



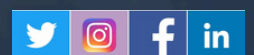
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REPORT ON 'EMPLOYMENT OF FPVS: A NEW PARADIGM IN DRONES' WARFARE'

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“The Value of Science Is in the Foresight: New Challenges Demand Rethinking the Forms and Methods of Carrying out Combat Operations”

- General Valeriy Gerasimov, Chief of General Staff of the Russian Federation

The Russo-Ukraine war has become the first major conflict to see several technological phenomena being innovated on the face of the battlefield-commercialisation of space capabilities and small drones. The mass use of reconnaissance and strike unmanned aerial systems (UAS), particularly First-Person View (FPV) drones and loitering munitions by both sides, will certainly characterise future war. Masses of small FPV attack drones have made the battlefield extraordinarily lethal because of their ability to hunt infantry soldiers and destroy individual vehicles and small groups of personnel with precise strikes in a cost-effective manner. FPV drones have been primarily used as strike weapons and have often been paired with surveillance drones in hunter-killer teams or as part of larger drone groups.

The newly evolved concept of Tactical Reconnaissance Strike Complex (TRSC) employs a combination of pervasive tactical reconnaissance platforms, primarily small drones; drone-corrected precision artillery fire of conventional ammunition; precision munitions delivered by fixed- and/or rotary-wing aircraft; drone-launched precision munitions; and large numbers of FPV drones / loitering munitions. Cheap and plentiful reconnaissance and FPV drones can loiter over the battlefield for extended periods as their operators search for individual targets. FPV drones can strike those targets immediately; reconnaissance drones can call in fires from available artillery when possible, or other FPVs or regular drones. This fusion of the sensor-shooter function in tactical drones and between those drones & longer-range artillery and rocket systems is what has brought the intended effects of the reconnaissance-strike complex, originally conceived as an operational level system, to the tactical level – hence the TRSC.

The mass use of FPV drones by both sides has seen the evolution of a new paradigm in drones' warfare. The HTS rebels in Syria used Ukrainian copybook style to great success in defeating the Syrian Army. Ukrainians have employed FPV drones to offset the shortage of artillery ammunition. Sub-units as small as companies and platoons operate reconnaissance and FPV drones and have the authority to prosecute targets they see with their own systems. The Ukrainians raised a new drone force in April 2024 and even permitted their artillery gunners to interact with frontline drone operators in a TRSC cycle. The Russians initially retained control of their artillery, often massed in battalions or brigades, at much higher levels until after the battle of Bakhmut. Ukrainian forces have started to use FPV drones as anti-drone interceptors, too.

Militaries worldwide are looking to arm their ground forces with these cheap commercials or 'Do It Yourself' (DIY) FPV kamikaze drones to provide additional cost-effective short-range precision fires. Russian and Ukrainian squads have multiple commercial quadcopters and hundreds of FPV kamikaze drones each. Ukrainian and Russian volunteers have produced tens of thousands of cheap FPV drones a month, as they have been rapidly used. Chinese People's Liberation Army (PLA) has ordered a million kamikaze drones. Taiwanese defenders plan to exploit FPV drones against PLA landing forces if the necessity so arises.

Round-Table Schedule

Having realised the importance of FPV drones in recent conflicts, CENJOWS organised a round-table discussion cum online webinar on 20 December 2024, which witnessed a record participation of 132 online attendees, besides physical attendees. The schedule of the conduct was as follows:

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|-----------|---|---------------------------------|
| 1000-1005 | Welcome Address by DG CENJOWS | |
| 1005-1020 | Keynote Address by CISC | |
| 1020-1030 | Introduction to FPV Drones | Brig A Narang Retd |
| 1030-1050 | C-UAS Measures including cyber-attacks against FPV drones | Gp Capt RK Narang |
| 1050-1120 | Employment of First Person View (FPV) Drones: A New Paradigm in Drones' Warfare & Lessons incorporated by PLA | Brigadier Anshuman Narang Retd |
| 1120-1135 | Indigenous FPVs Production – Indian Industry Perspective | Maj Gen Mandip Singh Retd |
| 1135-1150 | Industry perspective on Drones & Counter UAS by Adani Defence | Commander Abhimayu Arya |
| 1150-1215 | FPV protection via EW & EW resilient FPVs for future warfare | Navneet Singh, Kepler Space |
| 1215-1230 | Detection of small drones | Cdr Yudhvir Sahani, Retd |
| 1230-1255 | Open House Discussion – Employment of FPVs in Indian terrain profile & river valleys, Indigenisation Solutions & Counter Measures | Moderated by Brig A Narang Retd |
| 1255-1300 | Closing Remarks by DG CENJOWS | |

