

EMERGING TECHNOLOGIES AND ITS IMPACTS ON AIR POWER

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September 7, 2024

(Views expressed in the brief are those of the author, and do not represent those of ISSI)



Source: "Pakistan Air Force: Second to None," Hilal, February 2021, <https://hilal.gov.pk/view-article.php?i=4865>

Introduction

Airpower is the ability to project military power or influence through the control of air and space to achieve political, strategic, operational, or tactical objectives.¹ Since its inception, the world, in general, has indisputably used air power as the primary means of employing the military instrument of national power. Most conventional military actions since 1991 have either begun with or been largely covered with air power campaigns — at least from the perspective of friendly forces.² In modern warfare, air power remains highly effective. The Russia-Ukraine and Israel-Palestine conflicts are current examples where the air forces of Ukraine, Russia, and Israel have played vital roles in their respective wars.

Emerging technologies, such as Artificial Intelligence (AI), Unmanned Aerial Vehicles (UAVs), hypersonic weapons, cyber warfare tools, and Directed Energy Weapons (DEWs) revolutionized air power. This revolution in warfare was predicted by Sir Richard Barrons, former commander of Joint Forces (UK).³ Air power plays a key role in shaping global politics and pursuing national interests. In

¹ C R Melville MBE, "Re-presenting British Air Power Doctrine: A Visual Model of Air Power," RAF, <https://www.raf.mod.uk/what-we-do/centre-for-air-and-space-power-studies/documents1/re-presenting-british-air-power-doctrine-a-visual-model-of-air-power/>.

² Ibid.

³ Victor Gervais, *Emerging Technologies and the Future of Warfare* (Trends Research & advisory, 2021). <https://books.google.com.pk/books?id=QG9UEAAAQBAJ&printsec=frontcover#v=onepage&q&f=false>.

this regard, the Pakistan Air Force (PAF) has adopted these emerging technologies and initiated the modernization of its fleet and capabilities. PAF is committed to maintaining air superiority and ensuring national security. Efforts are underway to incorporate advanced UAVs and AI-driven systems. Meanwhile, PAF still requires DEWs for a broader strategy to enhance combat readiness and technological superiority and maintain the balance of power at the regional level, especially vis-à-vis India.

New Technologies

Unmanned Aerial Vehicles

UAVs, commonly known as drones, have transformed air operations by providing capabilities that were previously impossible. These remotely piloted or autonomous systems offer operational advantages such as extended endurance and reduced risk to human pilots because they are cost-effective. Moreover, most recently, extremist groups such as the Houthis in Yemen have used Unmanned Combat Air Vehicles (UCAVs) for strategic attacks in the Red Sea. So, the proliferation of drones has raised ethical and legal concerns, and the development of counter-drone technologies as well.

Artificial Intelligence

AI has rapidly changed the air power landscape. It enhances decision-making processes, automates complex tasks, and improves the effectiveness of air operations. It provides insights for mission planning and threat detection. In combat scenarios, AI-enabled systems have started assisting pilots with target identification, threat assessment, and military drills. The integration of AI also extends to autonomous UAVs, enabling them to operate independently or in coordination with manned aircraft. The combination of traditional human control of air assets and AI systems will allow greater flexibility to shape air battles.

In modern air warfare, AI is a critical element in the development of Lethal Autonomous Weapons Systems (LAWS), which are armed with the capability to autonomously distinguish and engage their targets without any command from human beings. It is bringing a clear shift in warfare, which is marked by changing from humans in the loop to humans out of the loop.⁴

⁴ Ibid.

Hypersonic Weapons

Hypersonic weapons are capable of traveling at speeds greater than Mach 5. The speed makes their interception difficult. These weapons can penetrate advanced air defence systems due to their high speed, maneuverability, and low-altitude flight paths. The development and deployment of hypersonic weapons have strategic implications, as they can deliver rapid, precise strikes on high-value targets, potentially altering the balance of power.⁵

Cyber Warfare and Electronic Warfare

Cyber and electronic warfare capabilities with air power systems have become important. It involves the use of computer technology to disrupt, degrade, or destroy enemy defence systems, communication networks, and critical installations. The aim is to break the coordination between the ground and sky (pilot, missile, or any ammunition). It damages the command-and-control system.

Electronic warfare includes the use of electromagnetic spectrum or DEWs to weaken enemy communications, radar, sensors, and other defence systems. It helps in gaining and maintaining air superiority without interruption from hostile aircraft in hostile or friendly territory. Turning off enemy defences can enhance the effectiveness of air operations. However, it is still vulnerable to jamming the missiles due to the relationship between the sensor-shooter bond of the missile.⁶

Air power assets require protection from cyber threats. It requires strong cybersecurity measures, training, and practice for effective results. Cyber and electronic warfare capabilities enhance the ability to conduct information warfare, influencing the strategic environment. UAVs provide persistent presence and flexibility, allowing for rapid response to emerging threats.

