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USING AI-POWERED TECHNOLOGIES TO WIN FUTURE WARS

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INTRODUCTION

From Artificial Intelligence (AI)-powered drones to quantum computers, the Next Generation of Missions and Technologies (NGMT) is revolutionising how the world defends itself. With the race to reach new frontiers of warfare accelerating, AI-powered technologies for defence applications are pushing the boundaries of innovation and security for nations worldwide. As the world continues to move towards a more connected and technology-driven future, it is essential that the Indian military and its Air Force keep pace with the evolving landscape.

At the forefront of NGMT are AI, robotics, quantum computing, 5G and the Internet of Things (IoT), hyperspectral and infrared imaging, directed energy weapons, and microsatellites. All of these are critical components of this new technological landscape. These technologies promise to revolutionise defence operations, enhancing the capabilities of military personnel while reducing costs and risks. However, the scale and scope of all these technologies are vast; it is impossible to do justice if we have to cover all these NGMTs in one

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Successful commanders throughout history were the ones who could sort through incomplete information, evaluate what was likely and what was improbable, and make a decision based on their professional judgment honed by experience.

article. Hence, to have in-depth coverage, we would go through in detail the most crucial of these technologies, i.e. AI and autonomous systems.

The finest tactical approach for war can be summarised in Lord Nelson's famous maxim, "*Go right at 'em*", i.e., how best to position a squadron, a fleet, or an Army battle group, to inflict maximum harm.[1] However, to achieve this, information is the key element. But accurate information is always difficult to obtain in the middle of a crisis. Generally, "first reports are always wrong".[2] Successful commanders throughout history were the ones who could sort through incomplete information, evaluate what was likely and what was improbable, and make a decision based on their professional judgment honed by experience.

COMBAT MANAGEMENT SYSTEMS (CMS)

In recent years, AI has become increasingly important in military operations. AI-powered Combat Management Systems (CMS) are being developed to provide commanders with enhanced situational awareness and automated decision-making capabilities. These systems can be used to facilitate more effective management of complex military operations and are expected to revolutionise the way the military engages in battle.

CMS are designed to provide commanders with a comprehensive picture of the battlefield. The system collects data from various sources

1. Graham Scarbro, "'Go Straight at 'Em!': Training and Operating with Mission Command," *Proceedings of US Naval Institute* 145/5, no. 1395, May 2019, https://www.usni.org/magazines/proceedings/2019/may/go-straight-em-training-and-operating-mission-command.
2. Elizabeth Owen Bratt, Eric A. Domeshek, and Paula J. Durlach, "The First Report Is Always Wrong, and Other Ill-Defined Aspects of the Army Battle Captain Domain," in *Intelligent Tutoring Technologies for Ill-Defined Problems and Ill-Defined Domains* (10th International Conference on Intelligent Tutoring Systems, Pittsburgh, Pennsylvania, USA, 2010), pp. 9–16, http://www.philippe-fournier-viger.com/ill-defined/ITS2010_Proceedings_IllDefinedDomains.pdf.

such as sensors, surveillance systems, and other intelligence sources and processes it to create an up-to-date view of the battlefield. This data is then used to generate a real-time 3D representation of the battlefield. The systems can be used to track the movements of friendly and hostile forces, predict the enemy's movements, and provide a high-level view of the overall battle.

AI-powered CMS are expected to revolutionise how the military engages in battle. These systems can provide enhanced situational awareness and automated decision-making capabilities and help commanders make better informed decisions faster.

AI-powered CMS are expected to revolutionise how the military engages in battle. These systems can provide enhanced situational awareness and automated decision-making capabilities and help commanders make better informed decisions faster. Additionally, the systems offer advanced analytics and forecasting capabilities, which can help commanders better anticipate enemy movements and plan their own tactics accordingly. As a result, these systems are likely to become an essential part of the modern battlefield and will help the military stay one step ahead of its adversaries.

