AI in the Indian Armed Services: An Assessment

Kartik Bommakanti

Abstract

This article surveys the extent to which service doctrines as well as the Joint Doctrine of the Indian Armed Forces (JDIAS) capture and define the role of Artificial Intelligence (AI) in the Indian military. The analysis captures the limited view and non-existent view of AI within service and tri-service doctrine. A gap has emerged between the services' doctrinal pronouncements and the actual use of AI in some form in the three branches of the military. AI come in two variants at least—semi-autonomous and autonomous systems. This ensuing assessment is only a partial critique of how service doctrine see or ignore AI, the problem relating to the use of technology and doctrine is not unique to the services, but extends to other areas.

Introduction

What is the extent of Artificial Intelligence's role in the Indian Armed Services? As an emerging technology AI has assumed considerable significance in recent years for armed services across the world. The Indian armed services are integrating AI or AI-driven technologies before making any doctrinal shift or at a minimum doctrinal change has only partly paralleled the effort to adopt AI-related technologies and platforms. Indeed, individual service doctrines do not do justice to the extent to which AI-related technologies have already been integrated

Mr. **Kartik Bommakanti** is Fellow at Observer Research Foundation, New Delhi.

into each service. Where AI features in service doctrine, it is treated as a key aspiration for future military capabilities. AI is a future goal, rather than a capability, which *actually* exists in some form. This analysis explores why this is the case with the three service branches of the Indian military. It draws on open source material and existing service doctrines and tracks the evolution of AI-related capabilities despite the absence of a visible doctrinal articulation of AI's growing significance. AI, like all technologies, represents both continuity and discontinuity or change as far as the Indian armed services are concerned. One way to distinguish between autonomous and semi-autonomous weapons is by way of how these weapons relate to humans. The latter set of weapons such as the US-built Predator drones can fly autonomously to some point on the planet or a destination, but the release of their lethal ordinance against a target is entirely in the control of their human operator.[1] On the other hand, the former set of weapons system consisting of automated weapons systems encompasses lethality and destructiveness such as the Israeli Iron Dome missile defence system.[2] This system can fire without human intervention and pre-programmed to identify and destroy incoming missiles.[3]

As will be demonstrated below India's service-specific doctrines do not capture these distinctions and do not address fully the importance of AI and nor does the tri-service doctrine or Joint Doctrine of the Indian Armed Services of the Indian military address how AI might be relevant to military operations and missions. Any doctrinal engagement with AI is at best uneven in that either as an emerging technology its possibilities excessively exaggerated or inadequately appraised. AI is yet to fully mature and is still evolving. Indeed, it is an "emerging technology", which by definition means it is undergoing an "evolutionary" process, rather than a "revolutionary" process. Indeed, the very dictionary definition of the word "emerging" means "gradual appearance".[4] At best one may extend the meaning to include something that appeared 'unexpectedly'. Regardless, something that appears unexpectedly is not the same as being

'revolutionary'. AI has not arrived unexpectedly, however, the possibilities that AI can accomplish today in the defence domain has grown. The only 'revolutionary' technology if there has ever been is nuclear technology both in the form of civilian and military applications.

Given this background, this analysis proceeds in three parts. First, it surveys what semi-AI technologies or systems the India Army (IA) has integrated. The second and third sections do the same for the Indian Air Force (IAF) and the Indian Navy (IN). And based on the assessment it provides some reasons as to why doctrinal change has not kept with the integration of AI into the armed services order of battle.

Defining Doctrine and Where do the Armed Services' Doctrines Stand on AI

Doctrine can be defined as a "belief system" that enshrines for the military an institutional mechanism through which a military seeks to fight.[5] Doctrine is based on an institutional construct and expression of guiding principles for the military. Guiding doctrinal principles do not necessarily reflect what needs to be done in specific situations where operational flexibility and not doctrinal rigidity are the key to military success.[6] The purpose of doctrine is to educate military personnel about warfighting principles and enunciate them. There are three distinct types of doctrine: fundamental doctrine, operational doctrine and technological doctrine.

