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Global AI Military Innovation and Future of Warfare

How Global Military Powers Are Preparing for Future AI Warfare

: Strategy, Governance and Technology Ecosystem

Edited by **Jungmi Cha**



NATIONAL ASSEMBLY
FUTURES INSTITUTE

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PROLOGUE

Today, conflicts of various scales continue to unfold around the world. The rapid development of disruptive technologies, such as artificial intelligence (AI), is transforming the nature of modern warfare, redefining the boundaries between military and civilian domains and between combatants and non-combatants. Amid these transformations, the world is paying close attention to AI's potential and the necessity of innovation to secure future victories in warfare. Simultaneously, efforts are being made to integrate AI into security strategies through technological and military innovations.

This study examines the global competition for AI-driven military innovation, a phenomenon resulting from the disruptive technological advancements and changes in warfare patterns brought about by AI. It focuses on the transformations in warfare facilitated by AI and analyzes how nations worldwide are pursuing AI-based military innovations from a comparative perspective. Conducted as a global collaborative research project involving scholars from around the world, this study explores the AI military innovation strategies, military structural reforms, technological ecosystems, talent development, and ethical governance of leading military powers. It also draws insights and implications for future security and AI military innovation in South Korea.

In an era where the race for AI military innovation is accelerating, South Korea faces a critical juncture. The country must pursue military innovation to secure a strategic edge in future security while demonstrating leadership and diplomacy to champion ethical and responsible AI innovation. As the pace of AI innovation intensifies, international cooperation and global governance are essential to mitigate the risks this competition entails.



This study aims to serve as a vital starting point for discussions on responsible military innovation in the age of AI warfare. By providing an in-depth understanding of global AI military innovation, we hope this research will be a valuable reference for policymakers, researchers, and global leaders as they study and debate the future of warfare and security in the AI era.

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Global Collaborative Research -Participants

Research Organizer and Editor



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ABSTRACT

1. Introduction

□ Artificial Intelligence (AI) and Changes in Warfare

- The use of AI technology in modern conflicts such as the Russo-Ukrainian War and the Israel-Gaza Conflict heralds a new era in the nature of warfare and the global security environment
 - AI technology is not only enhancing the capabilities of traditional forces such as the Army, Navy, and Air Force, but also changing the appearance of the battlefield, such as the change to network-centric warfare
 - The world is paying attention to the future of war, which is becoming increasingly digitalized and intelligent, and studying the changes in the nature of war
 - The core direction of recent global military innovation is AI-based intelligence innovation, and the militarization of AI technology is heralding changes in the security environment
 - The development of AI technology and changes in the nature of war demand innovation in security strategies and defense policies from a mid- to long-term perspective
- Changes in war and military innovation in the AI era are key topics in military security research today
 - Major countries around the world are seeking strategies to integrate AI technology into the military sector, and are producing various research results and strategic reports

- AI military innovation represents a broad change that goes beyond the military domain, including military strategy, military structure reform, and weapon system changes, and encompasses technology and education such as AI technology innovation and talent development
- The world's major military powers are focusing on AI technology as the key to victory in future wars, and as they focus on AI-based military innovation, the competition for AI military power is intensifying

□ **“How are the world's major military powers promoting AI-based military innovation?”**

- **The world is pursuing AI-based military innovation. Republic of Korea's 'Defense Innovation 4.0' also aims to become a strong AI science and technology military**
 - As all countries are in full swing with the AI military innovation competition, there is a lack of specific understanding and comparative research on the direction and content of AI military innovation pursued by countries around the world
 - Based on the understanding and comparative analysis of the military innovation of major countries in the AI era, it is necessary to derive implications for future warfare and changes in the security environment in the AI era and implications for Republic of Korea's AI defense innovation
- **Accordingly, this study analyzes the strategies and specific implementation of AI military innovation centered on the world's five major military powers - the United States, Russia, China, India, and the United Kingdom. It also includes Israel, a**

leader in AI military innovation, and NATO, a multilateral alliance

- Comparative analysis of AI military innovation in major countries, focusing on AI military innovation strategies, military structural reform, AI military technology innovation ecosystem, talent development, and ethics (human in the loop) issues
- This is a joint research report in which seven foreign scholars, who are experts in the military field, participated and analyzed cases of AI military innovation in various countries. It introduces the direction, structure, and policies of AI military innovation worldwide, discusses implications, and derives suggestions.

2. AI Military Innovation in Major Countries

□ The United States' AI Military Innovation

- The United States' vision for future warfare is fundamentally linked to the development and integration of AI technology
 - AI is expected to accelerate battlefield situational awareness and decision-making processes, and improve the accuracy and lethality of military operations
- The US Department of Defense has implemented various policies focusing on the militarization of AI technology, and has changed the defense structure
 - The Joint Artificial Intelligence Center (JAIC) was established in 2018, and it serves as a hub for AI innovation within the Department of Defense, promoting collaboration among the military, academia, and the private sector. However, there has

been no fundamental change in the existing organizational system and command structure

- There are AI-specialized initiatives for each military branch, such as the Navy AI TF, Army AI TF, and Air Force AI Acceleration Division, to integrate AI technology
- Although not yet realized, there are prospects for innovation in the command and control structure for AI-based decision-making
- **An important component of the US strategy for AI warfare is the emphasis on autonomous systems**
 - Invest in the development of autonomous vehicles, drones, and robotic systems, either independently or in collaboration with private operators
 - Reforms such as streamlining the defense procurement process to accommodate the rapid development cycle of AI technology. Establishing the Better Buying Power (BBP) initiative to transform the existing defense procurement system that hinders the rapid introduction of new technologies
 - Establishing a rigorous testing and evaluation process to ensure that AI technology is stable and effective. This includes the development of AI prototypes that undergo extensive simulation and field testing
- **Dual-use characteristics of AI technology and the military technology innovation ecosystem of civil-military fusion**
 - The core of AI military technology governance is civil-military fusion. A foundation for maintaining military technology superiority in an era when AI development is primarily driven by the private sector and academia

- The Defense Innovation Unit (DIU) serves as a bridge between the military and Silicon Valley, and leads civil-military technology cooperation.
- Universities and research labs are also key elements of the defense technology ecosystem
- Civil-military fusion positions the U.S. military at the forefront of technological innovation and promotes broader technological advancements that benefit both the civilian and military sectors, as well as national defense
- **Establishing AI ethics, norms, and governance. Maintaining a “human-centered” approach to autonomous weapon systems**
 - Ethical considerations and governance are important components of the approach to militarizing AI
 - US DoD Directive 3000.09 reflects concerns about the ethical and legal implications of autonomous systems and establishes a governance framework that ensures human oversight
 - The Defense Innovation Board of the Department of Defense released “AI Principles: Recommendations for the Ethical Use of Artificial Intelligence in the Department of Defense”
- **Establishing opportunities for recruiting, training, and promotion of AI talent**
 - Creating new roles and positions focused on AI expertise. The Department of Defense is actively recruiting in AI, machine learning, data science, and related fields
 - Focusing on attracting top AI talent from outside the military. Creating career paths and promotion opportunities for AI experts, enabling the military to attract and retain top talent

- Deploying AI experts in each unit, integrating AI tools and systems into everyday military operations
- Strengthening educational programs to enhance AI literacy and technical expertise within the military. Collaborating with universities and research centers to provide expertise and training from leading scholars

□ Russian AI military innovation

- **Russia's AI military innovation expands civil-military cooperation with the dual purpose of AI technology development and militarization**

- In 2018, the Russian Ministry of Defense, in cooperation with the Ministry of Education and Science and the Academy of Sciences, held the conference "Artificial Intelligence: Problems and Prospective Solutions". The goal is to integrate civilian and military science
- In 2019, the AI development law was issued, and the AI national strategy until 2030 was announced. The Russian Ministry of Defense's AI technology development priority strategy for 2021
- State-owned enterprises such as Rostec and private companies are developing AI-based weapons

- **Governance and technology ecosystem for AI military innovation led by the Ministry of Defense**

- The Ministry of Defense established an innovation system with 151 cooperation agreements with more than 1,200 institutions in cooperation with the Russian Academy of Sciences, financial institutions, major research centers, and universities

- The Ministry of Defense's Innovation Development Headquarters (GUIR) is responsible for defense innovation. Promoting cooperation between military industry, companies, and educational institutions
- The Future Research Institute (FPI) is an organization similar to the U.S. Defense Advanced Research Projects Agency (DARPA) and establishes a national center for robotics technology development. FPI promotes more than 100 research projects in cooperation with defense industry, companies, and universities. One-third of the institutions and universities affiliated with the Ministry of Education, Science, and Technology participate in FPI projects
- Establish an AI Development Bureau within the Ministry of Defense in 2022 to integrate AI technology into weapons development and develop military special equipment.
- Establish ERA Military Innovation Technopolis in 2018 to promote civil-military technology cooperation
- **Russia's ethical concerns have limited ability to restrict the development of military AI and autonomous weapon systems. Rather, actively promoting the introduction of AI in the military sector**

❑ **China's AI military innovation**

- **China is focusing on 'military intelligence innovation' with the goal of becoming a world-class military force in the mid-21st century**
 - China recently emphasized 'AI+' military innovation under the goal of building new qualitative combat capabilities

- China is expected to reduce the military power gap with the United States by integrating AI technology
- China recently emphasized the strategic guidelines for preparing for victory in “informatized local warfare with intelligent characteristics”
- China emphasizes A2/AD (anti access/area denial) capabilities in preparation for intelligent informationized warfare
- Although the reorganization of the military structure is not clearly revealed, some reorganizations such as the recent establishment of an Information Support Force, have been made
- **The core of AI military innovation is civil-military fusion, pursuing the integration of development and security**
 - Expanding investment in defense AI research and development for intelligence innovation
 - Reorganizing the technological innovation ecosystem in the direction of involving more commercial and private entities in existing military innovations. State-owned defense companies also expand AI research cooperation with universities and private companies
 - Education and training of defense AI experts through military-civilian fusion
- **Despite AI military innovation, China emphasizes maintaining human control on the battlefield as a critical factor**
 - Emphasizes that humans are central in the era of AI military, and that the Chinese Communist Party leads and controls the military
 - Also emphasizes active participation in global multilateral consultations on responsible use of AI