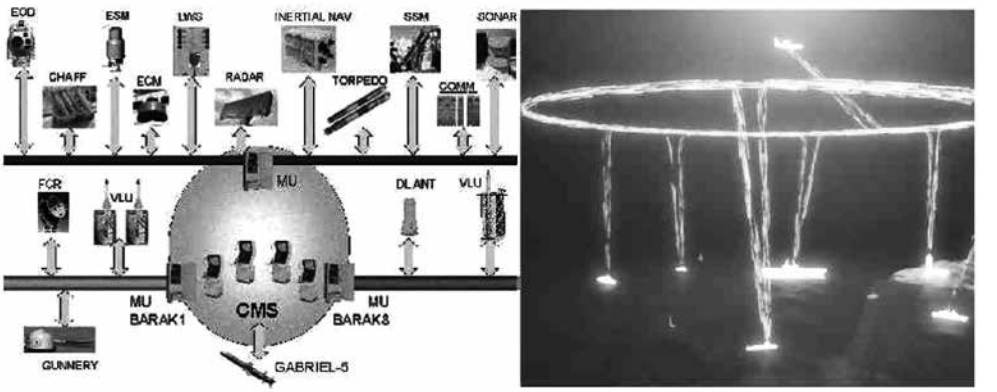
Nowadays, when CMS have proliferated throughout the tri-Services, a commander receives myriad digital information from multiple sources and sensors.[3] In addition, the vast proliferation of personal computers, the advent of the internet, and the incredible advances (potential for conflicts) in cyber space have inundated the entire world with information that previously required much time and human labour to acquire, analyse and classify.

Sorting the Information: In military operations, information is no longer primarily sourced from sensors located onboard own aircraft, warships, or mechanised vehicles, often termed 'organic sensors'. Accurate information is available from satellites, shore stations, other Services' joint assets, and open sources (Fig. 1). The amount of information available to a military commander

3. Mike Ball, "NATO Tactical Datalink Integrated into Naval Combat Management System," *Defense Advancement*, November 8, 2020, https://www.defenseadvancement.com/news/nato-tactical-datalink-integrated-into-naval-combat-management-system/.

today is immense, and it changes so very quickly that the human mind is unable to keep up with its pace and size. It is apparent that combat decision-makers need new ways to sort through all the data with which they are being swamped. Sorting through the complexity of information during operations by humans striving tirelessly is no longer enough. The ever-increasing scope of attacks calls for counter-measures that will push the boundaries of human cognition. Here lies the need to deploy machine learning and big data analytics algorithms to aid and hasten decision-making.[4] There is no way that the finest human watch-keeper could defend against multiple targets, undergoing zillions of manoeuvres per second, possibly travelling at hypersonic velocities that have been choreographed by AI across domains. *Humans cannot be everywhere at once, but software can.*[5]

Fig 1: CMS Integrated with NATO Data Link



Source: Mike Ball, https://www.defenseadvancement.com/news/nato-tactical-datalink-integrated-into-naval-combat-management-system/

Speeding up the OODA Loop: The information that is available to a commander facing the battles is as much as the information available to his

4. Justin Hendrix, "AI and National Security: Examining First Principles: A Conversation with Lucy Suchman," *Technology, Power, Policy and People,* April 11, 2021, https://techpolicy.press/ai-and-national-security-examining-first-principles-a-conversation-with-lucy-suchman/.
5. Eric Schmidt "Emerging Technologies and Defense: Getting the Fundamentals Right," February 23, 2021, at https://www.armed-services.senate.gov/imo/media/doc/Schmidt_02-23-21.pdf.

adversary, so *how, then, can we position ourselves better than the enemy?* The key lies not in the availability of information but in the speed of decision-making after the processing of the available data. Parallels can be drawn to US Air Force's Colonel John Boyd's model of the Observe-Orient-Decide-Act (OODA) loop propounded for air dogfights. Fighter pilots, who could cycle more quickly through the OODA loop, i.e. make correct decisions more quickly, generally won the dogfight. Today, there is a need to compress the time-frames of decisions from minutes to seconds. Fortunately, the advent of AI systems holds great promise to augment critical human decision-making, especially when the speed of the decision matters in terms of life or death. The true potential of AI algorithms is to speed up the OODA loop through new methods of human-machine teaming up and their collaboration.

IACCS FOR THE INDIAN AIR FORCE

The Integrated Air Command and Control System (IACCS) is a sophisticated air defence system employed by the Indian Air Force (IAF). This modern system was developed by Bharat Electronics Limited (BEL) at an approximate cost of Rs 8,000 crore.[6] It provides a comprehensive air defence system for the country. The IACCS is based on a network of radars and sensors integrated and managed through a single command and control system. This enables the detection and identification of incoming aircraft and missiles, and provides the IAF with an effective early warning system. The system is capable of providing detailed and accurate information on the location, size, speed and direction of detected aircraft and missiles. The IACCS is a multi-layered system that includes ground-based radars, airborne early warning systems and satellite-based surveillance systems. All these elements are integrated into a single command and control system that is managed by the IAF. The ground-based radars and the airborne

6. "Government Clears Rs 8000 Crore IAF's Integrated Air Command & Control System," *The Economic Times*, July 11, 2018, https://economictimes.indiatimes.com/news/defence/government-clears-rs-8000-crore-iafs-integrated-air-command-control-system/articleshow/49079201.cms.