The doctrine generally is insensitive or displays imperviousness to technological change or sees change as an aspirational aim. This is especially true of fundamental military doctrine which can be framed in very abstract terms. After all, fundamental doctrine as the Indian Air Force doctrine from two and half decades stated: "[A] … character is that fundamental doctrine is relatively insensitive to political philosophy and technological change".[7]

This statement is valid as far as fundamental doctrine goes. However, contemporaneous operational doctrines also tend to mirror fundamental

doctrine. The point to underline here is: why doctrinal articulations of the Indian armed services have not consistently captured technological change and capabilities integrated into the Indian armed services. The purpose of this analysis is to test this claim that doctrines of the Indian armed services are not in complete alignment with existing operational practices and technological change.

Service doctrines of the Indian armed forces today, still tend to be either insensitive to technological change or see it as a goal to be attained and integrated for military operations. This is especially true for the IA, which has a fairly exaggerated view of AI's impact. Take specifically the Indian Army's Land Warfare Doctrine (IALWD) which states: "The Indian Army will continue to modernise to fight in a techno-centric combat environment which is likely to emerge in futuristic conflict scenarios due to revolution in key technologies like Artificial Intelligence…."[8]

This statement does not do adequate justice to the IA's own contemporary operational practice and past AI-related technological use. Indeed, the IA already deploys UAVs which are a partial form of AI. The notion AI is 'likely' to emerge in 'techno-centric environments' nor is AI 'revolutionary' because it has been around in some form for many decades illustrating the weaknesses of IA's doctrinal articulation on emerging technologies. Indeed, it is not a revolutionary, but an evolutionary technology. Yet this conceptual muddle is the primary source of the problem for the IALWD. In this regard, the IA more specifically is laggard in laying out what AI-related capabilities actually exist and what AI could do in the future. Indeed, one serving officer even went so far as to say recently "One can argue that the use of AI and other niche technologies by the Indian Army is only inevitable…."[9] This statement again is partly illustrative of the problems of the IA's officer corps assessment of AI. It is partially inaccurate given it conceives of AI as an ideal or the promising technology that is yet to be grasped. Further, it also ignores the historical and contemporary record of semi-autonomous systems that have been in

use in some form for decades by the IA and the other services. The only issue is and for that reason the above statement is accurate is the extent to which AI and especially its sub-fields such as Machine Learning (ML) have been applied to defence systems, logistics, personnel management and so on in the IA and across the Indian military as well as the extent of its penetration. Semi-autonomous weapons are partly AI-driven and some non-lethal military platforms are also semi-autonomous.

The other two Indian armed service doctrines especially the IAF doctrine[10] does recognise both the strengths and limitations of AI-related or autonomous platforms, but the IAF does not define them as AI or see the importance of AI as a 'revolutionary' technology as the IA's LWD for operations and missions. Indeed, the IAF's doctrine does not even use the term AI or even use Unmanned Aerial Vehicles (UAVs) but describes them as Remotely Piloted Aircraft (RPAs). To that extent, the IAF at least appears to have the most realistic appraisal semi-AI-based platforms such as UAVs can and cannot do.[11] IAF RPAs are geared for Intelligence, Surveillance and Reconnaissance (ISR) missions. These RPAs or partial AI capabilities in its inventory are confined to sensing missions, rather than for lethal missions or delivery of ordinance.

Whereas the maritime doctrine of the IN[12] does not mention, let alone discuss emerging technologies such as AI and unmanned or autonomous platforms and their influence on operations and military strategy. Although both the IAF and IN do not mention AI within their doctrines, let alone define AI rigorously, both services have been using AI-related capabilities for many years. Indeed, all three services are working fairly intensively to acquire and integrate them for a wider range of missions and applications. To that extent, the IALWD goes farther than the other two services in acknowledging the growing application of AI. Beyond individual service doctrines, what do we make of the tri-service doctrine? Does it acknowledge the importance of autonomous systems? The tri-service doctrine also suffers from the same lacuna.

Thus, none of the doctrines remotely go far enough in aligning existing AI capabilities with their doctrinal pronouncements. All the doctrines of the Indian armed services display indifference, misunderstanding of AI's promise for warfare and at one level historical amnesia about the use of AI-related technologies in some capacity by the Indian armed services.