Stealth Technologies

Stealth technology has long been a game-changer for modern air power because it enables an aircraft to have a minimum radar cross-section (RCS), which allows it to evade enemy air defences.⁷ Stealth is added to an aircraft by either coating its surface with radar-absorbing materials, changes in

⁵ "Hypersonic Weapons: Background and Issues for Congress," Congressional Research Service," accessed August 30, 2024, <https://sgp.fas.org/crs/weapons/R45811.pdf>.

⁶ Mark Massa, "The Role of Electronic Warfare, Cyber, and Space Capabilities in the Air Littoral," *Atlantic Council* (blog), August 30, 2022, <https://www.atlanticcouncil.org/content-series/airpower-after-ukraine/airpower-after-ukraine-taking-todays-lessons-to-tomorrows-war/>.

⁷ "Stealth Technology and Air Warfare," 1991. <https://apps.dtic.mil/sti/tr/pdf/ADA529417.pdf>.

airframe designs, or reducing its infrared signature. It plays a crucial role in maintaining air superiority and executing strategic missions.

Though this technology is very expensive, it is justified due to the survivability and operational effectiveness of jets in hostile territory where otherwise traditional fighters fail. These jets are capable of destroying many targets in a single sortie to achieve strategic operational goals. In response to these jets, states have started heavy investments in anti-stealth technologies.

Directed Energy Weapons

Directed energy weapons, such as lasers and microwave weapons, offer the potential to revolutionize air defence and offensive capabilities. These weapons use focused energy to damage or destroy targets with precision, speed, and minimal collateral damage. DEWs can be employed for various purposes, including missile defence, disabling enemy sensors, and neutralizing UAVs. This technology can convert one form of energy to another form for exploiting and a vulnerability for paralyzing the adversary. These weapons include high-energy laser and high-power microwave weapons — the development and deployment of DEWs present opportunities for enhancing air power.

Impact on the Pakistan Air Force

The PAF has taken substantial steps to modernize its fleet and capabilities. PAF is currently operating advanced fighter jets like the JF-17 and F-16 with Mid-Life Update, J-10CE, and UAVs. A foundation for stealth jets like J-31 has already been laid.⁸ Recent acquisitions and upgrades have focused on enhancing combat readiness. These efforts are aimed at maintaining air superiority and addressing evolving security challenges at domestic and regional levels by providing a credible deterrent against any aggression.

PAF has advanced UAVs for surveillance and strike missions. Efforts are underway to develop AI-driven systems for improved decision-making through research and development, but PAF has a long way to go in this field.⁹ These initiatives are part of a broader military strategy to remain at the forefront of technological advancements.

⁸ “China’s J-10CE and Eurofighter Typhoon Jets Face off in Pakistan-Qatar Drills,” *South China Morning Post*, January 30, 2024, <https://www.scmp.com/news/china/military/article/3250201/chinas-j-10ce-vs-eurofighter-typhoon-jets-face-pakistan-qatar-air-drills>.

⁹ CASS-Journal of aerospace and security studies-Final-12-8-2022, P.19
<https://www.jassjournal.casstt.com/wp-content/uploads/2022/09/CASS-Journal-Final-12-8-2022.pdf>

Pakistan requires more UAVS for surveillance at its borders, especially the west and southwest border. Transnational terrorism was raised there right after the withdrawal of the U.S. from Afghanistan. Pakistani authorities have always expressed their concerns against the advanced weapons left by the U.S. and its friendly forces (NATO) there. Terrorist groups like TTP and BLA have been using these advanced weapons against Pakistan forces and their installations.

PAF should involve public-private partnerships through institutions, such as NASTP and other educational institutes like NUST, for self-reliance with minimal budget expenditures. This collaboration will not only help the defense posture of Pakistan but will also help in the generation of national wealth.

Conclusion

Emerging technologies have transformed air power, offered new capabilities, and altered the geostrategic defence posture of states. It has compelled states to reshape their defence doctrines. UAVS, UCVS, AI, hypersonic weapons, cyber and electronic warfare, advanced stealth, space weaponization, and DEWs each provide unique opportunities and challenges. The continuous evolution of these technologies will shape the future of air power. Nations that successfully introduce these advancements will maintain a strategic edge in defence and military operations.

With emerging technologies, Pakistan Airforce can secure its place as a formidable Airpower in the region, contributing to achieving its national objectives. These technologies hold the potential to enhance regional stability. Despite challenges such as high acquisition costs and the need for specialized training, the PAF's modernization efforts, including collaborations with international partners and investments in research and development, position it to counter regional threats effectively. With these technologies, PAF will be able to safeguard Pakistan's air space and conduct counterterrorism operations, thereby contributing to the security of Pakistan.