early warning systems provide the IAF with a 360-degree coverage of the skies and allow the IAF to detect and identify aircraft and missiles coming from any direction. The IACCS can automatically detect and track multiple targets simultaneously and provides the IAF with the capability to respond quickly to any threats. The system can also coordinate the efforts of various air defence units to ensure the most effective response. The IACCS has been instrumental in ensuring the safety and security of the Indian air space. The system enables the IAF to identify threats and respond quickly and effectively. The IACCS is a highly sophisticated air defence system and a testament to the technological prowess of the Indian Air Force. The system has been instrumental in ensuring the safety and security of the Indian air space and is a shining example of how technology can be used to protect a nation's security.

Naval CMS: All major warships around the world are fitted with CMS. CMS are embedded systems that use high-end processors with Real-Time Operating Systems (RTOS) software; they are critical to providing real-time decision support to commanders at sea who are responsible for managing the three-dimensional threat environment (air, surface, and sub-surface). The multitude of data that CMS receive is staggering. Today's CMS not only receive real-time data from organic sensors but also data from other ships in battle groups, distributed sensors placed strategically in the ocean, coastal support systems, aerial reconnaissance and satellites. The amount and highly dynamic nature of data received by CMS test human capacity; it is impossible for humans to make an appropriate decision without being assisted by Machine Learning (ML) and Big Data Analytics (BDA) techniques. The Indian Navy has made significant progress in this area; all major fleet ships are being commissioned with CMS, and CMS have been retrofitted in older vessels. A programme to develop indigenous CMS systems with enhanced Command, Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance (C4ISR) capabilities began in 2000. The Indian Navy is building CMS for conventional submarines in collaboration with M/s Tata Power Strategic Engineering Division (TPSED) for working

on warfare tactical functions provisioned by the Weapon Equipment and Systems Engineering Establishment (WESEE).[7]

Indian Army's BMS: The Indian Army envisioned Project Battlefield Management System (BMS) so that commanders at all levels could make decisions more swiftly, make more informed decisions thanks to real-time access to accurate operational data, and rapidly close the sensor-to-shooter loop. However, the BMS project has been saddled with delays. The Defence Acquisition Council (DAC) cleared the BMS as a 'Make in India' project in 2006 and commissioned an Integrated Project Management Team (IPMT) to do a study. In the wake of this, an Expression of Interest (EOI) was sent to a group of 14 Indian defence firms (both private and government-owned). Following an the IPMT, at the end of 2011, the DAC approved the BMS as a 'Make in India' project. However, the much-required BMS was shelved by the Ministry of Defence (MoD) in 2017, despite the approved requirements existing for the system, due to the funds being required for other essential items then. However, the MoD gave the go-ahead to two Indian consortia, one led by Bharat Electronics (BEL) and the other led by Tata Power (Strategic Engineering Division), to create a BMS prototype for the Indian Army, which could result in procurement worth between Rs. 40,000 and 50,000 crore. Both organisations will each create their own functional BMS. There will be four different iterations of each BMS prototype, one for infantry battalion groups, another for combat groups (armour), a third for combat groups (mechanised infantry), and a fourth for the special forces. Each prototype will feature technologies such as a geographic information system, a multi-sensor data fusion system, rugged computing devices, and a software-defined radio-based communication system for soldiers. It remains to be seen when these crucial systems will materialise on the ground for the Indian Army.

7. Huma Siddiqui, "Artificial Intelligence to Power Indian Navy's Combat Management System in Its Indigenous Aircraft Carrier," *The Financial Express* (blog), April 4, 2019, https://www.financialexpress.com/defence/artificial-intelligence-to-power-indian-navys-combat-management-system-in-its-indigenous-aircraft-carrier/1538247/.

In autonomous systems, the sensing, processing, activation, feedback and control functions done by the human brain have to be replaced with electronics and AI-based algorithms. This task is exciting and as well as overwhelming at the same time.

AUTONOMY AND ROBOTICS

What Are Autonomous Systems? The definition of autonomous systems, according to the US Defence Science Board (DSB), is a capability (or set of capabilities) that enables a particular action of a system to be automatic or, within programmed boundaries, self-governing. An autonomous system is one that operates without human intervention and can gather data about its surroundings and complete tasks over a long period of time in order to achieve predetermined goals. The spurt in the interest in, and development of, autonomous systems is due to recent advancements made in the areas of ML which enable machines to operate autonomously without or with little human intervention. In addition, newer and newer algorithms such as deep learning and convolutional neural networks are coming to the fore in providing the necessary computational rigour required, and faster computation by the 'brain' of autonomous systems for the real-world implementation of such systems. Apart from ML algorithms, the accelerated growth of electronic devices has contributed equally to the proliferation of autonomous systems that we have witnessed recently. Developments in the area of embedded systems and Micro-Electro-Mechanical Systems (MEMS) have made it possible to implement computationally intensive ML algorithms in the real world.