Capabilities or their synonym military technologies fall into two categories. One is an elaborate support system focused on logistics. Take the case of Helmuth J. Moltke, the Prussian Chief of Staff's design and integration of a complex logistics support system to mobilise and transport troops and equipment that enabled Prussian military strength to be projected over vast distances.[13] Nevertheless, there are examples of AI's application from more recent military experience in the domain of logistics such as in the run-up to the first gulf war of 1991. The Dynamic Analysis and Re-Planning Tool (DART) is a case in example. It is widely considered a significant breakthrough in AI application for military logistics.[14] DART helped plan through an AI-based decision support system by enabling humans to better transport military equipment from Europe to Saudi Arabia for Operation Desert Shield.[15]

The others are centred on technologies such as heavy machine guns and artillery systems that are geared for lethal application. Although, our focus is primarily on the latter (including sensors) in the subsequent analysis, however, both are equally necessary for successful military outcomes. Some of the most promising AI technologies thus far have been in the sensor domain and weapons lethality. Sensing and lethal AI technologies encompass Unmanned Aerial Vehicles (UAVs), whose variants can be deployed for surveillance and reconnaissance missions as well as for mission involving the application of lethal firepower.[16] Lethal Autonomous Weapons (LAWs) for instance use AI.

Brief History of Indian Armed Services' Early Use of Semi-Autonomous Systems

The most visible manifestation or operational role of AI in the IA were target drones. The most well-known early drone was the KD2R5 target drone built and supplied by Northrop Grumman to the IA in the early 1970s.[17] Also known as the Northrop KD2R5 "Sheldruck" was among the first examples actually of a rudimentary form of AI, in that it was unpiloted used as target for anti-aircraft gunnery. It was subsequently used as target training practice for the IA's earliest Air Defence missile systems built by the British—The Tigercat.[18] The KD2R5 was equipped with a parachute recovery system and flew on autopilot with radio control.[19] Other American built systems included Northrop Grumman's Chukar II and Chukar III Tactical Expendable Drone Systems (TEDS) which were respectively fielded by the IAF and the IN. Chukar II also known as the MQM-74C was primarily built for the United States Navy (USN), but was exported to several North Atlantic Treaty Organization (NATO) as well as non-NATO states such as India. The Chukar II was recoverable by parachute and when deployed remotely commanded or automatically especially when the command link suffered damage.[20] Its variant the Chukar III was operated or used as an aerial target for anti-aircraft gunnery and for missile training.[21] There were other variants of the MQM-74 TEDS, it is unlikely or at least there is little extant evidence to suggest they were used by the Indian armed services specifically. Nevertheless, the Shuldruck and Chukar series of target drones clearly stand as early examples of the Indian armed services use of autonomous or semi-autonomous platforms. In subsequent years' American arms sales restrictions against India meant that there was very little defence cooperation that involved the supply of such systems.[22] Over the last two and half decades India has sourced autonomous systems from overseas vendors and started building its own systems. Let us now turn to the autonomous systems by each service branch of the Indian military. Readers should be cautioned in advance that the empirical evidence

furnished in the succeeding sections is not exhaustive, because of reasons space, the author has confined the list to a small subset of cases.

Indian Army and the use of Semi-Autonomous Systems

Since the mid-1990s, the Israelis have been the primary source of most of India's UAV systems and these unmanned platforms are geared for ISR and target acquisition missions.[23] The IA initially acquired the Searcher I and Searcher II from Israel Aircraft Industries (IAI) Limited and thereafter received the Israeli built Heron UAVs and has extensively used them.[24] It is the IA that was initially at the forefront of inducting UAVs into the service.[25] The Heron UAVs in the mountainous terrain of Jammu and Kashmir (J&K) as well as the Thar Desert in Rajasthan for surveillance missions. Exercise Sindhu Sudarshan or also known as Sudharshan Shakti which is a joint military exercise regularly conducted in the Thar Desert involving the IA and IAF since at least the early 2010s have involved the extensive of use UAVs.[26] Thus the AI used in the IA is largely confined to UAVs and most of it dedicated to ISR or sensing missions. In addition, the IA is also using UAVs to meet the "communications" requirements of the service in the areas of post-disaster medical evacuations and rescue operations.[27] There are efforts underway to incorporate several other types of UAVs. These consist of man-portable micro and mini-spy UAVs that can help with surveillance, direct and deliver artillery fire.[28] The IA is working on integrating UAVs for the infantry and the mechanised infantry units.[29] The service recently concluded a US$ 20 million contract with IdeaForge for the supply of an unknown number of drones directed ISR missions in demanding weather and harsh environmental conditions.[30] As of today, the IA primarily deploys and operates the Israeli built Searcher Mark I, Searcher Mark II and the Heron UAVs. All of the IA' UAVs are semi-autonomous in that they are not operated independently any human involvement or without any human loop. Nevertheless, they are built on AI technology and perform tasks and missions that are AI-driven.