Inaugural Session

Maj Gen Ashok Kumar, VSM (Retd), DG CENJOWS, delivered the opening address. He highlighted the transformative impact of drones and FPV technology on warfare, including the challenges and countermeasures associated with their use. He pointed out that the use of drones and FPV technology is transforming warfare, and these are posing newer challenges to national security. FPV drones have become more effective in targeting individual soldiers, and there are efforts to modify them for greater impact.

Lt Gen JP Mathew, PVSM, UYSM, AVSM, VSM, CISC gave the keynote address. He brought out that the character of warfare is changing with the compression of the Observe, Orient, Decide, Act (OODA) cycle by the employment of drones. He reiterated the importance of FPV drones, that they had become essential in modern warfare, providing tactical advantages and disruptive capabilities. He emphasised the simultaneous importance of countermeasures against FPV drones, stretching from detection, tracking, neutralisation, and destruction using various technologies. He elaborated that the challenges in countering FPV drones include the need for new radar designs, the adoption of AI and automation, the development of hard kill systems, and research on autonomous launch capabilities. Citing the example of DRDO's multi-sensor multi-shooter system called the 'D Four for drone, detect, data and destroyed system, he asked the users and the civil industry to undertake various initiatives to address challenges of drone detection, countermeasures, and vulnerabilities through collaboration, innovation, and rapid prototyping.

Employment of FPV Drones – A New Paradigm in Drones' Warfare

Brig Anshuman Narang (Retd) Founder and Director Atma Nirbhar Soch and Adani Defence Chair of Excellence at CENJOWS on UAS Warfare introduced the FPV drones as home-made versions of loitering munitions. Highlighting the two new catchy combat concepts of "Big isn't Beautiful anymore" and "Detection Equals Destruction," he brought out the various roles of FPV drones from a Russian user manual available on Telegram and LinkedIn – classical hunter-killer, free hunting, FPV group strikes, drone ambush, FPV raids, combined strike, engineering tasks of mining and de-mining, spread of psychological propaganda, and cyber-hacking etc. FPV drones have altered the battlespace geometry by empowering platoon and section commanders with their own low-cost platform for reconnaissance, target identification, and clearance in urban battles.

The countermeasures have also simultaneously evolved. Apart from direct counter-drone measures, both Russia and Ukraine have evolved tactics to target enemy FPV drone crews, extensive employment of Unmanned Ground Vehicles (UGVs) and robots forming Multi-Domain Manned-Unmanned Teams (MUMTs) in conjunction with FPV drones, and most importantly, reducing the frontline exposure time of combat platforms and troops.

Brig Anshuman Narang highlighted the importance of skillset development. He explained how the Ukrainian and Russian military have successfully utilised FPV drones in combat through pilot skillset development, the raising of new drone forces, and rigorous training schedules through civil-military fusion. He cited Russian and Ukrainian examples to prove that on-the-fly innovation and iterative development are crucial for success in the drone industry.

The speaker highlighted the important aspect that the era of Western technology domination in small drone production is over, and there is a gradual shift simultaneously to the localisation of technology. Ukrainian Brave One Defence cluster is rapidly accelerating innovative developments to completely avoid any Chinese component due to denial / limited access and the Chinese support to Russia by Chinese component malfunction or intentional leakage of information. He urged the defence forces to ensure that the soldiers should be trained in technical skills to maintain, build, and design drones. Rapid prototyping and 3D printing should be normalised in military units and formations for quick and affordable production.

Indian Industry Perspective

Maj Gen Mandip Singh (Retd) from Dronacharya and **Cmde Abhimanyu Arya (Retd) from Adani Defence Aerospace** brought out the Indian Industry perspectives on indigenous FPV production, including the need for a better understanding of operational requirements and highlighted the need for greater support for startups by defence forces through hand-holding on many occasions. Maj Gen Mandip Singh brought out the growing demand for FPVs and highlighted the increased quantum of training and sales. He said that scaling up orders and incentivisation are necessary for Indian companies to meet the demand for indigenised orders. The speaker categorically stated that the industry needs assurance from uniformed personnel that there will be orders to support their business growth. Cmde Abhimanyu Arya articulated the achievements of Adani Aerospace to develop indigenous counter-UAS solutions

Counter-UAS

Gp Capt RK Narang (Retd) from IDSA highlighted the vagaries of copying Chinese products in counter-UAS products. He pointed out the problems of reliance on Chinese components, which could even disrupt pilots' control. The speaker very aptly pointed out the requirement of civil-military traffic management for unmanned vehicles and handing over of drones' threat as rogue drones cross over from military to civil areas or vice versa.