In autonomous systems, the sensing, processing, activation, feedback and control functions done by the human brain have to be replaced with electronics and AI-based algorithms. This task is exciting and as well as overwhelming at the same time. The environment sensors – RADAR (Radio Detection and Ranging), camera and LIDAR (Light Detection and Ranging)— are getting a lot of attention with the need for increasingly greater range and resolution being demanded by the 'eyes'.

In the parlance of warfare, autonomous systems have found their way into all three-dimensional threat environments. Various nations across the globe are developing unmanned autonomous vehicles for Intelligence, Surveillance, and Reconnaissance (ISR) and for more drastic warfare in the air, on the surface, and sub-surface. These new war machines are truly autonomous. These systems can gather information about their surroundings, remember where they've been and what they've been up to recently, make sense of data from various sources, formulate a course of action, and act.

UAVs are able to provide the IAF with greater situational awareness and surveillance capabilities, as well as being able to complement targeted strikes and reconnaissance missions without the need for personnel on the ground.

INDIAN AIR FORCE READINESS FOR AUTONOMOUS WAR

The IAF, the fourth largest Air Force in the world, has been utilising Unmanned Aerial Vehicles (UAVs) to enhance its capabilities in various roles for many years. UAVs are able to provide the IAF with greater situational awareness and surveillance capabilities, as well as being able to complement targeted strikes and reconnaissance missions without the need for personnel on the ground. The IAF has been an early adopter of UAV technology, having first operated UAVs in the late 1980s.[8] Since then, the IAF has steadily increased its fleet of unmanned aircraft and now operates several different types of UAVs. The IAF currently operates the Heron, Searcher and Heron TP, all of which are Israeli-made UAVs. The Heron is the most advanced UAV in the IAF's fleet and is capable of carrying out both ISR missions as well as precision strikes. The Searcher is a medium-altitude, long-endurance UAV that is used for surveillance and reconnaissance missions, while the Heron TP is a high-altitude,

8. Spansen, "This Tiny Aircraft Was India's 1st All-Composite Bird Built In The Country," March 31, 2020, https://www.spansen.com/2020/03/this-tiny-aircraft-was-indias-1st-all.html.

long-endurance UAV that is used for long-distance reconnaissance and strike missions.

In addition to its fleet of UAVs, the IAF has also been driving the indigenous research and development of UAV technology which resulted in the indigenously developed UAVs such as the Lakshya,[9] Nishant, and Netra. The Lakshya is a tactical Unmanned Combat Aerial Vehicle (UCAV) that can be used for target acquisition and reconnaissance, while the Nishant is a short-range UAV mainly used for reconnaissance and surveillance. The Netra is a long-range UAV that can be used for both ISR and strike missions. Both the Nishant and Netra are still under development, and design refinement is being carried out to make them suitable for induction by the IAF. The IAF has also been exploring the use of UAVs for various other roles such as search and rescue, reconnaissance, and even cargo delivery. The IAF has also been utilising UAVs in its disaster relief operations, allowing them to assist in areas that may be inaccessible to conventional aircraft. The IAF is continuing to promote the development of UAV technology and is expected to continue to increase its fleet of unmanned aircraft in the coming years.

Unmanned Autonomous Aircraft (UAA): Although the IAF has been keeping pace with the adoption of UAV technologies, there is one dimension where there is scope for improvement: Unmanned Autonomous Aircraft (UAA). Today, UAA are increasingly becoming the go-to solution for Air Forces around the world to improve their operations' efficiency and effectiveness. UAA are a must-have to gain a competitive edge in the global air power arena. They have become a viable solution for the Indian Air Force as they can conduct missions that are too dangerous or too expensive for manned aircraft to perform. These include surveillance and reconnaissance missions without the risk of casualties among the personnel. UAA have the ability to stay in the air for extended periods and can reach targets that are difficult to access by conventional aircraft. They can be flown in dangerous

9. "Lakshya Unmanned Aerial Vehicle," *Airforce Technology* (blog), August 17, 2011, https://www.airforce-technology.com/projects/lakshya-uav/.

or inhospitable environments such as Nuclear, Biological, Chemical (NBC) fallout areas, nuclear accident sites, volcanic eruptions, or oil spills, to gather data without putting human lives at risk.