In addition, there are efforts underway since at least 2016 to build an indigenous Tactical Communications Systems (TCS) by two Domestic Agencies (DAs). Each of these DAs are expected to build a prototype TCS over an 18-month period. Following development over 18 months, each of the TCS prototypes are to undergo technical evaluations by the IA.[31] The TCS, if and when validated for production and integration will help will generate 4G communication at 100 Mbps. In order to secure the network, the Defence Research and Development Organisation (DRDO)' Center for Artificial Intelligence and Robotics (CAIR) has been tasked with developing a native security solution to ensure network security.[32] Beyond UAVs, which are the most visible manifestation of using AI or semi-AI technology, the IA already uses the Daksha Remotely Operated Vehicle (ROV) for ordinance or bomb disposal built by the Research and Development Establishment (R&DE).[33] These ROVs have been operational at least since 2012. Bomb disposal units of the IA as well Indian paramilitary forces and Jammu and Kashmir police have also been using indigenously ROVs for nearly a decade. The IA has even sought under the "Make" category of the Defence Procurement Procedure (DPP) a Robotics Surveillance Platform (RSP) which is an AI-related or robotics system that is remotely operated to improve ground-based sensing system for detecting and tracking the movement of militants in built-up urban areas during Counter-Insurgency Operations (CIO).[34] The IA is also leasing for three years four MALE Heron surveillance drones from Israel to expand surveillance capabilities along the Line of Actual Control (LaC) with China.[35] Two of them are due for delivery in August 2021.[36] Beyond UAV and UCAV imports predominantly from Israel, there are native efforts as part of the DRDO's Research and Development (R&D) agenda to develop UCAVs such as the MALE UCAV the Rustom.[37] The latter has been under development for years. Following trials and validation, the IA at least hopes to deploy the Rustom or other UCAVs for each of its artillery brigades. In addition, the service expects to have

Loitering Missile Battery Systems and their associated ground segments for each Corps.

The foregoing is only a brief overview of AI's presence in aiding sensors and growing efforts on the part of the IA to adapt and integrate AI into weapons platforms for combat missions. Let us now turn to the IAF' efforts to integrate and deploy AI-related capabilities.

Indian Air Force and the use of Semi-Autonomous Systems

The IAF operates an estimated five squadrons of UAVs.[38] Although the precise number still remains classified.[39] These UAV platforms are a mixture of Searcher II Heron for ISR missions. The IAF has expressed interest in operating Unmanned Combat Aerial Vehicle (UCAVs) placing orders for the Harpy and Harop which are both built by Israel Aerospace Industries (IAI) and developed for lethal missions such as detection, tracking, attacking and destroying enemy's radar emitters and for Suppression of Enemy Air Defences (SEAD).[40] The IAF has also sought to re-design the Heron and Searchers in its existing inventory of UCAVs by testing additional capabilities and features. These include giving the Heron and Searchers to detect, attack and destroy the enemy's radar emission devices as well as SEAD capabilities. Extending and using UAVs to combat to perform lethal missions like several countries especially the United States, Israel, Russia and the Peoples Republic of China (PRC) is unsurprising. After all, India is proceeding with the purchase of 30 Predator B drones for 3 billion USD from US-based General Atomics.[41] The Predator-B UAVs are geared for lethal operations which following will give a confirmed remotely piloted autonomous capability for lethal missions. The IAF will also induct on lease the Heron TP which is a Medium Altitude Long Endurance (MALE) UAV that can carry out surveillance missions and deliver missile payloads. The Hindustan Aeronautical Limited (HAL) has concluded an agreement with Israel Aerospace Industries (IAI) Limited, to build the Heron TP UAV at HAL's facilities.[42] Thus, the IAF should

have UCAVs within the inventory in the not too distant future. The IAF for its part is moving or has proposed to develop a separate cadre to staff and execute UAV operations. The Ministry of Defence (MoD) and the Indian government have yet to sign off on a cadre specific UAV force.[43]