□ India's AI military innovation

- The Indian government focuses on actively utilizing and integrating AI into its defense strategy
 - The Army is increasingly integrating AI into its C4ISR capabilities. The Navy is strengthening maritime domain awareness and intelligence, surveillance, and reconnaissance (ISR) capabilities by integrating AI and machine learning. The Air Force is strengthening C4ISR capabilities by deploying small satellites
 - Actively developing and deploying advanced AI-powered autonomous systems. Collaborating with private companies. Startups are also contributing significantly
- Focus on changing the military structure and integrating cutting-edge AI technologies across the armed forces
 - Establishing the Defense Artificial Intelligence Committee (DAIC) to coordinate AI-related initiatives across the Army, Navy, and Air Force
 - Establishing the Defense Cyber Agency (DCA) to oversee cyber defense, intelligence analysis, and decision-making through initiatives such as AI-based maritime surveillance and autonomous systems
 - Changing the command and control structure. Changing strategies for AI-based warfare, including AI-centric divisions
- Strengthening civil-military cooperation and international cooperation for AI military technology innovation/ Prioritizing domestic AI technology development
 - India's vast talent pool of engineers, data scientists, and AI experts is a key asset

- The government invests more than 10 billion rupees (170 billion won) in AI projects every year
 - Supporting startups focusing on AI. Cooperating with many big tech companies including Microsoft
 - Expanding international cooperation such as the India-US Defense AI Partnership and the India-Taiwan AI and ML Joint Research Center
 - “Make in India Initiative.” India's goal of technological independence is the driving force behind AI innovation for defense. The Indian Defence Research Organization (DRDO) is developing autonomous drones and missile guidance technologies with private companies
 - Investing heavily in training AI personnel. The Ministry of Defence is establishing an AI excellence center. Military academies and defense research institutes are revising their curricula with AI and data science as core subjects. Private academic institutions and science and technology research institutes are educating military personnel. The Defence Advanced Technology Institute (DIAT) is educating military personnel on AI, machine learning, and robotics
- **Artificial intelligence and ethics. Human-in-the-loop is the core principle**
 - The Defence Artificial Intelligence Committee (DAIC) is developing an AI governance framework for responsible and ethical use of AI, while warning against excessive regulation that could stifle innovation
 - Establishing a certain bipartisan consensus that AI technology development is a priority in the defense sector

❑ The United Kingdom's AI military innovation

- Recognizing its lack of readiness for the AI era, the UK military published the 2022 Defence Artificial Intelligence Strategy Report, emphasizing the transformation of defense into an AI-ready organization
 - The UK Ministry of Defence is promoting more than 200 projects related to autonomous weapon systems
 - However, ethics and oversight are strong factors, focusing on Proceed with Caution
 - The government has an ambiguous position that it is difficult to limit itself amidst the possibility of AI technology misuse by other countries
- The House of Lords (HoL) of the UK Parliament oversees the military's AI development. The private sector is involved in ethical issues
 - The House of Lords establishes the 'AI Weapon Systems Committee' to write a report on the autonomous weapon system of the British military. The report emphasizes that 'human control must be consistently embedded in all stages from design to deployment'
- Emphasizes maintaining technological superiority over the enemy. Strengthening capabilities through civil-military cooperation in AI defense technology
 - The 2022 Defense AI Strategy (DAIS) document emphasizes that military AI development can never be the sole responsibility of the Ministry of Defense, but is a collaborative structure involving industry, academia, allies, and partner countries
 - Decentralization of AI development authority within the UK Ministry

of Defense. The Ministry of Defense sets strategy and policy

- Strategic Command is in charge of integrating AI across the combat domain. The Department of Defense AI and Autonomy (DAU) and the Defense AI Centre (DAIC) are each in charge of designing the AI strategy policy framework, AI R&D, and technology development
- The lack of a clear bottom-up structure is a weakness

□ Israel's AI military innovation

- **Israel continues to rely on its military technological superiority for defense, focusing on AI military innovation**

- Israel is one of the fastest countries to widely adopt AI-based military technology
- The Israel Defense Forces (IDF) integrates AI extensively into battlefield command and control systems, intelligence, etc

- **Restructuring the military to strengthen AI capabilities**

- Many military units enjoy a high degree of freedom and budget to develop their own technology solutions. Organizational change is necessary due to the emergence of parallel competitive solutions
- Establishment of a digital transformation directorate within the IT and cyber defense unit in 2019 Designing a Military-Wide AI Strategy
- One of the most important changes is the close collaboration between industry and military end users

- **The technology innovation and talent development ecosystem operates along three axes: military, technology companies, and**

universities

- The Israeli government adopted a resolution to encourage private sector activities for AI innovation in 2021
- **AI ethics issues, human-centered discourse are influenced by war and information needs**
 - Hamas' attacks, the COVID-19 pandemic, etc. have gained widespread acceptance of the extensive use of big data and the military use of AI
 - However, the 'human in the loop principle' is still clear, and AI does not replace humans but complements them

□ NATO's AI military innovation

- **AI and machine learning (ML) are at the forefront of change**
 - NATO's AI innovation aims to maintain technological superiority over competitors such as China and Russia
 - NATO's 32 member countries were passive in AI innovation due to factors such as research funding, defense budgets, and internal rifts within the alliance. However, with geopolitical changes such as the Ukraine War and the militarization of AI by Russia and China, the importance of AI research and development has been emphasized
 - In October 2021, NATO adopted its first "AI Strategy."
 - NATO's structural and organizational changes are not yet clear, but internal organizational changes based on AI after the Ukraine War were discussed
- **Establishment of governance and civil-military fusion for AI military technology innovation. In 2022, NATO launched the**

Data and Artificial Intelligence Review Board (DARB) and the NATO Defense Innovation Accelerator (DIANA) to foster civil-military cooperation in emerging technologies such as AI

- The establishment of the NATO Innovation Fund (NIF) in 2022 created a €1 billion venture capital fund to invest in startups specializing in technologies such as AI
- The AI Horizon Scanning initiative was launched in 2022 to assess the impact of AI on warfare, with participation from over 80 AI experts from member and partner countries
- **Cultivating Talent for AI Military Innovation: Advantages and Strategies**
 - Defense Education Enhancement Program (DEEP) focuses on AI tools and military training and education
 - Data and Artificial Intelligence Review Board (DARB), consisting of legal, engineering, military, and ethics experts, begins developing user-friendly AI certification standards

3. Conclusion

□ Five major implications

- **Acceleration of AI military innovation and future warfare**
 - Major countries recognize the role and importance of AI in future warfare, and lead efforts in AI military strategy, structural reform, technological innovation, and talent development
- **Acceleration of AI arms race: Concerns that “if we don’t do it, someone else will”**

- Concerns that we may fall behind in the militarization of AI by adversaries, and the goal of maintaining future strategic superiority is driving increased investment in AI research and development

- **Dual-use innovation and AI competition**

- AI has dual-use characteristics that contribute to both military power and economic growth. Military Technology Innovation has been accelerated for Dual-Use Purposes

- **Civil-Military Fusion (CMF) for AI Military Innovation**

- Utilizing the capabilities of commercial companies and contributing to technological innovation in the military. Responsible use of AI is also important for civil-military cooperation

- **The need for responsible innovation: “human in the loop”**

- Major powers all maintain the principle of "human intervention", but there is a certain difference in the balance between innovation and ethics. International cooperation is essential

- **Implications for South Korea's AI military innovation**

- **Need to establish a comprehensive mid- to long-term defense AI strategy**

- A more comprehensive and long-term vision is needed, encompassing both immediate threats and broad technology trends

- **Strengthening civil-military partnerships, leading AI military technology innovation**

- Strengthening cooperation among the government, defense, private AI companies, and university research institutes

- **AI talent development**

- Expanding specialized AI and defense technology programs. Recruiting top AI talent is essential for continuous innovation, making talent acquisition and promotion system reform a necessity

- **Strengthening defense AI diplomacy with allies and partners**

- Expanding international cooperation on joint defense research projects

- **Ethics and global norms for AI militarization**

- Developing a Korean model for defense AI ethics is crucial for leading AI governance and establishing global norms

- **Role of the National Assembly**

- The National Assembly of ROK can play a pivotal role in shaping the strategic direction of AI military innovation through legislative initiatives that ensure responsible AI development, allocate funding for defense innovation, and establish ethical standards. By providing oversight to maintain accountability in AI, and combining responsible innovation, international cooperation, and strong legislative support, Korea can enhance its security, uphold its values, and promote economic growth

1. 서론

□ 인공지능과 전쟁의 변화

- **러-우 전쟁, 이스라엘-가자전쟁 등 현대전쟁에서 인공지능 기술의 활용은 전쟁의 본질과 글로벌 안보 환경의 새로운 시대를 예고**
 - 인공지능 기술이 육, 해, 공 등 전통적 군의 역량을 증강시키는 것을 물론 네트워크 중심전쟁으로의 변화 등 전장의 모습을 변화시키고 있음
 - 세계는 점점 더 디지털화 지능화되고 있는 전쟁의 미래에 주목하고 전쟁양상의 변화 연구
 - 최근 글로벌 군사혁신의 핵심방향은 인공지능 기반의 지능화 혁신으로, 인공지능 기술의 군사화는 안보환경의 변화를 예고하고 있음
 - 인공지능 기술의 발전과 전쟁양상의 변화는 중장기적 관점에서 안보전략과 국방정책의 혁신을 요구하고 있음
- **인공지능 시대 전쟁의 변화와 군사혁신은 오늘날 군사안보 연구의 핵심 화두**
 - 세계 주요국들은 인공지능 기술을 군사 분야에 통합하는 전략을 모색하고 있으며, 다양한 연구결과와 전략보고서 도출
 - 인공지능 군사혁신은 군사전략과 군구조 개혁, 무기체계 변화 등 등 군사영역을 넘어 인공지능 기술혁신과 인재양성 등 기술과 교육을 포괄하는 광범위한 변화를 수반
 - 세계 주요 군사강국들이 미래전쟁 승리의 핵심으로 인공지능 기술에 주목하고, 인공지능 기반의 군사혁신에 주력하면서 인공지능 군사력 경쟁 심화