Fig 2: An MQ-9 Reaper Drone that Killed Soleimani

Source: WikiMedia

UAA are especially useful in carrying out surgical operations, like the one in 2019 where Libya's Government of National Accord (GNA) employed the lethal autonomous aircraft Kargu-2 to "hunt down and remotely engage" soldiers and convoys fighting for Libyan General Khalifa Haftar.[10] The Kargu-2 is a kamikaze drone developed by the Turkish arms entity STM. This incident marks the first-ever human fatality caused by an autonomous robot. It was the first case where an AI-powered machine, operating without human supervision, hunted and killed a human being. Another illustrative

10. Lipika Majumdar Roy Choudhury, et al., "Final Report of the Panel of Experts on Libya Established Pursuant to Security Council Resolution 1973, 2011" (New York: United Nations Security Council, March 8, 2021), https://documents-dds-ny.un.org/doc/UNDOC/GEN/N21/037/72/PDF/N2103772.pdf?OpenElement.

example is the elimination of the British-born Islamic State of Iraq and Syria (ISIS) terrorist Jihadi John in 2015[11] by the US Air Force. The drone used was a long-endurance MQ-9 Reaper that has been designed more for a "hunter-killer" role than just a surveillance one. In January 2020, the MQ-9 was again in action, killing Qasem Soleimani, the commander of the Iranian Quds Force. Sulemani was killed in a Hellfire missile strike fired by MQ-9 drones at Baghdad International Airport.

Autonomous Combat Aircraft: Autonomous combat aircraft comprise a relatively new technology being developed to provide a significant shift in aerial warfare. Autonomous combat aircraft are UAVs that are designed to fly, navigate, and fight independently. This technology is being developed to provide a platform for more efficient, cost-effective, and safer military operations. Autonomous combat aircraft have the potential to revolutionise the way aerial warfare is conducted. By eliminating the need for a pilot, these aircraft can be used in dangerous missions that would be too risky for a human pilot. This will reduce the number of casualties in combat and make operations more flexible. In addition, these aircraft can be used in situations where a human pilot would be unable to effectively engage an enemy target. The overload of information from many sensors and the quickly changing tactical situations might overwhelm a human pilot while the software can sort its way through even in such complex scenarios.

Autonomous combat aircraft are also expected to be much more cost-effective than traditional piloted aircraft. The lack of a human pilot and associated costs such as training and wages mean that these aircraft will be significantly cheaper to operate. This could provide a major cost saving in military operations. Additionally, autonomous combat aircraft can carry more payload as they are not saddled by the burden of pilot weight. The absence of pilots provides freedom to the designers to come up with ingenious shapes and sizes of aircraft that are more aerodynamic and have highly optimised onboard space.

11. Ben Quinn, Richard Norton-Taylor, and Alice Ross, "Mohammed Emwazi Killed in Raqqa Strike, Says Rights Group," *The Guardian*, sec. UK News, November 13, 2015, https://www.theguardian.com/uk-news/2015/nov/13/jihadi-john-definitely-killed-syria-raqqa-dead.

The technology behind autonomous combat aircraft is very complex. These aircraft must be able to fly, navigate, and engage enemy targets with precision. This requires a high level of AI which can interpret data from multiple sources and make decisions quickly and accurately. Autonomous systems must also be highly reliable and secure, to ensure that they are not compromised by enemy forces. Autonomous combat aircraft are still in the early stages of development, and many technical and political challenges must be overcome before they can be used in military operations. However, it is quite clear now that this technology could be a game-changer in how wars will be fought in the future.

This future is perhaps soon to be realised. Last year, the creators of the Bayraktar TB2 and Kargu-2 Savunma Teknolojileri Mühendislik (STM) from Turkey unveiled an autonomous combat drone, the Kizilelma.[12] According to the company, it has a maximum take-off weight of 6 tons, including 1.5 tons of ordnance, and will fly at a height of 35,000-40,000 ft. The prototype can fly at speeds ranging from 0.6 to 0.9 Mach. The Kizilelma can stay in the air for up to 4 to 5 hours. It will be capable of launching air-to-air missiles. For surface warfare, this futuristic unmanned autonomous plane will be armed with cruise missiles with a range of more than 250 km, and guided bombs for small attack missions. Once fully developed and integrated, this autonomous combat aircraft is likely to be better than conventional fighter aircraft in several ways. Autonomous aircraft would be more efficient, as they can fly longer missions and stay in the air for longer periods of time without refuelling or maintenance. Autonomous aircraft also require less human intervention and can be programmed to fly even without human intervention in specific conditions. Additionally, autonomous combat aircraft are more agile and able to respond quickly to changing battlefield conditions. Autonomous aircraft are also less expensive to maintain and operate than conventional fighter aircraft, as they require less manpower and resources. Finally, autonomous combat

12. Tayfun Ozberk, "Turkey's Future Unmanned Fighter Jet Conducts First Flight," *Defense News*, December 19, 2022, https://www.defensenews.com/industry/2022/12/19/turkeys-future-unmanned-fighter-jet-conducts-first-flight/.

aircraft can make decisions quickly, giving them an advantage in combat situations.