Indian Navy and the use of Semi-Autonomous Systems

The Indian Navy has been a leader in operating UAVs. UAVs have been involved in maritime surveillance, traffic control and anti-piracy operations and the defence of Exclusive Economic Zones (EEZs). As of today, the IN's fleet air arm has three UAV squadrons which are geared for ISR missions.[44] An additional UAV squadron consisting of Searcher II and Heron UAVs was established in Behala in West Bengal to track Chinese submarine movements in the Bay of Bengal and intrusions into India's EEZ.[45] The entirety of India's UAV squadrons are land-based and each of them are operated by their respective command headquarters. In addition, in order to execute carrier-based missions, the IN is working intensively to integrate UAVs that are ship-based and rotorised that meet the requirements of higher endurance and payload carrying capacities. These UAV's will have Over-the-Horizon (OTH) carrying capacities, battle damage assessment capabilities and communications capabilities.[46] There is also a proposal pending before the Indian government to acquire 10 ship-based drones to enhance the ISR missions against enemy navy vessels.[47] The IN like the other services is also considering the induction of combat UAVs. Beyond UAVs' the IN's Weapons and Electronics Systems Engineering Establishment (WESEE) has been involved in "interfacing Russian equipment with Western data" as well as the reverse.[48] For instance, WESEE was responsible for ensuring Russian missiles could understand and accept the inputs and commands of German Anshutz gyros for navigation.[49] This involved a form of automation. WESEE was the first entity in India to recognize that fairly obsolete computers could be used for converting Western data and made usable by Russian weapons

in the IN. Although not all of WESEE's native efforts were successful, but it was a harbinger of change for interfacing. In 2019, the IN under the aegis of WESEE invited bids to set up an AI and ML laboratory for its Combat Management System (CMS).[50] The purpose of the bid is to set up infrastructure and train personnel on-site for a period of 4 months. This does suggest that the IN leadership is alive to the importance of AI and ML.

Assessing the State of AI in India and Military Doctrines

In the foregoing, we have briefly, but not exhaustively reviewed the use of AI-related or partially AI-driven capabilities deployed or planned. All the operational UAVs in the three service branches of the Indian military are remotely piloted and the ground-based robotic systems for bomb disposal are also remotely operated by humans. India armed services use semi-autonomous airborne systems overwhelmingly for sensing missions. In a nutshell, the Indian armed services have primarily or overwhelmingly used and deploy are semi-autonomous systems. The armed services and more generally the Indian defence establishment's investments in purely autonomous systems that are strongly AI-driven have hardly matched that of the advanced industrialised states such as the USA, Japan, Europe and China. As Lieutenant General R.S. Panwar observed: "In India, however, the power of AI has hardly been exploited in defence applications, be it weapons systems, surveillance applications, decision support systems, big data analytics, etc. Existing robotic systems deployed for defusing landmines and other explosive devices have limited autonomy, and do not have a strong AI component".[51]

Existing platforms of all the three armed services that use AI are essentially semi-autonomous. Thus the cognitive exertion on the part of soldiers or personnel for the use and operation of existing defence systems across the services is still greater. Amidst all the promise of AI, existing service doctrines have not fully acknowledged the *actual* use of

AI even in its partial form. This is where a gap has developed between what has "emerged" and what is "emerging" in the area of AI and its subfields. Their applicability and limits, as one former senior IA officer recognised, such as ML, Deep Learning (DL), Augmented Reality (AR), Virtual Reality (VR) and Deep Fakes, Big Data and so on have yet to be fully understood and determined.[52] Consequently, it is reasonable to assume and infer the services have ended up producing doctrines that are muddled interpretations of AI. In the case of JDIAS, the mere mention of AI is visibly absent.