□ “세계 주요군사강국들 어떻게 인공지능 군사혁신을 추진하고 있는가”

- 세계가 인공지능 기반의 군사혁신 추구. 한국의 ‘국방혁신 4.0’도 인공지능 과학기술강군 목표
 - 모두 인공지능 군사혁신 경쟁을 본격화하는 속에서, 세계 국가들이 추구하는 인공지능 군사혁신의 방향과 내용 등에 대한 구체적인 이해와 비교연구 부재
 - 인공지능 시대 세계 주요국의 군사혁신에 대한 이해와 비교분석을 토대로, 인공지능 시대 미래 전쟁과 안보환경 변화에 대한 시사점과 한국 인공지능 국방혁신에의 함의 도출 필요
- 이에 본 연구는 세계 5대 군사강국-미국, 러시아, 중국, 인도, 영국, 인공지능 군사혁신의 선두에 있는 이스라엘, 다자동맹인 나토를 중심으로 인공지능 군사혁신의 전략과 구체적인 이행 내용 분석
 - 인공지능 군사혁신 전략, 군구조개혁, 인공지능 군사기술혁신생태계, 인재 양성, 윤리(human in the loop) 문제 등을 중심으로 주요국 인공지능 군사혁신 비교분석
- 해외학자 7인이 참여하여 각국의 인공지능 군사혁신 사례를 분석한 공동 연구보고서로, 세계의 인공지능 군사혁신 방향과 구조, 정책 등을 소개하고, 시사점과 함의, 제언을 도출함

2. 세계 주요국의 인공지능 군사혁신

□ 미국의 인공지능 군사혁신

- 미국의 미래전쟁 비전은 근본적으로 인공지능 기술의 개발 및 통합이 핵심
 - 인공지능이 전장상황 인식, 의사 결정 프로세스를 가속화하며 군사 작전의 정확성과 치명성을 제고할 것으로 전망

- **미국방부는 AI 기술의 군사화에 중점을 둔 다양한 정책 구체화, 국방 구조 변화**

- 2018년 공동인공 지능센터(Joint Artificial Intelligence Center, JAIC) 설립, 국방부 내 AI혁신의 허브 역할로 군, 학계 및 민간 부문 협업 촉진. 단, 기존의 조직체계와 지휘구조에는 근본적 변화 부재
- 해군 AI TF, 육군 AI TF, 공군 AI 가속부 등 각 군별로 인공지능 기술을 통합하기 위한 AI 전문 이니셔티브 존재
- 아직 실현되지는 않았지만 AI기반 의사결정을 위한 명령 및 통제 구조 혁신 등 전망

- **인공지능 전쟁에 대한 미국 전략의 중요한 구성 요소는 자율 시스템 강조. 획득 간소화**

- 독립적으로 또는 민간 운영자와 협력하여 자율 주행차, 드론 및 로봇 시스템 개발 투자
- AI 기술의 빠른 개발 주기에 맞춰 방위 조달 프로세스 간소화 등 개혁. 신 기술의 빠른 도입을 방해하는 기존 방위조달체계 혁신 위해 Better Buying Power(BBP) 이니셔티브 구축
- AI 기술이 안정적이고 효과적인지 확인하기 위한 엄격한 테스트 및 평가 프로세스 구축. 광범위한 시뮬레이션과 현장 테스트를 거치는 AI 프로토타입의 개발이 포함

- **인공지능 기술의 이중용도적 특성과 민군융합의 군사기술혁신생태계**

- AI 군사기술 거버넌스의 핵심은 민군 융합. AI 개발이 주로 민간 부문과 학계에 의해 주도되는 시대에 군사기술 우위 유지를 위한 토대
- 국방부 국방혁신부(DIU)가 군과 실리콘 밸리 간의 교량 역할, 민군 기술협력 주도. DIU는 군사적 적용이 가능한 민간 기술을 식별하고 자금을 지원. 민간용으로 개발된 기술 중 이중용도기술을 적극 식별하고, 재활용하여 군사 역량 강화
- 대학과 연구실도 국방 기술 생태계의 핵심요소. 인공 지능, 로봇 공학, 사이버 보안과 같은 분야에서 기초 연구 수행. 국가 방위 교육 프로그램

(NDEP), 미네르바 연구 이니셔티브등은 국방우선순위와 일치하는 학술연구에 자금 지원

- 이러한 연구지원은 기술적 역량 향상뿐만 아니라 미래의 방위 혁신에 기여할 수 있는 숙련된 과학자와 엔지니어의 파이프라인을 육성
- 민군융합은 미국 군대가 기술 혁신의 최전선에 위치하도록 하고, 국가방위뿐만 아니라 민간 및 군사 부문 모두에 이로운 보다 광범위한 기술 발전 촉진

- **인공지능 윤리 및 규범, 거버넌스 구축. 자율무기체계에서 ‘인간중심’ 접근 견지**

- 윤리적 고려와 거버넌스는 AI 군사화 접근 방식의 중요 구성부분
- 미국 DoD 지침 3000.09는 자율 시스템의 윤리적 및 법적 의미에 대한 우려 반영, 인간의 감독을 보장하는 거버넌스 프레임워크 수립. 2021년 2023년 국방수권법(NDAA) AI 기술 조직(JAIC 및 CDAO) 설립, AI 개발에 대한 특정 자금 지원 및 책임 조치를 의무화
- 국방부 국방혁신위원회, "AI 원칙: 국방부 인공지능 윤리적 사용에 대한 권장 사항" 발표

- **인공지능 인재 충원, 교육 및 승진 기회 확립**

- AI 전문 지식에 초점을 맞춘 새로운 역할과 직책 신설. 국방부는 AI, 머신러닝, 데이터 과학 및 관련분야의 전문 기술 인력 적극 모집
- 군 외부의 최고 AI 인재 유치 주력. AI 전문가를 위한 경력 경로 생성 및 승진 기회 확립, 군이 최고 인재를 유치, 유지하도록 함
- 각 부대에 AI 전문가를 배치, AI 도구와 시스템을 일상적인 군사운영에 통합. 이를 통해 모든 계층의 인력이 AI 기술을 탐구하고 실험하도록 장려하는 혁신 문화 촉진
- AI 시뮬레이션과 위게임 연습 군사 훈련 커리큘럼에 통합
- 군 내 AI 리터러시와 기술 전문성 강화 위한 교육 프로그램 강화. 대학 및 연구센터와 협력하여 선도적 학자들로부터 전문 지식과 교육 진행. 교육 혁신에는 윤리도 포함

□ 러시아의 인공지능 군사혁신

- 러시아 인공지능 군사혁신은 인공지능 기술개발과 군사화의 이중목적으로 민군협력 확대

- 2018년 러시아 국방부는 교육과학부, 과학아카데미와 협력하여 "인공지능: 문제와 전망적 솔루션" 컨퍼런스 개최. 민간 및 군사과학 통합 목표
- 2019년 인공지능 개발 법령 발표, 2030년까지의 인공지능 국가전략 발표. 2021년 러시아 국방부 AI 기술 개발 우선 전략
- 로스텍(Rostec)과 같은 국유기업과 민간기업들이 인공지능 기반 무기 개발

- 국방부 주도의 인공지능 군사혁신 위한 거버넌스 및 기술 생태계

- 국방부가 러시아 과학 아카데미, 금융기관, 주요 연구 센터 및 대학과 협력하여 1,200개 이상의 기관과 151개의 협력 계약을 맺은 혁신 시스템 구축
- 국방부 혁신 개발 본부(GUIR)가 국방혁신 책임. 군산업, 기업 및 교육 기관 간 협력 촉진
- 미래연구재단(FPI)은 미국방위고등연구계획국(DARPA)과 유사한 기관으로, 로봇기술 개발을 위한 국가 센터 설립. FPI는 방위산업, 기업, 대학과 협력하여 100개 이상의 연구 추진. FPI 프로젝트에 교과부 소속 기관과 대학 3분의 1이 참여
- AI 개발국을 2022년 국방부 내에 설립, 무기개발에 AI기술을 통합, 군사특수 장비 개발
- 2018년 ERA 군사혁신 테크노폴리스 설립, 민군 기술협력 촉진

- 러시아의 윤리적 우려가 군사 AI와 자율무기체계 개발을 제약하는 데에는 한계. 오히려 적극적으로 군사분야에서 인공지능 도입 추진

□ 중국의 인공지능 군사혁신

- 중국은 21세기 중엽 세계일류 강군을 목표로 '군사지능화 혁신' 주력

- 중국은 최근 새로운 질적 전투역량 구축이라는 목표 하에 'AI+' 군사혁신 강조

- 중국은 AI 기술을 통합하여 미국과의 군사력 격차 축소 전망
- 최근 중국은 "지능적 특성을 갖춘 정보화된 국지전" 승리를 준비하는 전략 지침 강조
- 또한, 지능화 정보화 해상 국지전에 대비한 A2/AD(접근 차단/지역 거부) 역량 강조
- 군구조 개편이 명확히 드러나지는 않으나, 최근 정보지원부대 신설 등 일부 재편
- **인공지능 군사혁신의 핵심은 민군융합. 발전과 안보의 통합이라는 관점에서 인공지능 혁신**
 - 지능화 혁신을 위한 국방AI 연구개발 투자 확대
 - 기존의 군주도 기술혁신에서 더 많은 상업, 민간주체를 참여시키는 방향으로 기술혁신 생태계 재편. 국영방산기업들도 대학, 민간기업과의 인공지능 연구 협력 확대
 - 과학기술부, 공업정보화부 등 정부부처와 인민해방군, 국영방위산업, 연구소, 대학 등이 연계된 민관군 협력 기술혁신생태계
 - 군민융합을 통한 국방AI 전문가 교육, 양성. 국방연구소, 국방과학기술대학 등 커리큘럼 재편
- **중국은 지능화 혁신에도 불구하고, 전장에서 인간통제 유지를 결정적 요소로 강조**
 - 인공지능 군사 시대에도 인간이 중심이고, 당이 군대를 이끌고 통제하는 것을 강조
 - 또한 AI의 책임있는 사용에 대한 글로벌 다자간 협의 적극 참여 강조