Fig 3: Turkish Drone Manufacturer Baykar Tech Conducted the First Flight Test of its Next-Generation Unmanned Fighter Jet, the Bayraktar Kizilelma, on December 14, 2022

Source: Baykar

Autonomous Naval Combat Aircraft. As on other fronts, naval warfare is also changing, and the Indian Navy should quickly embrace AI, robotics, and autonomy, or risk falling behind our adversaries. The military robotics revolution is approaching its third decade, and India has largely lagged behind while other nations have leapfrogged ahead. For example, the X-47, an unmanned combat air system carrier, a stealth drone that is piloted by a multitude of AI algorithms, has been developed by Northrop Grumman for the US Navy (USN).[13] It is completely autonomous and had successfully demonstrated carrier landing and aerial refuelling way back in 2009.

The Indian Navy, too, soon needs to develop such autonomous uninhabited aircraft that could extend the carrier's reach and the Navy's relevance in high-threat environments. The Navy is yet to recognise this

13. "X-47B UCAS," Northrop Grumman, https://www.northropgrumman.com/what-we-do/air/x-47b-ucas. Accessed on January 18, 2022.

crucial paradigm shift that is unfolding in this area. The Navy's aircraft carriers will be of diminishing utility over time, a "wasting asset" without a penetrating long-range stealthy drone that can persist at a range to hunt mobile targets.[14] Currently, the short-range human-inhabited MiG 29-Ks lack the necessary range to project power into high-threat environments, even with refuelling. If the Indian Navy's aircraft carriers want to remain operationally relevant, their short-range strike aircraft must be able to operate within reach of the Chinese People's Liberation Army's (PLA's) and Pakistan's Anti-Access/Area Denial (A2/AD) systems.

In the era of autonomous drones, the Stealth Wing Flying Testbed (SWiFT) UAV, India's stealth flying wing technology demonstrator, which is a scaled-down version of what will eventually be a remotely-piloted strike aircraft,[15] is perhaps already outdated. Even if the Navy moves promptly now to start plans for a stealthy combat drone to operate in contested areas, it will have lost decades in delays, setting back naval aviation a generation.

Fig 4: X-47B The Strike Fighter-sized Unmanned Aircraft Developed by Northrop Grumman

Source: Northrop Grumman, https://www.northropgrumman.com/what-we-do/air/x-47b-ucas/

14. Andrew F Krepinveich Jr, "The Pentagon's Wasting Assets: The Eroding Foundations of American Power," *Foreign Affairs*, 88, 2009, p. 18.
15. Girish Linganna, "SWiFT UAV – India's Stealth Flying Wing Technology Demonstrator," *Frontier India*, July 2, 2022, sec. Military.

The US Navy's integration of the Triton into maritime surveillance in "manned-unmanned teaming" with the P-8 Poseidon has been a force multiplier.

Autonomous ISR Aircraft: An effective Intelligence, Surveillance, and Reconnaissance (ISR) set-up is perhaps the most important prerequisite for battlefield preparation. Aerial ISR dates back to Napoleon's campaigns in the 19th century, when the French used observation balloons to monitor enemy activities. UAVs for ISR are well-known applications of the technology. The clear majority of UAVs are used purely for ISR missions. In current military usage, they range from the 'Global Hawk', with a wingspan bigger than a Boeing 737 airliner, to nano-helicopters' Black Hornet' that weighs 32 grams, and all points in between.[16]

The US Navy has undertaken a major leap by inducting the MQ-4C Triton, the high-altitude long-endurance uninhabited aircraft for the ISR function [one was shot down by an Iranian Surface-to-Air Missile (SAM)] when flying over the Strait of Hormuz in June 2019).[17] The US Navy's integration of the Triton into maritime surveillance in "manned-unmanned teaming" with the P-8 Poseidon has been a force multiplier. The combination of the manned P-8A and the unmanned MQ-4C provides more ISR coverage than either could achieve alone. The use of the Triton allows the P-8A to focus on areas that have more tactical relevance. The Indian Navy should also look to complement the P-8's Indian variant with the Triton-type autonomous ISR aircraft to keep our cutting edge sharp.

