Air Threat Domain: A Paradigm Shift

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We have just won a war with a lot of heroes flying around in planes. The next war may be fought with airplanes with no men in them at all.

— Gen Henry H "Hap" Arnold (1945)[1]

Paradigm Shift in Air Threat

The prophetic statement made by Gen Arnold right after World War II has indeed come to play in the dramatic revamping of the air threat in the six decades gone by. There was a time when the aerial threat vehicle basically implied a manned aircraft and its combat teeth mainly comprised guided/unguided munitions, essentially operating in the visible domain. As the severity and the lethality of the threat ran their course on the wings of technology, came a multitude of threat vehicles, each more lethal than the other, capable of delivering their combat loads with sub-metre accuracy. 'Precision', 'long range' and 'deep strike' and a capability to strike low at 'stand-off' ranges became the signatures of the new emerging threat.

While all other aerial threat vehicles like the attack helicopters, cruise missiles, anti-radiation missiles, surface-to-surface missiles (SSMs), smart/intelligent munitions, including precision guided missiles, charted their growth paths claiming some share of the overall 'threat pie', the ones that actually shot up in combat significance were unmanned aerial vehicles (UAVs) and unmanned combat aerial vehicles (UCAVs). Though their development cycle over the years as viable air threat vehicles has been marked by a series

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N.B. The views expressed in this article are those of the author in his personal capacity and do not carry any official endorsement.

of inconsistent periods of technological development and stagnation, it was not until the Vietnam War that the UAVs had a measurable impact on military operations. The post-war years saw the other technological developments (manned aircraft, SSM, munitions, NBC, etc) far overtake the UAV/UCAV development, pushing the latter onto the backburner till the extremely successful employment of UAVs by the Israelis again pushed their development to centre-stage. It was around 1990 that the UAVs finally emerged from the shadow of the manned aircraft and stood on their own as 'technologically enabled threat vehicles' capable of carrying out a whole range of combat tasks starting from real-time surveillance and reconnaissance to delivering precision strikes on pinpoint terror targets. Over time, the importance of UAVs/UCAVs shot to pivotal significance in the US Global War on Terror (GWOT), as commanders in the field swore by them.

UAVs/UCAVs: A Versatile Threat Vehicle

The UAVs/UCAVs today claim a large share of combat responsibility in the overall air threat continuum. Their mission spectrum includes intelligence, surveillance and reconnaissance (ISR) operations, close air support, interdiction, suppression of enemy defences, radio relay, observation, border security, conduct of electronic support measures/electronic counter-measures (ESM/ECM) missions, maritime surveillance, and most importantly delivering precision strikes on targets of choice.

Actually, the old debate of justifying the comparative advantage of UAVs/UCAVs over manned aircraft on cost terms alone is wearing out somewhat since modern UAVs/UCAVs with the state-of the-art combat means and support systems onboard also cost comparably [the cost of the Predator UAV: US $4.5 million; the cost of the Reaper UAV: US $ 11 million; the cost of the F-16 US $ 18 million (2007 figures)][2]. This is not to imply that a huge cost differential does not exist when the comparison is drawn between 'daily use' UAVs/UCAVs and frontline combat aircraft. Costs apart, what is actually sustaining the UAVs/UCAVs against competition from manned aircraft are their many other combat virtues which are enumerated below.

With no onboard pilot, the UAVs basically eliminate the risk of crew fatalities due to any reason, be it hostile fire, aircrew fatigue or training deficit, etc. Besides, these vehicles can loiter over a target area many orders of magnitude longer. A fully armed F-16 will most probably be in the target area for 30 minutes before having to air-refuel. A Reaper UAV with comparable weapon load could orbit for 18-20 hours[3], not to mention the Global Hawk UAV from M/S Northrop Grumman that has a range of 22,000 km[4]. Besides range and endurance, the fact that UAVs/UCAVs can carry comparable weapon loads (vis-à-vis manned missions) has been well established.

Integrated Battle Capability: Since neither the manned aircraft nor the UAVs/UCAVs are a total and complete replacement of each other, both are likely to coexist in a non-mutually exclusive domain, as a part of the net-centric battlefield. In fact, the cumulative strength of the 'human intelligence' onboard a combat aircraft along with the brute precision, range, reach, stealth, immunity and versatility of a UAV/UCAV will define the integrated battle waging capability optimised through a seamless command, control and battle management system threading the entire sensor-to-shooter cycle in a net-centric domain.