Should we single out the Indian armed services for criticism for the failure define terms rigorously, draw clear distinction between autonomous and semi-autonomous platforms and weapons system and capture with greater clarity technological change? In part, this may valid. After all India's leadership set out to release the country's nuclear doctrine long after it actually started surreptitiously improving weapons and acquired a "nonweaponised" nuclear capability in 1989-1990 and also continued to test missile systems.[53] Indeed, a Draft Nuclear Doctrine (DND) did not become publicly available until 1999 following the Pokhran nuclear tests of 1998.[54] Eventually, an official nuclear doctrine was released in 2003 and stands as a vivid example in that some capabilities were acquired before doctrinal principles were officially articulated and released publicly about the use and non-use of nuclear weapons.[55] Thus, this is not a unique experience for the Indian armed services as the Indian nuclear doctrine offers a historical precedent and parallel.

Nevertheless, each of the services needs to pay more attention to updating service doctrines as well as the tri-service doctrine. As tri-service cooperation grows and integrated commands crystallise there will be a greater need and imperative to harmonise the operational practices, missions and technological changes with doctrinal pronouncements of the armed forces.

Conclusion

It is fairly obvious from the foregoing, India's armed services have struggled to bridge the divide between doctrine and technology. Updating doctrine through periodic reviews is a mandatory requirement for all three armed services. Understanding the strengths and limits of emerging technologies such as AI is also essential. Service doctrines require constant engagement with emerging technologies, but as tri-service cooperation has increased the JDIAS needs to better capture, understand and layout the applicability to military missions, operations, command and control, logistics and weapons systems. Semi-autonomous platforms have been used extensively by the Indian armed services and thus, AI has undergone some form of diffusion and use. The Indian armed services are unique: AI-related capabilities are being integrated and developed or in use, even as doctrine has been laggard in capturing shifts in the adoption of AI. The Indian military leadership writ large and the large mass of retired officers from the three services recognise the importance of AI. However, service doctrines either misconstrue AI significance and in other instances do not provide adequate guidance to military commanders and the officer corps more generally about technological change that AI represents.

Notes

1. Jean Francois Caron (2020), "Defining semi-autonomous, automated and autonomous weapons in order to understand their ethical challenges", *Digital War 1*, pp. 173-174.
2. Ibid.
3. Ibid.
4. See definition "emerging", Thesaurus, Merriam-Webster. Available online at https://www.merriam-webster.com/thesaurus/emerging, accessed on February 5, 2021.
5. Aaron P. Jackson (2013), *The Roots of Military Doctrine: Change and Continuity in Understanding the Practice of Warfare,* Fort Leavenworth, Kansas: Combat Studies Institute Press, pp. 4-6.
6. Ibid.
7. *Doctrine of the Indian Air Force,* Air Head Quarters, New Delhi, 1997 (amended edition).
8. *Indian Army Land Warfare Doctrine-2018,* Army Headquarters, New Delhi, 2018.
9. Lt. Col. Akshat Upadhyay (2021), "Engagement or Estrangement: Gauging Indian Army's Relationship with the Emerging Technologies", Issue Brief 272, Center for Land Warfare

Studies, February 2021, p. 5. Available online at https://www.claws.in/publication/engagement-or-estrangement-gauging-indian-armys-relationship-with-the-emerging-technologies/, accessed on February 15, 2021.