Mr Navneet Singh from Kepler Aerospace highlighted that radar and signal detection are the primary modes used for drone detection. He very effectively articulated his suggestions for enhancing FPV protection via EW and methods for developing EW-resilient FPVs for future warfare. He recommended to consider proven technologies that are already available in the field for drone detection. He brought out that FPVs are being used in a wide range of frequencies and can quickly switch to new frequencies if jammed. A very important issue highlighted by him was that the era of Fixed frequency EW is over, as it is ineffective against intelligent FPVs that can change frequencies. Mr Navneet Singh came up with some very relevant recommendations, which are summed up later with other recommendations.

Cdr Yudhvir Sahani, (Retd) of Jugapro, spoke about why it is difficult to detect drones. He brought out as to how FPV drones have now become akin to flying cannons and how they can be assembled in large numbers locally using available munitions. He then brought out the possible solution of an SDR AESA radar system for detecting and tracking FPV drones and gave out a few examples of such radars.

Lessons Learnt / Recommendations

The talks by various speakers and open house discussion threw up many new ideas and brought out many lessons overall, the hybrid discussion came up with many relevant recommendations as discussed below:

- **Organisational Restructuring.** There is a need to revise our tactical level organisation structures for incorporating FPV drones into sub-unit level organisations for empowering our company, platoon, section and specialist crew commanders along our borders, coastline and even internally for counter-insurgency and even our police / paramilitary forces for peacetime law enforcement duties. **The forward deployment of portable 3D printers and drone machine shops in every military unit is a necessity today.**

Organisational architecture and procedural solutions also need to be found for developing multi-domain kill webs and TRSCs. **Multi-domain MUMTs would soon become the normal and not an exception.** Leadership styles would have to be adopted to lead men, machines, swarms, and systems in the era of 'Algorithmic Confrontation' to gain Algorithmic Superiority for achieving a decisive victory. The magic mantra is '**Adopt to Survive.**'

- **Tactics Revision.** FPV drones have become personal fire support today as they have redefined Close Quarter Battle (CQB), predominantly assault support for the last 100-250 metres and over the combat frontline extending from 10 to 15 km. Hence, the modern tactical drills need revision in view of the rising challenge of FPV drones, one-way attack drones and loitering munitions and their impact on methods of assault and combat dispersal. There definitely is a need for in-depth research and theoretical development on FPV technology and tactics. The frontline tactics need deliberations for maximising spatial dispersal, optimising innovative concealment and minimising exposure times.
- **Innovation to Induction Cycle.** There is a need to expand innovation across the length and breadth of the country through a whole-of-nation approach. However, there is a simultaneous need to expedite the complete technology cycle from innovation to induction, particularly for modern disruptive technologies during battle. The catchy phrase '**Become Innovators, Not Buyers**' by Mr Navnit Singh also highlighted the requirements for developing **technical expertise in the procurement teams.** A need was felt for stronger support and funding for startups in the drone industry to overcome R&D costs and ensure sustainability. All participants unambiguously agreed to foster collaboration and communication between the military and industry to better understand operational needs and develop battlespace solutions.
- **Intelligentisation / Autonomisation.** The speed of AI enablement of drones, as well as countermeasures in the face of battlefield innovations, has been rapid. Troves of data are being stored and archived for machine learning by both Russia and Ukraine. Indian defence forces, in conjunction with academia and civil industry, need to upgrade their data archival procedures for comprehensive machine learning and developing stronger algorithms.