□ 인도의 인공지능 군사혁신

- **인도정부는 인공지능을 방위전략에 적극 활용하고 통합하는 데 주력**
 - 인공지능 기반의 전장 모니터링 및 정보 수집 역량 강화. 육군은 C4ISR 역

량에 AI를 점점 더 통합. 해군은 AI와 머신 러닝을 통합하여 해상 영역 인식 및 정보, 감시 및 정찰(ISR) 역량 강화. 공군은 소형 위성을 배치하여 C4ISR 역량 강화

- 인공지능으로 구동되는 첨단 자율 시스템 적극 개발, 배치. 민간기업과의 협력. 신생 기업도 상당한 기여

- **군구조 변화 및 전군에 최첨단 인공지능 기술 통합 중점**

- 국방인공지능 위원회(DAIC) 신설, 육군, 해군, 공군의 AI 관련 이니셔티브 조정. AI 정책 프레임워크 개발, 연구개발 감독, 군, 학계, 민간 부문 간 협업 촉진
- 국방사이버 기관(DCA) 설립. AI 기반 해상 감시 및 자율 시스템과 같은 이니셔티브를 통해 사이버 방어, 정보 분석 및 의사 결정 등 감독
- 육군, 해군, 공군 내에 AI-centric Directorates 구축, 전군에 AI 도입 추구
- 지휘통제 구조 변화. AI 중심 사단을 포함하여 AI 기반 전쟁 위한 전략 변화

- **인공지능 군사기술혁신 위한 민군협력, 국제협력 강화/ 국내 AI기술 개발 우선**

- 인도의 엔지니어, 데이터 과학자, AI 전문가 등 방대한 인재 풀이 중요 자산
- 정부는 매년 100억 루피(1700여억원) 이상 인공지능 프로젝트에 투자. 단기적으로는 민군협력, 국제협력으로 보완/ 장기적으로는 AI 예산 확대 고려
- AI에 중점을 둔 신생 기업 지원. Microsoft 등 다수 빅테크기업 협력
- 인도-미국 방위 AI 파트너십, 인도-대만 AI 및 ML 공동연구센터 등 국제 협력 확대
- 인도의 기술자립 목표는 방위를 위한 AI 혁신의 원동력. 'Make in India 이니셔티브' 인도국방과학연구소(DRDO)는 민간 기업과 자율 드론 및 미사일 유도 기술 등 개발
- AI 인력 양성에 막대한 투자. 국방부가 AI 우수 센터 설립. 군사 아카데미와 국방 연구 기관은 AI와 데이터 과학을 핵심 과목으로 커리큘럼 개정. 민

간학술기관과 과학기술연구소 군인교육. 국방첨단기술원(DIAT) 군인들에게 AI, 머신러닝, 로봇공학 교육

- **인공지능과 윤리. 인간중심(human in the loop)이 핵심원칙**

- 국방인공지능위원회(DAIC)는 AI의 책임감 있고 윤리적 사용위해 AI 거버넌스 프레임워크 개발하는 한편, 혁신을 저해할 수 있는 과도한 규제에 대해 경고
- 국방분야에서 인공지능 기술개발이 우선순위라는 데에 일정한 초당적 합의 확립

□ **영국의 인공지능 군사혁신**

- **AI가 미래 전쟁의 주요 요소이고 러시아 중국 등 경쟁자에 뒤처져서는 안 된다고 인식**

- 영국 군은 아직 AI 시대에 준비되지 않았다는 인식. 2022년 국방인공지능 전략 보고서 발표, 국방을 인공지능 준비조직으로 전환 강조
- 영국 국방부는 자율무기체계 관련 200개 이상의 프로젝트 추진
- 단, 윤리와 감독의 문제가 강력한 요소로 '신중한 진행'에 초점
- 정부는 다른 국가들의 AI기술오용 가능성 속에 스스로 제한하기 어렵다는 모호한 입장

- **영국의회 상원(HoL)이 군의 AI 개발 감독. 민간의 윤리문제 관여**

- 상원은 'AI 무기시스템위원회의' 설립. 영국군대의 자율무기체계 관련 보고서 작성. '설계에서 배치에 이르기까지 모든 단계에서 인간의 통제가 일관되게 내재되도록 해야 한다' 강조
- 국방인공지능전략 보고서의 AI 윤리 등은 케임브리지, 옥스퍼드 등에서 참여
- 영국이 국방 AI 윤리 주도하는 리더가 될 것이라고 강조. '인간 중심주의 윤리 원칙'

- **적에 대한 기술적 우위 유지 강조. AI 국방기술 민군협력 통한 역량 강화**

- 2022년 국방인공지능전략(DAIS) 문서는 군사AI 개발이 결코 국방부만의 책임일 수 없고, 산업, 학계, 동맹국 및 파트너 국가가 참여, 협력하는 구조임을 강조
- 영국 국방부 내에서 AI 개발 권한 분산. 국방부가 전략과 정책 설정
- 전략사령부가 전투영역의 AI 전반 통합 임무. 국방AI 및 자율성 부서(DAU)와 국방 AI 센터(DAIC)가 각각 AI 전략정책 프레임워크 설계, AI R&D 및 기술 개발
- 명확한 상향식 구조가 없는 점은 취약점.

- **AI 인재 관련 인사문제가 중요. 민간의 수요도 높은 분야로 인재 유입 중요**

- 모든 레벨의 AI 리더십 제고. 국방 고위 간부에게 AI 관련 교육

□ **이스라엘의 인공지능 군사혁신**

- **이스라엘은 방위를 위해 군사적 기술적 우위에 지속 의존. 인공지능 군사 혁신 주력**

- 이스라엘은 AI 기반 군사 기술을 광범위하게 도입한 가장 빠른 국가 중 하나
- 이스라엘 방위군(IDF)은 AI를 전장 지휘 및 통제 시스템, 정보 등 광범위하게 통합
- 물류지원, 식별 등 전장 솔루션을 제공하기 위해 다양한 AI 기반 시스템. ‘라벤더’는 공습 대상을 식별하는 정보 분석

- **AI 역량강화 위한 군구조 개편**

- 많은 군 부대는 자체 기술 솔루션을 개발할 수 있는 높은 수준의 자유와 예산 향유. 평행적 경쟁적 솔루션의 등장으로 조직변화 필요
- 2019년 IT 및 사이버 방어부대 내에 디지털 전환 이사국 설치. 군 전체 AI 전략 설계
- 2020년 군의 ‘전투방법 및 혁신부대’는 전술지휘대학(Maltak)과 함께 전투지휘관 AI 교육

- 마이크로소프트와 협력 등 산업과 군 최종 사용자 간의 긴밀한 협력

- **기술혁신 및 인재양성 생태계, 군-기술기업-대학의 3축**

- 군가정보부(AMAN)에서 최첨단 AI 기술에 종사한 인재들이 전역 후 민간 기업으로 이동

- 이스라엘정부는 2021년 AI 혁신 위해 민간부문 활동 장려 결의한 채택

- 이스라엘은 1인당 하이테크 신생 기업의 비율이 가장 높고, 강력한 벤처 캐피털 기반. 정부 인센티브 및 하이테크 부문에 대한 투자를 선호하는 분위기에 의해 촉진

- **AI 윤리문제, 인간중심 담론은 전쟁과 정보 필요에 의해 영향 받음**

- 하마스의 공격, 코로나 팬데믹 등으로 광범위한 빅데이터 사용 및 인공지능의 군사적 사용에 대한 광범위한 수용을 얻음

- 그러나, 여전히 '인간의 개입 원칙' 명확, AI는 인간을 대체하지 않고 보완

□ 나토(NATO)의 인공지능 군사혁신

- **AI와 머신 러닝(ML)은 변화의 최전선에 있음**

- 나토의 인공지능 혁신은 중국이나 러시아와 같은 경쟁자에 대한 기술적 우위 유지 목표

- 나토 32개 회원국의 연구자금, 국방비 등 동맹내부 격차로 인공지능 혁신 수동적이었으나 우크라이나 전쟁과 러시아와 중국의 인공지능 군사화 등 지정학 변화로 AI 연구 개발 강조

- 2021년 10월 NATO는 첫 번째 "인공지능 전략" 채택. 2024년 1월 양자 전략 발표

- NATO의 구조 및 조직변화 아직 명확하지 않으나 우크라이나 전쟁 이후 인공지능에 기반한 내부 조직 변화 논의

- **AI 군사 기술 혁신을 위한 거버넌스 구축 및 민군 융합**

- 회원국간 기술격차 등 한계. 2020년 NATO 혁신위원회 설립, 동맹 혁신정책 조정. 회원국 간 혁신 촉진 위한 생태계 개발
- 2022년 NATO의 데이터 및 인공지능 검토 위원회(DARB) 설립. 2023년 NATO의 디지털 변환 구현 전략 채택
- 나토방위혁신가속기(DIANA, 2022) 설립, AI, 양자 및 생명공학 등 신형 기술 민군협력 촉진. 이중 용도 기술을 개발하는 혁신가 지원
- NATO 혁신 기금(NIF, 2022) 신설. 10억 유로 규모의 벤처캐피털 기금으로 인공지능 기술 등 신생 기업 투자
- AI Horizon Scanning(2022) 신설, AI 전쟁 영향 이해위한 이니셔티브 착수. 회원국과 파트너 국가의 80명 이상 AI 전문가 참여

