

# MANNED–UNMANNED TEAMING: CHANGING PARADIGMS OF AIR WARFARE

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## INTRODUCTION

Air power has been an effective tool with the state to impose its will on an adversary by virtue of its unique characteristics. The capabilities of its platforms, and the ability to calibrate escalation and disengagement control make it an ideal weapon for deterrence by punishment or denial.<sup>1</sup> It can dynamically create and enforce favourable asymmetry at the point of application. This ability of air power to be versatile and execute a swift response over extended ranges without regard to terrain restrictions gives enhanced flexibility to military planners.

The Gulf War, the recent conflicts in Armenia-Azerbaijan, the ongoing Russia-Ukraine and Israel-Hamas Wars have brought out various changing paradigms of air warfare. Network-centric warfare facilitated and expedited the US operations in Iraq, resulting in achieving air superiority over Iraq. However, the havoc created by

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1. Kapil Kak, "A Century of Air Power: Lessons and Pointers", *Strategic Analysis*, vol xxiv, no 12, March 2001, [https://ciaotest.cc.columbia.edu/olj/sa/sa\\_mar01kak01.html](https://ciaotest.cc.columbia.edu/olj/sa/sa_mar01kak01.html). Accessed on September 22, 2023.

drones in Armenia-Azerbaijan forced military planners to re-think and evolve to cater for these small and inexpensive platforms. An analysis of the sequence of events in the ongoing Russia-Ukraine conflict further highlights that while the primary aim of air power remains to gain control of the air, the character of air warfare is rapidly evolving.<sup>2</sup> The key reason for this evolution is the democratisation of air power.<sup>3</sup> Today, apart from nations, non-state actors can procure and employ seemingly large numbers of aerial platforms in the form of low-cost, expendable drones and small Unmanned Aerial Systems (UAS), making the task of exercising air control complex and challenging.<sup>4</sup>

War-fighting in the air dimension has evolved considerably. With the advent of technology and increased proliferation of UAS in the battlefield, efforts are on to enhance the capabilities of various platforms, to safeguard the vulnerabilities of manned aircraft. Manned-Unmanned Teaming (MUM-T) is a capability developed as part of the same, where a UAS operates in conjunction with manned aircraft.<sup>5</sup> This provides the pilot the ability to exploit the unique capabilities of the UAS and enhance his operational prowess.

## GENESIS

During the Cold War in the late 1960s, there was large scale uncertainty, fear, and panic between the United States of America (USA) and the erstwhile Union of Soviet Socialist Republics (USSR), primarily because of gaps in inputs on strategy, arms, and the intention of each other. This fear in the USA was primarily an outcome of the USSR's

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2. Kelly A Greico and Julia Seigel, "Air Power After Ukraine: The Future of Air Warfare", Atlantic Council, <https://www.atlanticcouncil.org/programs/scowcroft-center-for-strategy-and-security/forward-defense/airpower-after-ukraine/>. Accessed on January 2, 2024.
  3. Gwyne Dyer, "The Democratisation of Air Power", *Bangkok Post*, September 25, 2019, <https://www.bangkokpost.com/opinion/opinion/1757814/the-democratisation-of-airpower>. Accessed on January 1, 2024.
  4. Stuart Russell, "Why We Need to Regulate Non-State Use of Arms", Davos Agenda, World Economic Forum, <https://www.weforum.org/agenda/2022/05/regulate-non-state-use-arms/>. Accessed on January 2, 2024.
  5. G. Taylor and T. Turpin, "Army Aviation Manned-Unmanned Teaming (MUM-T): Past, Present, and Future", 18th International Symposium on Aviation Psychology 2015, [https://corescholar.libraries.wright.edu/isap\\_2015/12](https://corescholar.libraries.wright.edu/isap_2015/12). Accessed on January 1, 2024.