AUTONOMOUS SYSTEMS FOR LAND WARFARE

Autonomous combat systems for land warfare are becoming increasingly important for military forces all over the world. Autonomous systems

16. Benjamin S Lambeth, *Air Power against Terror: America's Conduct of Operation Enduring Freedom* (Santa Monica: RAND Corporation, 2001).
17. "U.S. Drone Shot down by Iranian Missile in International Airspace: US Source," Reuters, sec., *Aerospace and Defense*, June 20, 2019, https://www.reuters.com/article/us-mideast-iran-usa-shootdown-idUSKCN1TL0IR.

are being developed to take on a variety of roles in land warfare, from reconnaissance and surveillance, to target identification and engagement. Autonomous systems offer great potential for improving the effectiveness of the ground forces. By removing the need for a human operator, autonomous systems can reduce the likelihood of human error, and enable faster and more accurate decision-making. Autonomous systems can also reduce the risks associated with sending soldiers into dangerous situations and can increase the effectiveness of the ground forces by allowing them to focus on more strategic tasks such as planning and coordination.

Recent advances in AI and robotics have made autonomous systems even more capable and reliable. AI-enabled autonomous systems can learn from their environment and can be programmed to take on more complex tasks such as object identification and target engagement.

Recent advances in AI and robotics have made autonomous systems even more capable and reliable. AI-enabled autonomous systems can learn from their environment and can be programmed to take on more complex tasks such as object identification and target engagement. Autonomous systems can also be programmed to cooperate with one another in a swarm-like manner, allowing them to quickly identify threats and respond to them in a coordinated manner.

China has unveiled a new type of robot soldier called the "Sharp Claw" that is capable of firing weapons and conducting military operations. The robot is reportedly being tested for use in counter-terrorism and other military operations.

Unmanned Ground Combat Vehicle (UGCV): UGAVs are essentially robots of about the size of a tank, are generally equipped with a machine gun and are capable of carrying out reconnaissance missions, search and rescue operations and even attacking targets. The Chinese UGCV Sharp Claw is also able to manoeuvre through difficult terrain and is able to fire accurately even when on the move. The robot is designed to be a UGCV

that can be operated via remote control or autonomously by AI-powered software.[18] In recent years, the PLA has deployed about 88 Sharp Claw UGCVs in the Ladakh region. The move has been seen as a sign of China's increasing militarisation of the region and its growing presence in the region. These UGAVs can be used to monitor the borders, detect and deter any hostile activity and for counter-terrorism operations.

Robots are also seen as a way for China to gain an edge in military operations in the region. Robots are capable of operating in extreme weather conditions and can be used to patrol areas that are difficult for humans to reach. They can also provide the Chinese military with a powerful advantage in terms of surveillance and reconnaissance. Robots are part of China's efforts to develop high-tech military hardware and comprise a major step forward in the country's military modernisation programme. China has already invested heavily in UAVs and is now turning to the development of military robots. The Sharp Claw is just one of many robots being developed by China, and is tipped to become a dominant player in the global robotic warfare market in the coming years. As China continues to invest heavily in robotics, we are likely to see more of these robots very soon.

India is surrounded by hostile neighbours such as China and Pakistan and there is a constant need for the Indian Army to develop new and innovative ways to counter these threats. It is imperative that India takes measures to counter the strides made by China in the development and adoption of robot soldiers. Robot soldiers could provide the Indian Army with an edge over its adversaries by reducing the number of human casualties, as well as increasing the Indian Army's offensive and defensive capabilities. They could also be used in areas where human soldiers are not able to go, such as in areas with hazardous terrain or where there is a risk of chemical, biological, or nuclear weapons.

18. Peter Suciu, "China's Army Now Has Killer Robots: Meet the 'Sharp Claw,'" Text, The National Interest (Centre for the National Interest, April 17, 2020), https://nationalinterest.org/blog/buzz/chinas-army-now-has-killer-robots-meet-sharp-claw-145302

Fig 5: PLA has Deployed Sharp Claw Fighting Vehicles Fitted with Light Machineguns to its Border Region with India

Source: Mail online https://www.dailymail.co.uk/news/article-10352255/China-replaces-soldiers-machinegun-carrying-robots-Tibet.html

Additionally, robot soldiers could also be used in counter-terrorism operations. Equipped with explosive charges, they can be used to breach fortified structures containing violent, armed, or dangerous objects. The US, Israel, Korean Demilitarised Zone, and Gaza, all have these robots in one form or the other. These "killer machines" can be autonomous or semi-autonomous.