10. *Basic Doctrine of the Indian Air Force Doctrine, 2012,* Indian Air Force, Air Headquarters, New Delhi, pp. 89-90.
11. Ibid.
12. *Indian Maritime Doctrine: Indian Navy,* Naval Strategic Publication, 1.1., Indian Naval Headquarters, New Delhi, 2016.
13. Daniel J. Hughes (1993), *Moltke of the Art of War: Selected Writings,* New York: Ballantine, pp. 109-111.
14. Sara Reese Hedberg (2002), "DART: Revolutionizing Logistics Planning", *IEEE Intelligent Systems,* May/June 2002, p. 81.
15. Ibid.
16. For lethal AI use see for example, Marcus Weisgerber (2017), "The Pentagon's New Artificial Intelligence Is Already Hunting Terrorists", *DefenseOne,* 21 December 2017. Available online at https://www.defenseone.com/technology/2017/12/pentagons-new-artificial-intelligence-already-hunting-terrorists/144742/, accessed on February 5, 2021.
17. Aditi Malhotra and Rammohan Vishvesh (2014), "Taking to the skies – China and India's quest for UAVs", *Journal of the Indian Ocean Region,* Vol. 10, No. 2, p. 171.
18. M.K.K. Iyer, "A Shot in the Arm", *Force,* http://forceindia.net/cover-story/a-shot-in-the-arm/.
19. "Northrop KD2R5 "Sheldruck" Basic Training Target Drone", Western Museum of Flight, Torrance: CA. Available online at https://www.wmof.com/kd2r5.htm, accessed February 15, 2021.
20. "Northrop MQM/BQM- 74 *Chukar".* Available online at http://www.designation-systems.info/dusrm/m-74.html, accessed on February 10, 2021.
21. Ibid.
22. Aditi Malhotra and Rammohan Vishvesh (2014), "Taking to the skies", n. 17, p. 171.
23. Ibid.
24. P.K. Chakravorty (2018), "Employment of Unmanned Aerial Vehicles (UAVs) and Need for Unmanned Combat Aerial Vehicles (UCAVs) in the Indian Army", *Indian Defence Review,* 15 June 2018, at http://www.indiandefencereview.com/spotlights/employment-of-unmanned-aerial-vehicles-uavs-and-need-for-unmanned-combat-aerial-vehicles-ucavs-in-the-indian-army/, accessed on February 7, 2021.
25. Ibid.
26. Sushant Kulkarni (2019), "Sindhu Sudarshan desert exercise: Testing ground capabilities, messages for adversaries", *The Indian Express,* 9 December 2019. Available online at https://indianexpress.com/article/cities/pune/desert-exercise-testing-ground-for-capabilities-message-for-adversaries-6156363/, accessed on February 6, 2021. Also see, Aditi Malhotra and Rammohan Vishvesh (2014), "Taking to the skies", n. 17, p. 175.

27. P.K. Chakravorty (2018), "Employment of Unmanned Aerial Vehicles", n. 24.
28. Rajat Pandit (2013), "Indian armed forces building deadly drone arsenal, also want combat UAVs", *The Economic Times,* 5 February 2013. Available online at https://economictimes.indiatimes.com/news/politics-and-nation/indian-armed-forces-building-deadly-drone-arsenal-also-want-combat-uavs/articleshow/18342256.cms?from=mdr, accessed on February 6, 2021.
29. Aditi Malhotra and Rammohan Vishvesh (2014), "Taking to the skies", n. 17, p. 175.
30. "Indian Army signs a pact to procure high altitude drones from ideaForge for $20 million", *The Economic Times,* 14 January 2021. Available online at https://economictimes.indiatimes.com/news/defence/indian-army-signs-a-pact-to-procure-high-altitude-drones-from-ideaforge-for-20-million/articleshow/80265458.cms?from=mdr, accessed on February 8, 2021.
31. Vivek Raghuvanshi (2016), "Indian Prepares to Kick-Start Delayed Tactical Comms Project", *DefenseNews,* 13 July 2016. Available online at https://www.defensenews.com/global/asia-pacific/2016/07/13/india-prepares-to-kick-start-delayed-tactical-comms-project/, accessed on February 18, 2021.
32. Ibid.
33. "Indian Daksh ROV Enters Service", LiveFistdefence.com, 30 January 2012. Available online at https://www.livefistdefence.com/indian-daksh-rov-enters-service/, accessed on February 7, 2021.
34. "Indian Army Wants 500 Anti-Terror Robotic Vehicles in Kashmir", livefistdefence.com, 18 November 2019. Available online at https://www.livefistdefence.com/indian-army-wants-500-anti-terror-robotic-vehicles-in-kashmir/, accessed on February 7, 2021.
35. "India Set to Get Four Heron Long-endurance Drones Israel", News18, 26 May 2021. Available online at https://www.news18.com/news/india/india-set-to-get-four-heron-long-endurance-drones-from-israel-3780212.html, accessed June 1, 2021.
36. Ibid.
37. A.K. Sachdev (2019), "Unmanned Platforms in the IAF: The Need to Bolster", *Indian Defence Review,* Issue Vol. 34, January-March 2019, http://www.indiandefencereview.com/news/unmanned-platforms-in-the-iaf-the-need-to-bolster/#:~:text=The%20first%20IAF%20UAV%20Squadron,squadrons%20and%20a%20Tech%20Flight, accessed on February 5, 2021.
38. Aditi Malhotra and Rammohan Vishvesh (2014), "Taking to the skies", n. 17, p. 175.
39. A.K. Sachdev, "Unmanned Platforms in the IAF": The Need to Bolster", n. 37.
40. Aditi Malhotra and Rammohan Vishvesh (2014), "Taking to the skies", n. 17, p. 175.
41. Sudhi Ranjan Sen (2020), "India to buy 30 US Predator drones for $3 bn to counter China, Pakistan", *Business Standard,* 11 March 2020. Available online at https://www.business-standard.com/article/current-affairs/india-to-buy-30-us-predator-drones-for-3-bn-to-counter-china-pakistan-121031000515_1.html, accessed on February 15, 2021.
42. Manu Pubby (2021), "HAL to make advanced armed UAVs with Israeli Co.", *The Economic Times,* 3 February 2021. Available online at https://economictimes.indiatimes.com/news/defence/hal-to-make-advanced-armed-uavs-with-israeli-co/articleshow/73887330.