Anti-Access/Aerial Denial (A2/AD) environment. On May 1, 1960, a US U-2 reconnaissance aircraft was struck by a Russian surface-to-air missile. The USSR had restricted the US' credible intelligence capability. During the period prior to development of the KH-4 and KH-7 satellite collection systems, there was an urgent need of capability development to breach the USSR's A2/AD environment and provide the requisite intelligence picture. During this time, the US developed a reconnaissance platform employing a team of a manned platform and a drone. This led to the technological MUM-T concept of the US air power history: Project OXCART.<sup>6</sup>

In 1962, under Project OXCART, the Central Intelligence Agency (CIA) and the air force ordered various versions. In one case, a ramjet powered 43-ft-long drone was carried and launched by the A-12 aircraft. It could attain a speed of Mach 3.3. The drone was called the D-21 and the carrier was referred to as the M-12.<sup>7</sup> This was worked under the project known as TAGBOARD.<sup>8</sup> This project was the first instance when drones were attempted to be used in conjunction with a manned platform.

### **UNDERSTANDING THE CONCEPT**

The U.S. Army Aviation Centre defines MUM-T as “the synchronized employment of soldiers, manned and unmanned air and ground vehicles, robotics, and sensors to achieve enhanced situational understanding, greater lethality, and improved survivability.”<sup>9</sup> In this concept, complex data linkages are utilised to connect manned platforms with UAS at various Levels of Interoperability (LOI). This facilitates both manned aircraft and ground forces to exploit the capabilities of the UAS. This will improve decision-making and

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6. Major W. Maxwell, USAF, “A Historical Approach of Manned-Unmanned Teaming and Application to Future Concepts: An Air Power Perspective”, <https://apps.dtic.mil/sti/pdfs/AD1176485.pdf>. Accessed on August 4, 2023.

7. John Pike, “Senior Bowl D-21 TAGBOARD”, FAS Intelligence Resource Programme, <https://irp.fas.org/program/collect/d-21.htm>. Accessed on January 1, 2023.

8. George Washington University, “The U-2's Intended Successor: Project OXCART,1956-1968”, p. 33, <https://nsarchive2.gwu.edu/NSAEBB/NSAEBB434/docs/U2%20-%20Chapter%206.pdf>. Accessed on September 4, 2023.

9. BAE Systems, “What is Manned- Unmanned Teaming”, <https://www.baesystems.com/en-us/definition/what-is-manned-unmanned-teaming>. Accessed on September 4, 2023.

enhance mission effectiveness. The intelligence picture obtained from the UAS will provide new tactical options that could influence the changes or suitable amendments to the application of force, or changes in the strategy. The concept offers new LOI among the ground forces, manned aircraft, and UAS. The various LOI specified by the North Atlantic Treaty Organisation (NATO) Standard Agreements 4586 (STANAG 4586)<sup>10</sup> to accommodate operational needs are as follows:

- **Level 1:** Indirect receipt and/or transmission of sensor product and associated metadata.
- **Level 2:** Direct receipt of sensor product data and associated metadata from the Unmanned Aerial Vehicle (UAV).
- **Level 3:** Control and monitoring of the UAV payload, unless specified as monitor only.
- **Level 4:** Control and monitoring of the UAV, unless specified as monitor only, less launch and recovery.
- **Level 5:** Control and monitoring of the UAV launch and recovery, unless specified as monitor only.

### EVOLVING FOOTPRINTS OF MUM-T

With the advancements in drone technology, the concept is being explored and exploited at various LOI worldwide. The effort is focussed towards complementing the capabilities of the two platforms i.e. manned vs unmanned platforms and overcoming the vulnerabilities. It is being referred to as the “loyal wingman”<sup>11</sup> whereby the UAV can be configured to undertake numerous missions in conjunction with manned platforms. Most of the leading military powers are employing this technology and have suitably modified/developed their Concept of Operations (CONOPS) accordingly.

The United States Air Force (USAF) undertook this science-and-technology initiative under Programme Skyborg.<sup>12</sup> The programme

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10. MM Marques, “STANAG 4586—Standard Interfaces of UAV Control System (UCS) for NATO UAV Interoperability”, NATO, <https://www.sto.nato.int/EN-SCI-271-03>. Accessed on September 4, 2023.