Is it a revolution in military affairs (RMA)? Does the phenomenal growth in the UAV/UCAV capability domain in the recent years represent an RMA? Some experts believe that three core elements must drive an RMA. Firstly, the concept must be driven by a technological breakthrough or a radically new strategy; secondly the new concept must result in doctrinal and organisational changes; and, finally, such changes must fundamentally alter the entire conduct of military operations. Without hazarding an opinion in the binary 'yes' or 'no' terms, it can be appreciated how the 'unmanned technology' is largely a radically new technology giving a run for its money to the manned aircraft in every combat function, be it range, reach, precision and endurance for continuous operation or capability to carry lethal load, and manoeuvre, etc. Also, unmanned aircraft have indeed brought a 'paradigm shift' in the employment of air power (doctrinal?). According to William K Lewis, "In times to come, UCAVs may obviate the requirement of a manned aircraft to a very large extent… There will most likely be a time in future when UCAVs will become more effective."[5]

Experts believe that an affordable air superiority UCAV will be a serious competitor for a manned aircraft – the former is considered to be as effective as a manned platform while being much more affordable. The highly manoeuvrable, stealthy, high speed UCAVs fully integrated into a complex network of sensors will prove to be deadly air threat vehicles having tremendous potential, high immunity, long reach and precision strike capability at minimum costs/risk to war-fighting. Experts also predict that slowly, over time, as data transfer rates and artificial intelligence capability increase, the combat effectiveness of unmanned systems may surpass that of the manned systems. When that happens, UCAVs are likely to dominate the manned fighter aircraft in all realms of mission execution. These will no longer be a mere alternative but an imperative to prosecute an air campaign. This end state is likely to be effective by the year 2025.[6]

On the flip side, critics feel that until fully autonomous machines can reason like humans and make moral judgments and until data transfer latency rates approach zero, there will be roles for humans in the cockpit. Current projections show that advanced processors which would simulate human cognitive processing may start no earlier than 2030. Although air superiority UCAVs will most likely be technologically feasible by the year 2025, it will still require many more years of technological development before it can supersede manned aircraft.

The White Scarf Syndrome: In the US, the resistance to the development of the UCAV from the pro-pilot bias lobby is commonly referred to by various authors as the “White Scarf Syndrome”[87]. The proponents of this syndrome opine that while the UCAV comprises a promising technology, it has many risks and uncertainties. In that, while the UCAVs may become technologically feasible, they will still require many years of development before they can supersede manned aircraft.

While the debate of UCAVs vs manned aircraft may go on both ways, the essence lies in the fact that manned and unmanned technologies are not mutually exclusive. Removing the pilot from the cockpit reduces the risk of capture, injury or death but may possibly increase the susceptibility of others to fratricide or collateral damage[8]. The final acceptable position may be summed up as, “While the unmanned system may provide an effective and affordable alternative, the best answer may be a mix of manned and unmanned aircraft. Such a combination may exploit the strengths and minimise the weaknesses of both.”

Emerging Future of UCAVs

The 3Ds (dull, dirty and dangerous) experts opine that the 3Ds could characterise the signature and mission profile of future UAVs. ‘Dull’ implying long duration missions lasting several hours, too long for a pilot to physically endure; ‘Dirty’ missions are those where the threat of biological and chemical contamination is too high to risk sending a manned aircraft; and ‘dangerous’ missions are those where the risk of losing a human trained resource (pilot and crew) is very high, i.e., suppression of enemy air defence missions in an intense air defence environment.[9] The technological challenges faced in the development of UAVs today have resulted in the successful development of many technologies, such as miniaturisation of electronics, improvement of sensors, and development of reliable and jam resistant data links and, most importantly, the revamp of UAVs through stealth features. The first generation of aerial vehicles designed as stealthy UAVs took to the air in 2002 when Dassault and Saab flew Petit Duc in 2000 and Swedish Highly Advanced Research Configuration (SHARC) took to the air in February 2002.[10]

Further Integration and Manned/Unmanned Joint Operations: Sweden further plans to develop a fully integrated net-centric defence, linking land, sea and air commands, with the UCAV as its key strike element. The US Defence Advance Research Project Agency (DARPA) has visions of battlefields where UCAVs and manned AHs (Apache and Comanche) will prosecute joint operations in a perfectly synergised mode, complementing each other in the prosecution of the air battle. Similarly, frontline UAVs and UCAVs are being developed to operate ex aircraft carriers by 2015. Efforts to develop submarine launched UCAVs are also under progress.