- **인공지능 군사혁신 인재육성과 윤리**

- 국방 교육 강화 프로그램(DEEP)이 인공지능 도구 중점두고 군사훈련 및 교육
- AI Horizon Scanning Initiative는 AI 책임있는 개발 노력의 일부
- 법률, 엔지니어링, 군사 및 윤리 전문가로 구성된 데이터 및 인공지능 검토 위원회(DARB)는 사용자 친화적인 AI 인증 표준 개발 시작

3. 결 론

□ 5대 주요 시사점

- **AI 군사 혁신과 미래 전쟁의 가속화**

- 주요국은 미래전쟁에서 AI의 역할과 중요성 인정, AI 군사 전략, 구조적 개혁, 기술적 혁신, 인재 양성 주도 노력

- **AI 군비 경쟁 가속화: "우리가 하지 않으면, 다른 누군가가 할 것"이라는 우려**

- 적대국의 인공지능 군사화에 뒤처질 수 있다는 우려, 미래 전략우위 유지의 목표가 AI 연구 및 개발 투자 확대 전인

- **이중 용도 혁신과 AI 경쟁**

- AI는 군사력과 경제 성장 모두에 기여하는 이중 용도 특성. 이중용도목적의 군사기술혁신

- **AI 군사 혁신을 위한 민군 융합(CMF)**

- 상업 기업의 역량 활용과 군사분야의 기술혁신 기여. 책임 있는 AI 활용 또한 민군협력 중요

- **책임 있는 혁신의 필요성: "인간 개입(human in the loop)"**

- 주요 강국들은 모두 "인간 개입" 원칙을 견지하나, 혁신과 윤리간 균형에 일정한 차이. 국제협력이 긴요

□ **한국의 AI 군사 혁신에 대한 시사점**

- **종합적 중장기적 국방인공지능 전략 수립 필요**

- 보다 포괄적이고 장기적인 비전이 필요. 당면한 위협과 광범위한 기술 동향 모두 포괄

- **민군 파트너십 강화, 인공지능 군사기술혁신 주도**

- 정부, 국방, 민간 AI 기업, 대학 연구기관 간의 협력 강화, 혁신과 안보 수요 모두 충족

- **AI 인재 개발**

- 대학에서 전문 AI 및 국방 기술 프로그램 확대, 민군협력, 국제 협력 강화. 지속적인 혁신을 위해 최고의 AI 인재를 유치하는 것이 필수라는 점에서 인재 채용과 인사제도개혁 등 필요.

- **동맹 및 협력국과의 국방인공지능 협력 강화**

- 공동 국방 연구 프로젝트 등 기술 협력 확대

- AI 군사화의 윤리와 글로벌 규범

- 국방AI 윤리에 대한 한국형 모델 개발. AI 거버넌스 및 규범 주도

- 국회의 역할

- 한국의 국회는 AI 군사 혁신의 전략적 방향을 형성하는 데 중요한 역할. 책임감 있는 AI 군사혁신을 위한 법적 토대 확립, 국방혁신 투자 확대, 윤리적 기준을 유지하기 위한 감독 등 중장기적 종합적 관점의 인공지능 군사 혁신을 위한 역할과 리더십 발휘 필요

PART I

Introduction: Artificial Intelligence (AI) and the Future of Warfare

Jungmi Cha

1. Disruptive AI Technologies and the Future of Warfare
2. Great Power Competition and AI Wars : Emerging AI Arms Race
3. Framework and Structure of the Report:
“How Global Military Powers Are Preparing for Future AI Warfare”

1

Disruptive AI Technologies and the Future of Warfare

NATIONAL ASSEMBLY FUTURES INSTITUTE

The November 2024 issue of *Foreign Affairs* featured the cover title “World of War.” For the first time since World War II, a full-scale conflict, initiated by Russia’s invasion of Ukraine, has persisted into its third year. Simultaneously, the Israel-Hamas war, sparked by Hamas’s terrorist attacks, has extended beyond a year, presenting an ever-looming risk of escalation. These ongoing conflicts underscore the stark absence of effective global governance and leadership capable of mitigating or resolving such crises. As a result, the global community is confronted with unprecedented levels of tension, conflict, and the pervasive threat of war. Furthermore, these wars exemplify the transformative impact of emerging technologies, particularly artificial intelligence, in reshaping the nature of warfare. This evolution introduces new risks and challenges to humanity.

The continuous evolution of warfare has been primarily driven by advancements in technology. Disruptive innovation has historically been propelled by significant developments in military-related technologies, with emerging scientific and technological breakthroughs facilitating military innovation. Over the past 500 years, the majority of groundbreaking military innovations have originated outside formal military institutions. While notable exceptions exist, such as the atomic bomb, satellites, and stealth aircraft, many transformative technologies that revolutionized warfare—such as the pistol, the steam engine, the telegraph, aviation, and lasers—were initially developed without military applications in mind, often emerging from the ingenuity of individual inventors. Technological advancements have thus profoundly reshaped the nature of warfare, making the interplay between technology and armed conflict a longstanding and significant subject of scholarly inquiry.¹⁾

After World War I, Italian general and air power theorist Giulio Douhet highlighted the transformative impact of new technologies, such as fighter aircraft, on the nature of future warfare in his 1921 book, *Command of the Air*. In the aftermath of World War I, during which advancements in aviation and other technologies reshaped the battlefield, the question “What will the war of the future be like?” became a central topic of global discourse.²⁾

Today, more than 100 years later, the Ukraine war has once again raised the same question: “What will the war of the future be like?” The novel paradigms of warfare driven by technological innovation are redefining the critical elements and strategic considerations for achieving success in conflict. Consequently, these developments underscore the urgent need for states to engage in strategic preparation and conceptualize robust frameworks to address the future of warfare. Two colonels in the People's Liberation Army (PLA), Qiao Liang and Wang Xiangsui, in their work *Unrestricted Warfare*, also emphasize the relationship between technological advancements that drive changes in the nature of warfare and the innovation in military technology necessitated by evolving war dynamics. In *Unrestricted Warfare*, Qiao and Wang argue that two fundamental questions—“What kind of war will be fought with what weapons?” and “What kind of weapons will be developed for what kind of war?”—offer a clear distinction between traditional and future warfare.³⁾ These questions, they suggest, elucidate the intricate relationship between war and technology.

Today, among the various disruptive technologies poised to reshape the future of warfare, artificial intelligence stands out as the most profoundly transformative. The war in Ukraine serves as a catalyst for envisioning a new era of AI-driven warfare. The February 2024 cover of TIME magazine was titled “The First AI War.” Former Chairman of the Joint Chiefs of Staff, General Mark Milley, noted that “the most profound and fundamental shift in the nature of warfare in

¹⁾ Max Boot. *War made new: Technology, warfare, and the course of history, 1500 to today*. (Gotham Books, 2006.)

²⁾ Giulio Douhet. *Command of the Air*, New imprint by Air Force History and Museum Program. (1921).

³⁾ Qiao Liang, Wang Xiangsui *Unrestricted Warfare*, Kyowoo Media (in Korean) (2021).

recorded history” is accelerating.⁴⁾ The war in Ukraine has been characterized as the first conflict to extensively develop and deploy artificial intelligence for military purposes.⁵⁾ AI technology is driving transformative changes across multiple dimensions of warfare, including battlefield reconnaissance and intelligence, communication systems, weapons platforms, tactical operations, and training methodologies. It has emerged as both a foundational framework and a critical enabler of effective operational execution.

Today’s world views artificial intelligence technologies as the game-changer in the future of warfare. Today military-related technologies are progressing at a fast pace and on a broad front. They encompass increased computational power—including the prospect of quantum computing—facilitating big data analytics, machine learning, and, through them, advances in artificial intelligence. Impressive progress is also being made in additive manufacturing, robotics, directed energy, and hypersonic propulsion.⁶⁾ Data-enabled decision-making and AI-enabled predictive sustainment are the nervous systems of an adaptive sustainment network. Achieving decisive advantage over the adversary requires the ability to collect and process volumes of data quickly and to provide relevant, reliable information to decision-makers faster than the adversary. AI will not replace soldiers in combat, but soldiers who know how to use AI will defeat those who do not.⁷⁾

Artificial Intelligence (AI) is widely regarded as one of the most pivotal emerging technologies for securing strategic superiority in future warfare. At the AI Summit London during last year’s London Tech Week, Dr Nikos Loutas, NATO’s

⁴⁾ Bergengruen, “How Tech Giants Turned Ukraine Into an AI War Lab”, *TIME*. (2024.02.8). <https://time.com/6691662/ai-ukraine-war-palantir/>

⁵⁾ Vitaliy Goncharuk. “Russia’s War in Ukraine: Artificial Intelligence in Defence of Ukraine,” *International Centre for Defence and Security*, (2024.09.27), <https://icds.ee/en/russias-war-in-ukraine-artificial-intelligence-in-defence-of-ukraine/>

⁶⁾ Andrew F. Krepinevich. *The Origins of Victory: How Disruptive Military Innovation Determines the Fates of Great Powers* (New York: Yale University Press, 2023), p. 86.

⁷⁾ Maj. Gen. Ronald R. Ragin and Maj. Christopher G. Ingram, “Theater Sustainment Transformation: Lessons from the Russia-Ukraine War,” *U.S. Army*, (2024.04.23.). https://www.army.mil/article/274914/theater_sustainment_transformation_lessons_from_the_russia_ukraine_war

head of data and artificial intelligence (AI) policy said: “We are really convinced that ongoing and future conflicts may be won, lost or heavily impacted by AI speed, AI efficacy and who is actually using AI in the battlefield.” The war in Ukraine has been a testing-ground for new applications.⁸⁾ With the recognition that AI will be crucial for achieving victory in future conflicts, many global military powers have taken the lead in advancing AI military technologies, publishing numerous reports that emphasize the critical role of AI in shaping the future of multi-domain warfare. With the belief that AI technologies will drive the fundamental changes in warfare, the global military powers are actively advancing AI-driven military innovation.