11. Valius Venckunas, “Loyal Wingmen: The Cyberpunk Future of Aerial Warfare”, *Aerotime*, March 30, 2023, <https://www.aerotime.aero/articles/25825-loyal-wingmen-the-cyberpunk-future-of-aerial-warfare>. Accessed on January 1, 2024.

12. Air Force Research Laboratory, “SKYBORG: Bringing Cutting-Edge Autonomy Capabilities to the Fight at a Faster Pace and Lower Cost”, *AFRL*, <https://afresearchlab.com/technology/skyborg>. Accessed on January 1, 2024.

aims to enable manned-unmanned teaming by integrating diverse drone technologies with open mission systems. The endeavour is to design a family of UAS that can use Artificial Intelligence (AI), can adapt to the operational environment, and can execute decision-making at machine speeds. These autonomous platforms act as robotic wingmen for manned aircraft.<sup>13</sup>

In March 2015, the first MUM-T squadron was raised in the USA.<sup>14</sup> The squadron was configured by pairing the AH-64D/E Apache helicopters with the RQ-7B Shadow UAV of Textron Systems in one heavy attack-reconnaissance unit. It can perform operations from LOI 2 to LOI 4. During the US Pacific Fleet's Unmanned Integrated Battle Problem '21 exercise in April 2020, the MQ-9A Block 5 exhibited connectivity with the US Navy surface ships and planes in a test to incorporate unmanned capabilities in daily fleet operations and battle plans.<sup>15</sup> In October 2020, an MQ-1C Gray Eagle Extended Range UAS, in conjunction with an Apache AH-64E helicopter and a Shadow RQ-7BV2 Block III tactical UAS, successfully executed the launch of a missile.<sup>16</sup>

In August 2020, Russia displayed and projected the Grom Unmanned Combat Aerial Vehicle (UCAV) in its army exhibition as part of its endeavours to join the race of the MUM-T programme.<sup>17</sup> The Grom UCAV is designed to operate in conjunction with the Su-35 and Su-57 fighter aircraft.<sup>18</sup> These UCAVs can carry a

13. John Harper, "BREAKING: Air Force to Fly New Skyborg Drones Next Year", *National Defense*, July 28, 2020, [nationaldefensemagazine.org](https://nationaldefensemagazine.org). Accessed on September 5, 2023.

14. Beth Stevenson, "US Army Establishes First Manned-Unmanned Unit", *Flight Global*, March 24, 2015, <https://www.flightglobal.com/helicopters/us-army-establishes-first-manned-unmanned-unit/116335.article>. Accessed on January 1, 2024.

15. Richard R. Burgess, "Navy's Unmanned Integrated Battle Problem 21 to Culminate in Missile Shoot", *SEAPOWER*, April 20, 2021, <https://seapowermagazine.org/navys-unmanned-integrated-battle-problem-21-to-culminate-in-missile-shoot/>. Accessed on September 5, 2023.

16. Colonel Mandeep Singh, "The Future is Now: Air Power in the Age of Manned-Unmanned Teaming", *SEAPOWER*, April 20, 2021, [https://www.defstrat.com/magazine\\_articles/the-future-is-now-air-power-in-the-age-of-manned-unmanned-teaming/](https://www.defstrat.com/magazine_articles/the-future-is-now-air-power-in-the-age-of-manned-unmanned-teaming/). Accessed on September 9, 2023.

17. "Unmanned Combat Aerial Vehicle Grom", *REDSTAR*, [https://www.redstar.gr/index.php?option=com\\_content&view=article&id=5543:unmanned-combat-aerial-vehicle-grom&catid=783&lang=en&Itemid=530](https://www.redstar.gr/index.php?option=com_content&view=article&id=5543:unmanned-combat-aerial-vehicle-grom&catid=783&lang=en&Itemid=530). Accessed on January 1, 2024.