Driven by the tremendous advantages of unmanned aerial threat vehicles and enabled by remote piloting technologies, M/S Lockheed Martin is developing an unmanned version of its joint strike fighter F-35 soon after the manned version. The growing threat of technologically enabled UAVs complete with their combat teeth is indeed a nightmare for the air defence warriors owing to the difficulties involved in shooting them down. While some weapons out of the conventional family of ground-based air defence weapon systems (GBADWS) can be successfully employed to shoot down UAVs, there is a growing imbalance between a threat UAV and the high cost of surface-to-air missiles (SAMs) or a manned fighter being scrambled to engage it? A Turkish researcher, Kemal Codur, has opined, “Countries usually have a few hundred combat aircraft and a few hundred missiles and the current air defences are organised according to such numbers, but since the UAVs in a theatre of operation are likely to be deployed in thousands, the current counter-measures based on existing conventional air defence assets will invariably prove to be either ineffective or an overkill.”

The conventional arsenal capable of bringing down the UAVs basically includes the frontline SAMs (Spyder kill range 1 to 15 km, altitude coverage of 200 to 9,000 m, Barak kill range 10 to 70 km, etc). The cost imbalance factor is being addressed by building low cost counter UAV attack solutions based on kinetic kill vehicles like the Cougar (an attack concept using a miniature turbojet to propel a monoplane airframe configuration which is given a mid-course guidance on to a stern attack) or the peregrine counter UAV system (low cost, low on fuel loitering aircraft which upon detection of a UAV threat, sheds a portion of its wings, switches propulsion sources and proceeds at high speed for a mid-air collision with the enemy UAV).[11]

Besides the conventional/kinetic solutions, the best way to bring down the UAV still may be in the domain of directed energy kill vehicles. Boeing's Avenger System that successfully mounts a laser on the Avenger combat vehicle has shown promising capability to shoot down small UAVs. The laser Avenger integrates directed energy weapons (DEWs) together with a kinetic weapon on-board the proven air defence system. Another promising laser close-in-weapon system (CIWS) was put on display by M/S Raytheon at the Farnborough Air Show in July 2010. In May 2010, the weapon successfully demonstrated its capability to shoot down a UAV in flames soon after its laser kill beam (50 kW solid state fibre laser) was incident on the threat.[12]

ELINT-Based Solutions: In another innovative solution, Russian designers are modifying their existing and proven inventory of GBADWS to take on the UAV threat on a different route. The Russian aircraft industry site Avra Port reported on September 2009 that it has equipped its conventional Strela 10M, ZSU-23, Tunguska, TOR and other SAM systems with a new type of radar, an electronic intelligence (ELINT) station and opto-electronic sensors (OELS). The ELINT station is meant to disclose the UAV/UCAV data link emissions giving the initial coordinates to the radars and OELS. This enables the UAV interceptors to be directed to the zone of the enemy mini or micro UAV, cruising and jamming its communication data links.[13] In the end, the following comment is interesting, "Regardless of the fears and uncertainties, the military domain's love affair with UAVs/UCAVs shows no sign of ebbing (White-Scarf Syndrome notwithstanding), as such, the world will be watching the industry with a keen eye in times to come."[14]

Notes

1. US Air War College Strategic Research Project, titled "UAVs-Revolutionary Tools in War and Peace" by Lt Col Richard P. Schwing
2. http://www. af.mil/faircrafttsheets.asp?fsID=102
3. Ibid., p. 12
4. http://www.af.mil//information/faircrafttsheets/faircrafttsheet.asp?ID=13225
5. Maj William. K. Lewis, "UCAV –The Next Generation Air Superiority Fighter?" Thesis presentation by the officer at School of Advanced Air power studies, Maxwell Air Force Base. ALBAMA http://www.av.AF.mil/av/AWC/AWC Gate/SAAS/Lewis.pdf
6. *Uninhibited Combat Aerial Vehicles*, (Maxwell AFB, Ala : Air University Press), p. 496.
7. Carl Builder, *The Icarus Syndrome: The Role of Air Power*, (New Brunswick, NJ : Transaircrafttion Publishers, 1994).
8. A Noguier, "Next Mission Unmanned: The Human Factor in Air Power Tomorrow" *Royal Air Force Air Power Review,* Winter 1999, p. 112.
9. *Strategic Affairs,* Vol 5, Issue, No 8, April 19, 2011, p.16.
10. Ibid., p. 17
11. http://en.wikipedia.org/wiki/BQM-145.perigrine
12. "Anti-UAV Laser from Raytheon on Display at the Farnborough Air Show," http://www.flightglobal.com/articles...military.html
13. "A Russian UCAV/UAV Killer" igorrgroup.blogspot.com/2009/…/Russian
14. defence forum india.com/…/14820-good-bad-ugly-uavs-report-border patrol-duty.html