⁸⁾ Jason McGee-Abe. “One year on: 10 technologies used in the war in Ukraine”, (2023.02.24). <https://techinformed.com/one-year-on-10-technologies-used-in-the-war-in-ukraine/>

2

Great Power Competition and AI Wars: Emerging AI Arms Race

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Dual-Use Characteristics of Artificial Intelligence (AI) Technologies and U.S.–China Strategic Competition for AI Supremacy

Artificial Intelligence (AI) technologies are inherently dual-use, meaning they can be applied across both civilian and military domains. This dual-use nature is a fundamental characteristic that highlights their transformative potential which simultaneously generating the complex strategic and economic value. As a dual-use technology, artificial intelligence (AI) is compelling the United States and China to rapidly implement strategies aimed at securing long-term advantages. As strategic competition between the United States and China intensifies, the struggle for leadership in the future international order has led to a heightened focus on military power competition. Notably, the dominance of emerging technologies is increasingly recognized as a crucial factor in the global competition for hegemony. Securing a competitive edge in critical emerging technology domains, such as artificial intelligence (AI), is emphasized not only as a core priority in national strategies but also as a fundamental element of defense strategies.

The United States and China recognize that AI will fundamentally reshape the nature of future warfare. Winning these conflicts will not only demand advanced capabilities but also structural reforms and innovative approaches tailored to AI-driven military engagements. Consequently, the competition to achieve superiority in AI military applications has intensified, driving the swift mobilization of national defense strategies in both countries.

In February 2019, President Trump signed an executive order titled “Maintaining American Leadership in Artificial Intelligence.” The order

emphasized that “maintaining American leadership in AI is critical to sustaining the nation’s economy and national security, as well as shaping the global evolution of AI in a manner consistent with our values, policies, and priorities.”⁹⁾ China also views artificial intelligence (AI) as a key technology for establishing itself as a global power. During a group study session on the theme of “Artificial Intelligence,” held by the Central Political Bureau of the Communist Party of China in November 2018, President Xi Jinping emphasized that “AI is a strategic technology driving the industrial revolution, and accelerating the development of next-generation AI is a critical strategic asset for securing China’s leadership in global scientific and technological competition.”¹⁰⁾ These leaders’ recognition of the importance of AI technology in the future global leadership race has fueled competition for superiority in defense AI capabilities.

Concerns about the competitors’ AI capabilities have been a driving force behind the acceleration of AI military innovation and investment. The U.S. Department of Defense’s 2018 Artificial Intelligence Strategy report highlighted the advancements in technology by other nations, particularly China and Russia, as a significant threat. The report stated, “The United States has traditionally maintained technological superiority, which has underpinned its military dominance. However, countries like China and Russia are making substantial investments in AI for military purposes, posing a challenge to the U.S.’s technological and strategic advantage.”¹¹⁾ Chinese 2019 Defense White Paper also argued that international military competition is undergoing historic changes, driven by the rapid application of cutting-edge technologies such as artificial intelligence (AI), in the military domain.¹²⁾ The U.S.-China competition for global

⁹⁾ The White House, “Executive Order on Maintaining American Leadership in Artificial Intelligence, (2019. 02.11.). https://trumpwhitehouse.archives.gov/presidential-actions/executive-order-maintaining-american-leadership-artificial-intelligence/?utm_source=chatgpt.com

¹⁰⁾ 中国共产党新闻网, “习近平讲故事: 人工智能具有很强的“头雁”效应.” (2019.07.26). <http://cpc.people.com.cn/n1/2019/0726/c64094-31256975.html>

¹¹⁾ DOD of U.S. “Summary of the 2018 Department of Defense Artificial Intelligence Strategy.” <https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF>

¹²⁾ The State Council of the People’s Republic of China, “Full Text: China’s National Defense in the New Era,” (2019, 07, 24) .

leadership, increasingly linked to emerging technologies such as artificial intelligence (AI), has led to a rapid escalation in AI investments within the military sector. The competition in military AI investment and the militarization of AI technologies is driven by dual objectives: securing victory in future warfare and asserting dominance in future global leadership.

US DoD has made a number of recent announcements regarding its use of AI. In November 2023, it released an AI adoption strategy and, in January of 2024, Deputy Assistant Secretary of Defense Michael C. Horowitz stated that the DoD had launched a number of AI initiatives and investments. These announcements, and the dramatic increase in AI spending, come at a time of fierce technological competition between the U.S. and China.¹³⁾

China also has regarded the AI technological advance as the most important factor to realize their dream of becoming a world-class military power. Military intelligentization (junshi zhinnenghua, 军事智能化) has been the key discourse in China's strong military dream. China has invested a lot of military efforts and funds to develop the AI based military system and self-reliant AI military technology ecosystem. It is anticipated that China will enhance its information and intelligence military capabilities while actively engaging the AI technologies from a long-term perspective.

The U.S.-China AI military competition is grounded in a techno-deterministic perspective that views AI as a key technology, not only for achieving victory in future warfare but also for securing dominance in the broader competition for global hegemony. This dual techno-determinism comprises two perspectives: first, the belief that AI will be a game-changer in the reconfiguration of future economic and international power structures; and second, the view that the militarization of AI and the intelligence-driven nature of future warfare will be decisive in shaping military power. These perspectives coexist, fueling the

https://english.www.gov.cn/archive/whitepaper/201907/24/content_WS5d3941ddc6d08408f502283d.html
¹³⁾ Will Henshall. "The U.S. Military's Investments Into Artificial Intelligence Are Skyrocketing", *Time*, (2024.03.29), <https://time.com/6961317/ai-artificial-intelligence-us-military-spending/>

acceleration of AI military competition between the United States and China.

Modern Wars and the Rising Probability of AI-Driven Conflicts

Modern warfare is witnessing a surge in the informatization and intelligentization of battlefields. Today, the two wars in Ukraine and Gaza have demonstrated the transforming warfare with characteristics of digitization and intelligentization. Especially the artificial intelligence (AI) technology has been most notable factor in these modern warfare. The wars in Ukraine and Gaza show us the extent to which AI has become integral to battlefield operations. Analyzing the conflicts in Ukraine and Gaza through the lens of military innovation reveals that the application of AI is the most striking development. It is revolutionizing security policies and will sooner or later fundamentally reshape the way wars are fought.

Ukraine has been utilizing advanced AI technologies to enhance its military capabilities in the ongoing conflict with Russia. These technologies include AI-enhanced software for geolocation and analysis of open-source data, such as social media content, to identify Russian soldiers, weapons, systems, units, or their movements. AI technology helps Ukrainian forces to understand troop movements and conduct battlefield damage assessments.¹⁴⁾ As the future of warfare pivots towards artificial intelligence, Ukraine is sitting on a valuable resource: millions of hours of footage from drones which can be used to train AI models to make decisions on the battlefield. AI has been deployed by both sides on the battlefield during Russia's invasion of Ukraine to identify targets, scanning images far quicker than a human can.¹⁵⁾ These AI technologies collectively contribute to a robust system that enhances Ukraine's capabilities in electronic

¹⁴⁾ Robin Fontes and Jorrit Kamminga, "Ukraine A Living Lab for AI Warfare," *National Defence*, (2023.03.24.), <https://www.nationaldefensemagazine.org/articles/2023/3/24/ukraine-a-living-lab-for-ai-warfare>.

¹⁵⁾ Max Hunder, "Ukraine collects vast war data trove to train AI models," *Reuters*, (2024.12.21.) . <https://www.reuters.com/technology/ukraine-collects-vast-war-data-trove-train-ai-models-2024-12-20/>

warfare, data analysis, and tactical decision-making on the battlefield. This strategic use of AI underscores a broader trend of employing advanced technologies to gain intelligence and operational advantages in modern conflicts, highlighting the significance of technological and operational innovations engaging the AI technologies. While still short of changing the character of war, Ukraine has been a laboratory in which the next form of warfare is being created. It is not a laboratory on the margins, but a center-stage, relentless and unprecedented effort to fine-tune, adapt and improve AI-enabled or AI-enhanced systems for immediate deployment. That effort is paving the way for AI warfare in the future.¹⁶⁾

Israel's war on Gaza has witnessed the deployment of several AI systems in its operations. AI models such as "Gospel" and "Lavender" exemplify the growing role of AI-enabled warfare, with the military leveraging artificial intelligence to identify bombing targets in Gaza. The Israeli military says it's using artificial intelligence to select many of these targets in real-time. The military claims that the AI system, named "the Gospel," has helped it to rapidly identify enemy combatants and equipment, while reducing civilian casualties.¹⁷⁾ The proliferation of AI applications on battlefields has profoundly influenced global perceptions of future security, highlighting the transformative implications of AI in warfare. This shift signals the emergence of an era where the integration of advanced AI technologies is redefining military strategies and the nature of conflict.

The growing importance of artificial intelligence (AI) in military operations has been underscored by these two conflicts in Gaza and Ukraine. These conflicts illustrate how AI is transforming modern warfare and emphasize the necessity for states to integrate AI into their defense architectures to maintain strategic competitiveness in an increasingly technology-driven security environment. Emerging trends demonstrate that AI is no longer a supplementary tool but a

¹⁶⁾ Robin Fontes and Dr Jorrit Kamminga, (2023.03.24)

¹⁷⁾ Geoff Brumfiel, "Israel is using an AI system to find targets in Gaza. Experts say it's just the start," *NPR*. (2023.12.14.). <https://www.npr.org/2023/12/14/1218643254/israel-is-using-an-ai-system-to-find-targets-in-gaza-experts-say-its-just-the-st>

foundational asset for addressing future security challenges and enhancing military readiness. The innovations highlight AI's ability to enhance operational efficiency and provide tactical advantages on the battlefield, setting a new benchmark for military preparedness in technologically advanced conflicts.