18. Roger McDermott, "Russia's UAVs and UCAVs: ISR and Future Strike Capabilities", The Jamestown Foundation, <https://jamestown.org/program/russias-uavs-and-ucavs-isr-and-future-strike-capabilities/>. Accessed on January 2, 2024.

payload of two tons of bombs and missiles and operate at a speed of 1,000 kmph. These are primarily being planned to be employed for suppression/destruction of enemy air defences, along with engagement of ground targets, based on the requirement. In 2019, the S-70 Okhotnik-B UAS operated in conjunction with the Su-57 and had demonstrated MUM-T capability.<sup>19</sup> The Russian S-70 Okhotnik UCAV was reportedly used on the Ukrainian battlefield on June 27, 2023, where it struck Ukrainian military facilities in the regions of Sumy and Kremenchuk.<sup>20</sup>

The development of MUM-T capabilities has also been reported in China. However, the inputs on the same have been scanty. Sky Hawk, China's stealth drone, has technology which facilitates communication and collaboration with manned aircraft during various stages of operations. The Chief Engineer at China Aerospace Science and Industry Corporation, Ma Hongzhong has mentioned that the Sky Hawk has MUM-T capabilities.<sup>21</sup> If media reports are to be believed, the FH-97 wingman drone is similar to the US XQ-58A Valkyrie, and the GJ-11 has been developed as a rival to the US' stealth RQ-170.<sup>22</sup> Further, the twin-seat J-20 is likely to be utilised to control the wingmen drones.<sup>23</sup> In October 2018, it was reported that the Pakistan Aeronautical Complex and Chengdu Aircraft Corporation had entered into a contract to co-produce 48 Wing Loong-II UCAVs for Pakistan.<sup>24</sup> The Wing Loong-II is capable of performing the

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19. Leonid Nersisyan, "Russia Jumps on the MUM-T Bandwagon", *Shephard News*, September 25, 2020, shephardmedia.com. Accessed on September 5, 2023.

20. Vijander K. Thakur, "Russia's S-70 Okhotnik Heavy Stealth Drone Starts Bashing Ukrainian Forces as Kyiv Desperately Awaits F-16s", *The EurAsianTimes*, July 1, 2023, <https://www.eurasiantimes.com/russias-s-70-okhotnik-heavy-stealth-drone-starts-bashing/>. Accessed on September 6, 2023.

21. Kristin Huang, "China's Sky Hawk Stealth Drone has Capability to Talk to Fighter Pilots, Developer Says," *my NEWS*, January 11, 2019, <https://www.scmp.com/news/china/military/article/2181731/chinas-sky-hawk-stealth-drone-has-capability-talk-fighter-pilots>. Accessed on September 5, 2023.

22. Reuters, "China Unveils 'Loyal Wingman' Armed Drone Concept", *The Tribune*, September 29, 2021, <https://tribune.com.pk/story/2322516/china-unveils-loyal-wingman-armed-drone-concept>. Accessed on January 2, 2024.

23. Parth Satam, "China's J-20 Fighter Flies With Trio Of Stealthy GJ-11 'Wingmen' Combat UAVs – CCTV Graphic Sets Internet Ablaze", *The EurAsian Times*, October 13, 2022, <https://eurasantimes.com>. Accessed on September 7, 2023.

24. Lieutenant General (Dr) V K Saxena, PVSM, AVSM, VSM (Retd), "Unmanned Aerial Systems: Manned and Unmanned Teaming in India's Neighbourhood", *Indian Military*

MUM-T role. Pakistan would be looking forward to developing and exploiting this capability.