- **Counter-UAS.** Indian defence forces need to study and incorporate the latest EW technologies for countering drones. Each stage of the Counter-UAS procedure needs to be studied, evolved, and implemented ruthlessly—detection, tracking, neutralisation, or destruction. The possibility of integrating a defensive drone system to destroy incoming drones or act as a decoy must be considered. There is an urgent need to explore alternative methods of jamming drones, such as DRFM-based electronic warfare or kinetic kills, particularly for fibre-optic FPVs.
- **High-Altitude Solutions.** There is an urgent need to come up with FPV drone solutions for operating in high altitudes, particularly addressing the quality of batteries. There is a need to explore solutions for issues such as magnetic interference, wind speed distortion and problems faced in the use of lithium-ion batteries in high altitude conditions.
- **Pilot Skillset Development.** FPV drones are dual-purpose DIY COTS drones which can be used for drone-racing competitions, logistics delivery including hot coffee, cyber-hacking, medical emergencies like blood delivery, peacetime law enforcement and a multitude of military tasks. Indian government must take up a strong initiative for developing dual-purpose training infrastructure to develop drones related skillsets from pilot to producers, assemblers, and repair mechanics. The production of millions of drones is not enough. The nation requires many pilots and mechanics, too. There is also a need to define DGCA norms for certified FPV drones' pilots.
- **Quality and Quantity.** Mr Navneet Singh rightly pointed out that 'Quantity has a Quality of its Own.' Hence, there is a very important balance required between quality and quantity. Apropos, Indian defence forces should be ready to accept cheaper and easier innovations that can be mass-manufactured.
- **Hardened FPVs.** In a densely congested AD, contested EM and GPS-denied environment, FPVs need to be hardened by lightweight OFC cables, EM hardening, cyber protection, vision-based GNSS-denied strap-down celestial navigation kits, mapping of likely flight routes in adversarial areas, etc.
- **R&D.** The Turkish, Iranian, Ukrainian, and Chinese technological advancements have proven that the Western era of military technological domination, particularly in a few selected areas, is over. Apropos, the Indian defence forces, in conjunction with various start-ups and civil industry, need to accelerate

a variety of R&D projects to innovatively adopt new technologies such as elevated radars, AI automation, SDR RF systems, electro-optic systems, acoustic systems, high-power microwaves/lasers, and IR detectors etc. Along lines of Ukrainian Brave One and Russian VOK projects, India needs to strengthen its R&D vertical, especially within the HQ IDS, to strengthen the integration amongst the three services. **Local formations need to establish Technology Incubation Centres with the startups in their geographical areas to accelerate R&D.**

- **Overcoming Chinese Dependency.** Ukraine's Ukrainisation of its drones and the Counter-UAS industry to completely move away from its reliance on Chinese components has shown the way for the eventually desired Indianisation of our drones' industry. There is an urgent need to get over the Chinese dependency by exploring indigenous solutions preferably, and if not possible, then non-Chinese alternatives should be explored, particularly for flight controllers and receiver transmitters. **The indigenisation certification and standards need streamlining with clear-cut punishments for defaulters resorting to copying Chinese products or undeclared use of Chinese components.**
- **Whole-of-Nation Approach.** With the dual-purpose advantages of FPV drones, it was felt that there is a case for developing a national policy on FPVs as an institutional response. A simple case in point is the multi-domain traffic management coordination required by the police for unmanned platforms and multi-domain battlespace management by the military. Legal procedures and policies need to be updated. The management of rogue drone threats transiting from civil to military areas and vice versa needs to be addressed procedurally, legally, and institutionally through a whole-of-nation architecture.

Conclusion

Major General Ashok Kumar, DG CENJOWS, concluded the seminar by highlighting that the future of conventional weapons and soldiers is not threatened by FPVs, but they are a disruptive tool that requires a holistic approach. Overall, kamikaze FPV drones offer cheap precision strike capabilities but are tactical beyond-line-of-sight weapons that primarily extend the reach of ground forces. FPV drones have increased the risk to tanks and other vehicles in the tactical battle area. However, till FPVs are autonomised, FPV drone pilots require training and must be very skilled to effectively steer the fast drones and crash them into vulnerable

parts of armoured targets. The density of small military, commercial, and FPV drones has made it risky for militaries to mass forces near the front lines, which in turn has decreased the ability to launch surprise attacks. Militaries, including the PLA, are changing their tactics for using multiple FPV kamikaze units to support assaults and defences.

There is also a need for controlled proliferation and accessibility, particularly to rogue non-state actors. It is important that a wider range of stakeholders are involved at the earliest for initiating a whole-of-nation approach. The Russo-Ukraine war has clearly established the requirement for mass production capacities to ensure combat sustenance and facilitate collaborative innovation in an era of decentralised warfare.