Drones: Today, AI fuelled technology has penetrated the lowest level of the land war hierarchy. Drones are used in every stage of conflict alongside large fleets, air defences, and jamming systems. Drones play a crucial role in long-distance conflict, allowing the opposing forces to spy on, and strike at, each other, without ever coming within striking distance.

The Russo-Ukraine conflict began as Russian tanks rolled over Ukraine's borders in World War I style, carving trenches into the earth and pounding the landscape with Soviet-made artillery. Now, however, the conflict has

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taken on a more modern dimension, with soldiers monitoring the battlefield on a tiny satellite-linked monitor while their palm-sized drone hovers out of sight. The conflict in Ukraine, which was sparked by a land grab fit for an 18th-century emperor, has evolved into a competition for technological superiority in the skies, a watershed moment in military history marked by the daily flights of hundreds of reconnaissance and attack drones. Russia has repeatedly used Iranian-made Shahed-136 self-destructing drones, a low-cost substitute for high-precision missiles, to strike Ukraine's vital civilian infrastructure. The Russo-Ukraine War has displayed the ingenious use of drones. At times, they are used for taking out other drones: one such incident was reported by *The Washington Post* in November 2022,[19] when a Ukrainian attack drone followed the same route as the Russian reconnaissance drone, the Orlan-10—and delivered a strike on the fleet of the enemy 'eyes'.

IMPEDIMENTS TO THE ADOPTION OF AUTONOMOUS PLATFORMS

What accounts for the difference in the adoption of uninhabited and robotic vehicles among different elements of the three Services? The operational need for robotics and autonomous systems is compelling in all three domains, where the defence forces face increased threats as adversary precision-strike systems hold our military air, surface, and undersea assets at risk. Moreover, in all three domains, uninhabited vehicles will allow the defence forces to operate with greater range and

19. Michael E. Miller and Anastacia Galouchka, "Ukraine's Drone Hunters Scramble to Destroy Russia's Iranian-Built Fleet," *Washington Post*, November 28, 2022, https://www.washingtonpost.com/world/2022/11/28/ukraine-drone-hunters-mykolaiv-russia/.

persistence, giving commanders greater situational awareness and allowing more rapid prosecution of fleeting targets. Worldwide, many states have capitalised on the opportunities presented by autonomous systems as the technology has matured, but the Indian tri-Services have not moved with the same alacrity.

Despite enormous advances made by AI, particularly in pattern recognition and computer vision, machine learning hasn't been able to imbibe common sense with the rich common sense of human beings.

However, there are some genuine concerns about the adoption of the autonomous platform, such as, AI is still learning 'common sense.' Interestingly, common sense has been an important challenge to AI since the earliest days of its foundation in the mid-1950s. Despite enormous advances made by AI, particularly in pattern recognition and computer vision, machine learning hasn't been able to imbibe common sense with the rich common sense of human beings. For example, AI would fail to comprehend real-world situations such as an AI-powered autonomous car will stop unnecessarily when it sees a plastic bag flying in front, or the ML system will stop the vehicle if its sensors sense a flock of birds sitting on the road. The AI may not understand that the birds will fly away as it moves forward. Data privacy and cyber security are other significant concerns for the adoption of autonomous systems. The data needs to be protected from hackers to avoid any adverse situation. Therefore, it is necessary that robust security protocols are in place to protect the data being processed inside the autonomous system and when it gets transmitted.

CONCLUSION

Those who resist cultural changes rarely do so for transparently self-interested reasons; they are genuine in their attachment to the benefits of an older way of doing business. Psychological studies have shown that people are susceptible to cognitive biases that cause them to reject

new information that threatens their identities.[20] This is a major hurdle for capitalising on the AI revolution. Robotics, autonomy, and artificial intelligence will be valuable in every aspect of military operations. Indeed, the benefits of uninhabited vehicles, which are numerous, only begin to scratch the surface of the benefits of more intelligent machines. Over time, AI will become as widely used in military operations as computers or electricity. In some cases, AI and robotics will allow militaries to conduct the same tasks more effectively or efficiently. This is the case for airborne ISR today, where the principal advantage of drones is their longer endurance, allowing for more persistence over target areas. But the real transformative potential of AI, like any new technology, lies not in doing the same thing better but in doing it differently. *A longer spear had military advantages, but the shift to firearms was a revolution*.

20. Dan M Kahan, et al., "Motivated Numeracy and Enlightened Self-Government," *Behavioural Public Policy* 1, no. 1, 2017, pp. 54–86, at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2319992.