### DEVELOPMENTS IN INDIA

Hindustan Aeronautics Limited (HAL) is undertaking the Indian project on MUM-T under the Combined Air Teaming System (CATS).<sup>25</sup> The system comprises three unmanned systems, namely CATS Hunter, CATS Warrior, CATS Alfa-S. The project is to integrate the programme with the Light Combat Aircraft (LCA) Tejas, Su-30MKI, Jaguar and Rafale. It aims to enhance the mission effectiveness and reduce the vulnerability to the lives of pilots. The CATS Warrior is likely to join the Indian Air Force (IAF) by 2024-25.<sup>26</sup>

CATS will function as an umbrella system in conjunction with an LCA-based mother ship.<sup>27</sup> The twin-seater Tejas MK1 trainer will be the "Mothership for Air teaming Exploitation" (MAX). The command and control system of the aircraft is being suitably upgraded to meet the requirements of its role as the MAX. The weapon system operator of the MAX will be capable of controlling every UAS/swarm drone associated with the LCA. There will be a network of autonomous drones linked to fighter platforms through CATS. They can be employed for air-to-air, air-to-sea, and air-to-ground combat. The Tejas twin-seat trainer is being perfected as part of a manned-unmanned teaming idea.<sup>28</sup>

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*Review*, April 9, 2020, <https://imrmedia.in/army2020-unmanned-aerial-systems-manned-and-unmanned-teaming-in-indias-neighbourhood/>. Accessed on January 4, 2024.

25. Prasad Gore, "Decoding HAL CATS Program", *Defence XP India Defence Network*, February 6, 2021, <https://www.defencexp.com/decoding-hal-cats-program/>. Accessed on January 1, 2024.
26. Rohit Srivastava, "Manned-Unmanned Teaming – New Era in Air Warfare", *Indian Defence Industries*, February 17, 2021. Accessed on September 7, 2023.
27. "HAL/Newspace Combat Air Teaming System (CATS) Program - Updates and Discussion", *Strategic Front*, <https://www.strategicfront.org/forums/threads/hal-newspace-combat-air-teaming-system-cats-program-updates-and-discussion.4355/>. Accessed on January 1, 2024.
28. Group Captain (Dr) Dinesh Kumar Pandey, "Manned-Unmanned Teaming in Combat Air Systems: Revolutionizing Contemporary Warfare", *India Strategic*, June 14, 2023, <https://www.indiastrategic.in/manned-unmanned-teaming-in-combat-air-systems-revolutionizing-contemporary-warfare/>. Accessed on September 7, 2023.

## CHANGING PARADIGMS

The MUM-T concept brings in adequate flexibility. Its application needs to be well deliberated so that suitable modifications can be done in CONOPS to integrate it in the operational construct. Certain changing paradigms which are evident with this new concept are enumerated below.

- **Risk Mitigation:** The MUM-T concept brings in loyal wingmen drones capable of performing dangerous missions, without risking the pilot's life.<sup>29</sup> With the infused AI, it allows control of sensors and shooters, provides added potential to fly the designated route and carry out the desired reconnaissance patterns. The ability to communicate with various UAS, reduces the time at the objective, thereby mitigating the risk to both the air crew and the manned platform.
- **Suppression/Destruction of Enemy Air Defences:** These platforms can be effectively employed as low-cost decoys to identify, saturate, suppress/destroy enemy air defences and thereby facilitate the effective engagement by the main effort without exposing the manned platforms to enemy fire.<sup>30</sup>
- **Force Multiplier:** The teamed-unmanned platforms will amplify and effectively assist in optimising the advanced capabilities of manned aircraft. With the advancement in the technology and the induction of fifth generation stealth aircraft, the operational reach and capabilities will enhance manifold.<sup>31</sup>
- **Force Preservation:** With the increased sensor range and amalgamation of low-cost drones, the concept enhances the effective detection and engagement capability of fighter aircraft. This permits a smaller number of manned platforms to cover larger areas of the battlespace. As per the Mitchell Institute of Aerospace Studies, low cost, attritable aircraft "could extend the

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29. "MUM-T: Manned-Unmanned Teaming", *UAV Navigation*, September 5, 2023, <https://www.uavnavigation.com/company/blog/mum-t-manned-unmanned-teaming>. Accessed on January 4, 2024.