cms?from=mdr, accessed on February 7, 2021. For a brief overview of the Heron TP system see, "Heron TP: MALE Unmanned Aerial System (UAS)". Available online at https://www.iai.co.il/p/heron-tp, accessed on February 7, 2021.

43. A.K. Sachdev (2019), "Unmanned Platforms in the IAF", n. 37.
44. Aditi Malhotra and Rammohan Vishvesh (2014), "Taking to the skies", n. 17, p. 176.
45. Jayanta Gupta (2013), "Behala to house UAV squadron", *The Times of India,* 18 July 2013. Available online at https://timesofindia.indiatimes.com/city/kolkata/Behala-to-house-UAV-squadron/articleshow/21132531.cms, accessed on February 8, 2021.
46. Rikeesh Sharma (2013), "Transformation of Indian Naval Aviation", *Journal of Defence Studies,* Vol.7, Issue 1, p. 40.
47. "Indian Navy to urgently buy 10 ship-based drones", *Livemint*, 14 August 2020. Available online at https://www.livemint.com/news/india/indian-navy-to-urgently-buy-10-ship-based-drones-11597409699622.html, accessed on February 7, 2021.
48. See K. Raja Menon (2012), "Technology and Indian Navy", in Harsh V. Pant (ed.), *The Rise of the Indian Navy: Internal Vulnerabilities, External Challenges,* Surrey: Ashgate Publishing Limited, pp. 90-92.
49. Ibid.
50. "India navy setting up AI and ML lab for combat management system", *Defence.Capital,* 15 November 2019. Available online at https://defence.capital/2019/11/15/india-navy-setting-up-ai-and-ml-lab-for-combat-management-system/, accessed on February 5, 2021.
51. Lt. Gen. R.S. Panwar (2018), "Artificial Intelligence in Military Operations: A Raging Debate, and Way Forward for the Indian Armed Forces", USI Monograph, No. 2, United Service Institution of India (USI), p. 34.
52. Lt. Gen. S.P. Kochhar (2019), "Use of Technology Including Artificial Intelligence (AI) and Robotics to Enhance War Winning Capabilities", *Journal of the United Service Institution of India*, Vol. CXLIX, No. 618, October-December 2019, pp. 528-529.
53. George Perkovich (2000), *India's Nuclear Bomb: The Impact On Global Proliferation*, New Delhi: Oxford University Press, pp. 293-317.
54. Ministry of External Affairs (1999),"Draft Report of National Security Advisory Board on Indian Nuclear Doctrine", 17 August 1999. Available online at https://mea.gov.in/in-focus-article.htm?18916/Draft+Report+of+National+Security+Advisory+Board+on+Indian+Nuclear+Doctrine, accessed on February 7, 2021.
55. Prime Minister's Office (2003), "Cabinet Committee On Security Reviews Progress In Operationalizing India's Nuclear Doctrine', 4 January 2003. Available online at https://archive.pib.gov.in/archive/releases98/lyr2003/rjan2003/04012003/r040120033.html, accessed on February 7, 2021.