AI's potential to disrupt the current balance of power and significantly influence strategic operations is becoming increasingly evident. This realization, coupled with ongoing geopolitical crises, has prompted global military powers to intensify their efforts to adapt to the evolving dimensions of warfare. By prioritizing the development and integration of emerging technologies, particularly AI, global military powers are positioning themselves to leverage the most transformative innovation in modern defense. AI's capacity to revolutionize military capabilities across multiple domains—spanning intelligence, surveillance, combat, and logistics—underscores its pivotal role in shaping the future of global power dynamics. For global military powers, integrating AI into defense strategies is no longer a choice but an imperative for any nation striving to maintain relevance in an era where technological superiority defines security, influence, and strategic dominance.

3

**Framework and Structure of the Report:
“How Global Military Powers Are Preparing for
Future AI Warfare”**

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Today military technologies encompass increased computational power—including the prospect of quantum computing—facilitating big-data analytics, machine learning, and, through them, advances in artificial intelligence.¹⁸⁾ With growing awareness that AI will fundamentally change the nature of future warfare, its military applications and utilization have become a primary focus of global military innovation. States are accelerating the race to develop and deploy AI-led technologies in military contexts. The competition for AI military superiority is particularly prominent between the US, striving to maintain its existing overwhelming military advantage, and China, aiming to close the gap through rapid advancements in intelligence-driven innovation. Beyond these two superpowers, other global military powers such as Russia, India, and the UK are also investing in AI-driven military innovations to advance their military capabilities.

The expansion of AI applications in military affairs has intensified the AI arms race, yet little research has been conducted on how global military powers are preparing for future AI-driven warfare or what their military innovations look like. Against this backdrop, this study examines the strategies and policies of major global powers from a comparative perspective. The purpose is to analyze how these nations perceive AI-driven future warfare and to understand the AI-driven military innovations they are pursuing to prepare for this transformative shift in global security dynamics. This study examines how global military powers are preparing the future AI warfare and what their AI-driven

¹⁸⁾ Andrew F. Krepinevich. *The Origins of Victory: How Disruptive Military Innovation Determines the Fates of Great Powers* (New York: Yale University Press, 2023), p. 86.

military innovation looks like.

The countries analyzed in this study include the top five military powers based on the 2024 Global Fire Power Index: the United States, Russia, China, India, and the United Kingdom. Additionally, Israel, recognized as a leader in AI military innovation, and NATO, a representative collective security organization, are included, bringing the total to six military powers plus NATO. This study examines these global military powers' perceptions of AI military innovation, along with lessons learned from recent conflicts, such as the war in Ukraine and the Gaza conflict. Building on these insights, it provides an in-depth analysis of AI military innovation strategies, military structural reforms, AI military technology innovation ecosystems, talent cultivation strategies, and AI ethics in these nations' military innovation strategies.

Chapter 2 of this report analyzes case studies of AI military innovation in major countries, featuring contributions from international scholars. Chapter 3 presents key takeaways and implications derived from these analyses in the conclusion. The purpose of this study is to enhance understanding of the current status and trends in the global competition for AI military innovation by examining national strategies, governance, technological innovation, talent development, and ethics related to AI military advancements in major countries.

This study aims to provide direction for global AI military innovation and contribute to fostering global discussions on responsible AI military innovation. With integrating artificial intelligence into military operations, concerns rise over ethics, transparency, and unintended consequences. Against this backdrop, this research not only offers a robust framework for understanding the dynamics of AI military innovation but also underscores the need for international cooperation in shaping the ethical and responsible use of AI in military contexts. As AI continues to redefine the strategic landscape of warfare, the insights derived from this study will be instrumental in informing policy decisions, guiding technological developments, and encouraging dialogue on the delicate balance between security, innovation, and ethical responsibility in the age of AI-driven warfare.

For future security, it is essential to adopt a creative and innovative approach that recognizes the critical role of emerging technologies and the diverse threats they pose to global security. O’Hanlon suggests that the Pentagon should expand its current 4+1 threat framework—which focuses on Russia, China, North Korea, Iran, and transnational violent extremism or terrorism—to include a second 4+1 list encompassing biological, nuclear, climatic, digital, and domestic economic dangers.¹⁹⁾ This expanded framework needs to incorporate AI for innovative strategies to address the evolving landscape of security challenges.

Over time, new threats stemming from the rapid advancements in computing, information technology, and the internet revolution are likely to emerge. By highlighting the strategic importance of responsible AI governance and military innovation, this report aspires to serve as a foundation for robust and informed discussions. Our ultimate goal is to foster a global dialogue that promotes responsible AI-driven military innovation while safeguarding human dignity and achieving sustainable global peace. Through collaboration and foresight, we can navigate these unprecedented challenges and work toward a more secure and ethical future.

¹⁹⁾ Michael O’Hanlon. *The Art of War in an Age of Peace: US Grand Strategy and Resolute Restraint* (New York: Yale University Press, 2021), p. xii

PART II

Global Military Powers' AI Military Innovation

1. The United States' AI Military Innovation
2. Russian AI Military Innovation
3. Chinese AI Military Innovation
4. Indian AI Military Innovation
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6. Israel's AI Military Innovation
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1

The United States' AI Military Innovation

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Philip M. Baxter

1) Perception of AI and the Future of Warfare

The integration of artificial intelligence (AI) into military operations is rapidly transforming the nature of warfare, presenting both opportunities and challenges for the United States military. The lessons learned from recent conflicts, although not explicitly covered in the provided documents, highlight the increasing importance of AI in enhancing situational awareness, decision-making, and operational efficiency. The conflicts in Ukraine and the Israel-Hamas war, for instance, underscore the necessity for advanced technologies that can provide a strategic edge in complex and fast-evolving battle environments. In these scenarios, the ability to quickly gather, process, and act on vast amounts of data has proven crucial, a capability that AI can significantly enhance.

In the Ukraine conflict, the application of AI-driven surveillance and reconnaissance technologies has demonstrated the potential for AI to revolutionize intelligence gathering and target identification. AI-enabled systems can process and analyze data from various sensors in real time, providing commanders with critical insights and allowing for more informed decision-making. This capability not only improves the precision of military operations but also enhances the ability to anticipate and counter adversary actions. Similarly, the Israel-Hamas conflict has illustrated the role of AI in urban warfare and counter-terrorism operations, where rapid and accurate information processing can mean the difference between success and failure.

The U.S. military's strategic vision for AI encompasses a comprehensive

approach to integrating this technology across all facets of operations. The Department of Defense (DOD) has articulated a clear strategy to leverage AI for maintaining and extending technological superiority. This includes the establishment of specialized units and the adoption of AI across various command levels to enhance the speed and accuracy of military responses. The Joint Artificial Intelligence Center (JAIC) and other initiatives reflect the military's commitment to embedding AI into its operational framework, ensuring that the U.S. remains at the forefront of technological innovation in warfare.

Structural and organizational changes are essential to realize the full potential of AI in military operations. The U.S. military is restructuring its command-and-control frameworks to incorporate AI, fostering a more agile and responsive force. This involves the development of new doctrines, training programs, and operational concepts tailored to the capabilities and requirements of AI-enabled systems. By integrating AI into the core of its operational strategy, the U.S. military aims to enhance its ability to conduct complex operations with greater efficiency and effectiveness.

The governance of AI military technology is another critical area of focus. The DOD is actively working on developing robust processes for the acquisition, testing, and deployment of AI technologies. This includes ensuring that AI systems are reliable, secure, and ethically sound. The civil-military fusion approach, which leverages advancements in the commercial sector for military applications, is pivotal in accelerating the development and integration of AI technologies. By fostering partnerships with private industry and academia, the military can stay ahead of the technological curve and effectively address the challenges posed by emerging threats.

In conclusion, the U.S. military's perception of AI and its strategies for future warfare reflect a deep understanding of the transformative potential of this technology. By learning from recent conflicts and implementing comprehensive structural and organizational changes, the military is positioning itself to harness the power of AI. The focus on ethical governance and robust processes ensures

that AI integration not only enhances operational capabilities but also aligns with international laws and ethical standards. As the nature of warfare continues to evolve, AI will undoubtedly play a central role in shaping the future battlefield, providing the U.S. military with the tools it needs to maintain its strategic advantage.

What is AI?

Artificial intelligence is categorized into three primary levels: narrow AI, general AI, and artificial superintelligence, each with distinct capabilities and potential applications in military contexts. Understanding these levels is crucial for grasping the current state of AI, its prospects, and the strategic implications for military operations.

Narrow AI, also known as weak AI, is designed to perform specific tasks and operates within a predefined scope. These systems excel at particular functions such as image recognition, natural language processing, and predictive analytics. In the military, narrow AI is already being deployed in various applications, enhancing capabilities in intelligence, surveillance, and reconnaissance (ISR). For instance, AI algorithms can process vast amounts of satellite imagery to detect enemy movements or identify strategic targets with high precision. Narrow AI is also instrumental in cybersecurity, where it monitors network traffic for anomalies and potential threats, enabling proactive defense measures. The key strength of narrow AI lies in its ability to handle specialized tasks with a high degree of accuracy and efficiency, making it an invaluable tool for augmenting human capabilities in specific domains.

General AI, or strong AI, represents a more advanced level of artificial intelligence, capable of performing any intellectual task that a human can do. This type of AI possesses the ability to understand, learn, and apply knowledge across a wide range of activities, adapting to new situations with minimal human intervention. While general AI remains largely theoretical and has not yet been

realized, its potential implications for the military are profound. A general AI system could autonomously strategize, make complex decisions in real time, and even engage in tactical operations without direct human oversight. This would revolutionize military command and control, allowing for faster and more adaptive responses to dynamic battlefield conditions. The development of general AI would mark a significant leap forward, enabling more comprehensive and integrated AI-driven military operations.