30. Air Marshal Anil Chopra (Retd), "UAV Trends", *SP's Aviation*, issue 12, 2023, <https://www.sps-aviation.com/story/?id=3424&h=UAV-Trends>. Accessed on January 1, 2024.

31. "Manned-Unmanned Teaming", *Airbus*, <https://www.airbus.com/sites/g/files/jcbtal136/files/2021-09/MUT%20Datashheet.pdf>. Accessed on January 1, 2024.

effective sensor range and kill radius of the F-22s, and F-35As, allowing smaller numbers to cover larger areas of the battlespace and kill more threats per sortie.”<sup>32</sup>

**Protection of Critical Assets:** Some of the critical assets like the Airborne Warning and Control System (AWACS), Airborne Early Warning and Control (AEW&C) and Flight Refuelling Aircraft (FRA) need the requisite degree of protection to withstand the enemy air threat. The loyal wingman, with integrated surveillance and offensive capability, can be a viable solution for the protection of these critical assets. This will result in releasing the fighter aircraft for other missions and thereby enhance the operational efficiency.

- **Operating Through Electronic Warfare (EW):** With suitable kitting, the integrated drones can be a viable option to facilitate operations through an intense EW environment. They can act as decoys as well as serve as EW escorts for the main effort.
- **Enhanced Situational Awareness of Aircrew:** The interoperability between these unmanned platforms and integrated manned platformme, provides the aircrew with enhanced situational awareness and thereby facilitates deliberate and timely decision-making.<sup>33</sup>
- **Enhanced Lethality:** Unmanned platforms significantly contribute in MUM-T mission accomplishment as they can strike heavily defended targets, which would be too risky for manned aircraft to attempt.
- **Enhanced Precision:** The loyal wingmen drones can execute complex procedures in reduced time-frames. With improved AI and programming, they can achieve enhanced precision and can improve targeting as the risk of human error is reduced.
- **Role of Aircrew:** The role of fighter pilots will be more challenging as they will be the only human interface once airborne. While, pilots will have enhanced situational awareness, management of

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32. Mark Gunzinger and Lukas Autenried, “Understanding the Promise of Skyborg and Low-Cost Attritable Unmanned Aerial Vehicles”, *Mitchell Institute Policy Paper*, Vol 24, September 2020, [https://mitchellaerospacepower.org/wpcontent/uploads/2021/01/a2dd91\\_2a1da65374434775b321619daf50a0a3.pdf](https://mitchellaerospacepower.org/wpcontent/uploads/2021/01/a2dd91_2a1da65374434775b321619daf50a0a3.pdf). Accessed on September 7, 2023.

33. Thomas Withington, “Manned – Unmanned Teaming”, *EMESOPEDIA*, <https://www.emsopedia.org/entries/manned-unmanned-teaming/>. Accessed on January 1, 2024.

the interplay of the machines and exploitation of the edge against the adversary would be required.

- **Employment in a Non-Combat Role:** These unmanned platforms can be effectively and innovatively utilised during training to perform as the aggressor and can be used to replicate the hostile force package.
- **Cost-Effectiveness:** The unmanned loyal wingman is relatively cheaper, more potent, and versatile. It can reduce casualties and provide deeper penetration in contested zones with reduced risk because of the low Radar Cross-Section (RCS) and reduced cost. It can fly and execute manoeuvres which are riskier than those of manned platforms and can also operate as the kamikaze against a designated target if the operation requires it.<sup>34</sup> The initial cost and the advantages accrued will prove to be much more economical overall.

## CHALLENGES

The concept provides an opportunity to air planners to exploit the technology and have an edge in the air battle. However, it also poses certain challenges, which need to be catered for while planning operations. Some of the critical challenges are as under:

- **Task Saturation and Excessive Workload on the Pilot:** MUM-T may become a significant problem for pilots of manned platforms. In 2015, the United States Army Aeromedical Research Laboratory focussed on this issue and conducted a study analysing Human Factors (HFs) and aeromedical challenges which could be posed by MUM-T applications.<sup>35</sup> As per the study, pilots, while operating in the MUM-T mode the may face visual overload. The increased workload and the task saturation may also cause distraction and motion sickness.

