of ADE can be visited at link http://drdo.gov.in/drdo/labs/ADE/English/index.jsp?pg=AreasWork.jsp. he various levels of development of a UAV, from Level 1 to Level 10 were discussed.

Maj Gen P K Chakravorty, VSM (Retd), Consultant, BrahMos

Whenever a man is replaced with a machine, there is bound to be some resistance. No pilot would like to give up his job and over the years, the Air Force and the Aviation Corps has been resisting this change by being the biggest opponent of UAVs. US government has been contemplating USD 300 billion reduction in defence expenditure. This will prove how important these machines (UCAVs) are for being part of the country's defence arsenal.

The Navy in particular is an organization which takes value for instruments on board better than anyone else. Undoubtedly, the first UAVs were used by Iranians, who are very scientifically oriented. But, the era of unmanned combat aerial vehicle (UCAV) started with Vietnam War, where also, it was proved to US that physical use of force cannot really change anything drastically.

Indian defence research in this field is at level 3 or 4. Indian Army was first one to get the UAVs before Navy and the Air Force. But when these were taken for field trials, they were resisted by the Army Aviation. We, in the Corps of Artillery, are strong believer that UCAV does bring significant impact on battle field.

Origin of UCAV

The origin of UCAVs can be traced as under:-

· UCAVs were first introduced by US Navy. The QH-50 DASH were the first TORPEDO launching helicopter drones deployed on their destroyers.

· US Air Force experimented with Project "HAVE LEMON" for SEAD missions with Maverick missiles, which resulted in BGM-34 UCAV.

· On 10 May 1971, UCAVs beat two F-4 Phantoms in dog fight. At the same time, a paper was submitted to the Pentagon by a US Air Force pilot how UCAVs are better placed than a manned fighter aircraft. Not to mention the today's predator which moves at speeds of 300 kmph, including that it can be subjected to upto 8 or 9 G. My personal experience at Space Center Orlando that it was upto 6.

· The US navy has already aired its views that they have almost cancelled the orders for F35s joint strike fighters because there are talks today of replacing these joint strike fighters with UCAVs.

· The US Test Squadron was disbanded in 1979, which sends some important signals.

· DARPA of US Army ordered Boeing X-45 UCAV in 1999 for US Navy. The project leads to a joint UCAV system in 2003. The US Navy goes fully for it and one of its 11 US aircraft carriers may fully have it.

· China is focused on limiting the operations of US in Asia Pacific. Thus question for future is whether to employ AS35 to attack or employ S45 UCAVs for similar missions.

· In the summer of 2003, during an Air show, a BGM-34, with slower speeds, was displayed with 2 HELLFIRE Missiles. This shift from TOW to HELLFIRE functions in combination of millimeter and IR as seeker cum designator. Thereafter, Sweden, UK Germany etc, all are developing UCAVs.

Desired Capabilities in UCAVs

The future UCAVs must have following capabilities:-

· Light, Maneuverable and long endurance.

· Capability to engage air to air, air to land and air to sea combat.

· Capable of lifting cargo loads. Eg, in Afghanistan, UCAV have been employed for same.

· **Loitering Missiles**.

o It must manifest itself as a loitering missile with capable of achieving pin point accuracy. These are ideal for surgical strikes.

o MBDA have already been put to use as loitering missiles by UK and carrying out attacks in Afghanistan.

o Also, HARON (of IAI), Jaguar (Rafael) and one from Lockheed Martin been put to use as demonstrator.

· Can be pre programmed or controlled from the ground.

· **Cost Effective**. The moment a pilot is replaced with a UCAV, it brings down costs tremendously – pilots pay, pension, family pension etc and other financial expenditures attached to them. Commercial impacts of replacement are drastically in favour of employing UCAVs.

As per the latest defence proposal of US President Barrack Obama, the entire US forces are being reorganized based on Carrier Task Groups and UAVs. The UAVs are being tested extensively along the coast of Florida.

Predator B

This UAV is the one which is impacting today. This has been deployed in Afghanistan, and Yemen. In Libya, not a single US person was physically involved as it was entirely by Air and UAV and Cruise Missiles, with total cost being 1.1 billion USD.

This UCAV has following characteristics :-

· **Basic Characteristics**.

o Wing length 84 ft,

o Speed-390 km/hour,

o Pay load -1360 kg,

o Altitude ceiling : 52,000 ft. With full load, operational ceiling of 25000 feet.

o Endurance 14 hours when fully loaded with ammunition, else 42 hours is maximum. Thus, with move in and move out time removed, it has about nine hours loiter time, fully loaded with ammunition.

· It was the first Hunter Killer UCAV.

· Manufactured by General Atomics; also known as MQ-9.

· **Weapons / Ordnance on Board.**

o AGM-114 Hellfire missiles,

o GBU_12 Paveway II laser guided bombs,

o AIM-9 Sidewinder ,

o AIM-92 Stinger and

o GBU-38 JDAM(Joint Direct Attack Munitions).

· The UAC is capable of carrying weapons at 7 hard points. Combination of carriage:-

o Up to 14 Hellfire missiles or

o 4 Hellfire missiles & two 500 lb GBU-12 Paveway bombs.

Operational Usage of UCAVs

· Combat missions have been flown in Iraq & Afghanistan since 01 May 2007.

· It has also been used for anti-piracy patrols in Seychelles.

· About 33,000 combat missions being flown by UCAVs in one year. Not to mention the saving in hours of flying in manned combat aircraft.

· Regular night flying of combat and logistic missions can be attempted.

In future, it is anticipated that 30 percent of the combat air crafts of US and UK will constitute UAVs and UCAVS. The decision is to be taken by their respective governments. To the tune that US Navy is reconsidering its decision to purchase UCAVs in place of F-35 fighter aircrafts.

Conclusion

Even a normal helicopter has its problems of flying in high altitude areas. But flying of UAVs can be attempted. Operational finesse can only be achieved by tuning these machines and equipment to altitude they are not subjected to while being in laboratory unless there is no difference between laboratory and actual scenario.

UAVs are great Force Multipliers. UAVs are ideal for deployment at Division and below level. In a network centric environment, where we have less response time between situational awareness, sensing and destruction, the UCAV will be most important weapon.

Interactive Session

The current planning for induction of UAVs is deliberate. The inter and intra service issues with respect to their employment and deployment must be resolved professionally.

Integration. The integration of employment of UAVs in an intense air space management system will be a challenge for inter service coordination. With advance abilities, it is not very complicated. The GCS should be suitably so located. Further, better instrumentation, integration and coordination can help resolve all these issues.

Development – in Cost and Time and leap frogging technology is the need of hour.

During the lifecycle of development of an equipment / technology, it should get integrated with the users, thus mature it concurrently, rather than waiting for inducting fully matured equipment. When we are ready to experiment with foreign inductee equipment, the same must also be one with indigenous equipment. Better coordination and cooperation between Services and DRDO is required.

Synergizing and integrating Indian Private Sector into overall technology development, especially in micro mini UAV and related requirement for home land security. There is lot of scope in same. The issue was discussed at great length.

Use of UAVs against the insurgents / terrorists will need a different model of usage, rather than being an inter-services affair.

UAVs are the machines of future and thus, there is a need to reconfigure our doctrines and war fighting capabilities and see as to how best can these be configured in overall process.