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34. Air Marshal Anil Chopra (Retd), "Why Manned-Unmanned Aircraft Teaming is the Future", News18, June 8, 2023, <https://www.news18.com/opinion/opinion-why-manned-unmanned-aircraft-teaming-is-the-future-8032147.html>. Accessed on January 1, 2024.

35. S. J. Gaydos, and Curry, "Manned-Unmanned Teaming: Expanding the Envelope of UAS Operational Employment" (Reprint), *Aviation Space and Environmental Medicine* 85(12), pp. 1231-1232, December 2014, [https://www.researchgate.net/publication/269184034\\_Manned-Unmanned\\_Teaming\\_Expanding\\_the\\_Envelope\\_of\\_UAS\\_Operational\\_Employment](https://www.researchgate.net/publication/269184034_Manned-Unmanned_Teaming_Expanding_the_Envelope_of_UAS_Operational_Employment). Accessed on November 23, 2023.

- **Risk of Spatial Disorientation:** The United States Army Aeromedical Research Laboratory study warns that processing conflicting sensory information (between the aerial platform motion cues and unmanned platform orientation), and other consequences of increased unmanned aerial system interoperability in the cockpit, may increase the risk of spatial disorientation.<sup>36</sup> The study states that while the battlefield situational awareness may increase, the flying situational awareness would decrease.
- **Variables Affecting Employment of Unmanned Platforms:** Various factors like counter-measures available on the platform, its manoeuvrability, degree of control of the air, risk of getting targeted, reaction-time delays due to human input requirements, and susceptibility to datalink disruption are some of the major challenges which need to be catered for, for effective employment.<sup>37</sup>
- **Policy and Doctrine:** Lack of a clear policy and enunciated doctrines which would facilitate in chalking out tactics, carrying out training and establishing procedures is a major challenge for the concept's effective employment.<sup>38</sup>
- **Regulatory Framework:** The concept is still in the process of maturing for universal acceptance. Thus, the nuances of airspace management, communication and datalinks, along with the support structure which would facilitate optimum exploitation of this concept, both technically and tactically, is still evolving. A regulatory framework, hence, needs to be established.

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36. Lieutenant Colonel Livio Rossetti, "Manned-Unmanned Teaming: A Great Opportunity or Mission Overload?", Joint Airpower Complete Centre, January 2020, Journal Edition 29, <https://www.japcc.org/articles/manned-unmanned-teaming/>. Accessed on November 23, 2023.

37. Syed Agha Hasnain Mohsan, "Unmanned Aerial Vehicles (UAVs): Practical Aspects, Applications, Open Challenges, Security Issues, and Future Trends", *Springer Nature Link*, <https://link.springer.com/article/10.1007/s11370-022-00452-4#citeas>. Accessed on January 6, 2024.

38. Lieutenant Commander Dave "DB" Barnhill, "The Manned-Unmanned Team: Where's the Doctrine?", US Naval Institute, March 2019, Proceedings, Vol. 145/3/1,393, <https://www.usni.org/magazines/proceedings/2019/march/manned-unmanned-team-wheres-doctrine>. Accessed on November 23, 2023.

## **CONCLUSION**

The recent advancements in drone technology coupled with AI, chip technology, and robotics have resulted in a plethora of innovations towards machine learning, achieving mutual coordination and accomplishing multiple tasks. The outcomes of these are being innovatively employed in modern day warfare. The MUM-T concept is an outcome of the same and it is likely to be further improved as the technology develops. The recent conflicts in Armenia-Azerbaijan and Russia-Ukraine are testimony to drone warfare. The teaming of these drone platforms as smart drones with manned platforms will only add to the lethality and capability of the platforms. However, the dividends will depend on the application and suitable modifications of CONOPS.