Artificial superintelligence goes beyond the capabilities of general AI, achieving levels of intelligence that surpass human cognitive abilities across virtually all domains. Superintelligent systems would be able to solve complex problems, innovate new technologies, and make decisions with unprecedented speed and accuracy. In a military context, artificial superintelligence could transform warfare, offering predictive insights, optimizing logistics, and even developing new tactics and strategies that humans might not conceive. However, the advent of superintelligence also raises significant ethical and security concerns. Ensuring that such powerful AI systems are aligned with human values and controlled effectively to prevent misuse or unintended consequences is paramount. The strategic advantage offered by artificial superintelligence would be immense, but so too would be the challenges in governing and integrating such a transformative technology.

The different levels of AI represent a continuum of capabilities, each with its unique potential and challenges for military applications. At present Narrow AI and some General AI applications are being used by the public, with Narrow AI the focus for the US military. The following sections highlight some of the takeaways from the ongoing conflicts in Ukraine and the Middle East.

Lessons Learned from the Ukraine War

The conflict in Ukraine has provided a stark and profound illustration of how modern warfare is evolving, heavily influenced by technological advancements,

particularly in artificial intelligence. For the Ukrainian military, the lessons learned from this war are multifaceted, encompassing strategic, operational, and tactical dimensions. The integration of AI and other advanced technologies has underscored their critical role in contemporary conflict, highlighting both the potential advantages and the significant challenges they bring.

One of the most significant lessons for the Ukrainian military has been the transformative power of AI in intelligence, surveillance, and reconnaissance (ISR). AI-driven tools have enabled the rapid processing and analysis of vast amounts of data from various sources, such as satellite imagery, drones, and electronic surveillance.²⁰⁾ This capability has provided the Ukrainian forces with enhanced situational awareness, allowing for more precise targeting and better-informed decision-making. The ability to quickly identify and track enemy movements has been crucial in both defensive and offensive operations, demonstrating the value of real-time intelligence in a dynamic battlefield environment.²¹⁾

The war has also highlighted the importance of AI in enhancing cybersecurity and electronic warfare capabilities. The Ukrainian military has faced numerous cyber-attacks aimed at disrupting communications, compromising data, and undermining critical infrastructure.²²⁾ AI has played a vital role in defending against these threats by identifying anomalies, predicting potential attacks, and automating responses to mitigate damage.²³⁾ The lessons learned here emphasize the need for robust AI-enabled cybersecurity measures to protect military networks and maintain the integrity of operations.

Moreover, the conflict has underscored the potential of AI in optimizing

²⁰⁾ Bendett, S. "The Roles and Implications of AI in the Russian-Ukrainian Conflict." *Russia Matters*, (2023) <https://www.russiamatters.org/analysis/roles-and-implications-ai-russian-ukrainian-conflict>.

²¹⁾ Mozur, P. and Satariano, A. "A.I. Begins Ushering In an Age of Killer Robots." *The New York Times*, (2024.07.02). <https://www.nytimes.com/2024/07/02/technology/ukraine-war-ai-weapons.html>.

²²⁾ Duguin, S. and Pavlova, P. "The Use of Artificial Intelligence in Armed Conflicts." *European Parliament*, (2023) [https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/702594/EXPO_BRI\(2023\)702594_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/702594/EXPO_BRI(2023)702594_EN.pdf).

²³⁾ Goncharuk, V. "Russia's War in Ukraine: Artificial Intelligence in Defence of Ukraine." *International Centre for Defence and Security*, (2024a) <https://icds.ee/en/russias-war-in-ukraine-artificial-intelligence-in-defence-of-ukraine/>.

logistics and supply chain management. The Ukrainian military has had to navigate significant logistical challenges, often under conditions of disrupted infrastructure and supply lines. AI algorithms have been employed to streamline the distribution of supplies, predict logistical needs, and ensure that resources are efficiently allocated where they are most needed.²⁴⁾ This has proven essential in maintaining operational readiness and sustaining prolonged engagements.

However, the war has also revealed several challenges and limitations associated with AI integration. One of the key lessons learned is the necessity of robust and resilient AI systems capable of operating in contested and degraded environments. The Ukrainian military has experienced instances where communication networks were disrupted, and AI systems had to function autonomously or with limited connectivity. This has highlighted the need for AI solutions that can adapt to and function effectively in the face of such disruptions.

In conclusion, the lessons learned from the Ukraine war from the perspective of the Ukrainian military underscore the profound impact of AI on modern warfare. While AI has provided significant advantages in ISR, cybersecurity, and logistics, it has also presented challenges that need to be addressed to fully realize its potential. The experience has highlighted the importance of developing resilient, adaptable, and ethically sound AI systems to enhance military effectiveness in future conflicts. As the Ukrainian military continues to evolve and integrate these technologies, the insights gained from this conflict will be invaluable in shaping their strategic and operational approaches.

Lessons Learned from the Israel–Hammas War

The Israel–Hammas conflict has provided critical insights into the evolving nature of modern warfare, particularly highlighting the significant role of AI and other

²⁴⁾ Goncharuk, V. "Survival of the Smartest? Defense AI in Ukraine." In: Borchert, H., Schütz, T., Verbovsky, J. (eds) *The Very Long Game*. Contributions to Security and Defence Studies. (Springer, Cham., 2024b). https://doi.org/10.1007/978-3-031-58649-1_17.

advanced technologies. For the Israeli military, the war underscored the transformative potential of AI in enhancing operational effectiveness, precision, and decision-making in highly complex and asymmetric combat environments.

One of the primary lessons learned is the crucial role of AI in ISR operations.²⁵⁾ As with the conflict in Ukraine, AI-driven tools and systems enabled the Israeli Defense Forces (IDF) to process vast amounts of data from various sensors and sources in real-time. This capability allowed for rapid identification and tracking of threats, enhancing situational awareness and enabling more accurate targeting.²⁶⁾ The integration of AI into ISR operations proved particularly effective in urban warfare scenarios, where distinguishing between combatants and civilians is challenging. By leveraging AI, the IDF was able to minimize collateral damage and improve the precision of their strikes.

Additionally, the conflict has highlighted the importance of AI in optimizing command and control (C2) processes.²⁷⁾ AI algorithms facilitated the rapid analysis of battlefield data, supporting decision-making at all levels of command. This improved the speed and accuracy of operational decisions, allowing the IDF to respond more effectively to dynamic and fluid combat situations. The ability to quickly adapt to changing conditions and threats is a significant advantage in modern warfare, where the tempo of operations can shift rapidly.

The Israel-Hamas war also demonstrated the potential of AI in autonomous systems and unmanned platforms. The IDF deployed various autonomous drones and robotic systems for reconnaissance, surveillance, and targeted strikes.²⁸⁾ These systems operated with a high degree of autonomy, reducing the risk to

²⁵⁾ Liberman, J. "Beyond the Headlines: Combat Deployment of Military AI-Based Systems by the IDF." *Lieber Institute West Point*, (2024). <https://lieber.westpoint.edu/beyond-headlines-combat-deployment-military-ai-based-systems-idf/>.

²⁶⁾ Beaumont, P. "'The Gospel': How Israel Uses AI to Select Bombing Targets." *The Guardian*, (2023.12.01). <https://www.theguardian.com/world/2023/dec/01/the-gospel-how-israel-uses-ai-to-select-bombing-targets>.

²⁷⁾ Liberman, J. (2024). Op.cit.

²⁸⁾ Wrobel, S. "Israeli Developer of VR Drone System Used by IDF in Hamas War Raises \$40M." *The Times of Israel*, (2024) <https://www.timesofisrael.com/israeli-developer-of-vr-drone-system-used-by-idf-in-hamas-war-raises-40m/>.

human operators and enhancing operational flexibility.

However, the conflict also underscored several challenges and ethical considerations associated with the use of AI in warfare. One of the key lessons learned is the need for robust oversight and control mechanisms to ensure that AI-driven systems operate within established legal and ethical frameworks. The deployment of autonomous weapons raised concerns about accountability and the potential for unintended consequences, emphasizing the importance of maintaining a "human in the loop" to oversee critical decisions involving the use of force.²⁹⁾

In conclusion, the Israel-Hamas conflict provided valuable lessons on the integration of AI into modern military operations. The use of AI in ISR, C2, and autonomous systems significantly enhanced the operational capabilities of the IDF, offering a glimpse into the future of warfare. However, the challenges and ethical considerations associated with AI deployment underscore the need for careful management and oversight. As militaries around the world continue to integrate AI into their operations, the insights gained from the Israel-Hamas war will be instrumental in shaping strategies and ensuring the responsible use of AI in combat.

2) Vision and Strategies for Future AI Warfare

The United States' vision for the future of warfare is fundamentally linked to the development and integration of artificial intelligence technologies. Recognizing the transformative potential of AI, the DoD is committed to leveraging these advancements to sustain military superiority, address emerging threats, and adapt to the rapidly evolving dynamics of modern conflict.³⁰⁾ Central to this vision is the

²⁹⁾ McLaughlin, T. "When Algorithms Decide Who Is a Target: IDF's Use of AI in Gaza." *Tech Policy Press*, (2024). <https://www.techpolicy.press/when-algorithms-decide-who-is-a-target-idfs-use-of-ai-in-gaza/>.

³⁰⁾ Department of Defense. Summary of the Department of Defense Artificial Intelligence Strategy: Harnessing AI to Advance Our Security and Prosperity. (2018)., <https://media.defense.gov/2019/Feb/12/2002088963>

concept of multi-domain operations, which aims to enable superior battlespace awareness, seamless coordination, and decision-making across various domains.³¹⁾ AI plays a crucial role in this approach, enhancing situational awareness, accelerating decision-making processes, and improving the precision and lethality of military operations.³²⁾

To achieve this vision, the DoD has launched several key initiatives focused on fostering the development and deployment of AI technologies. One of the cornerstone efforts is the establishment was the Joint Artificial Intelligence Center (JAIC) in 2018. The JAIC served as the central hub for AI innovation within the DoD, facilitating collaboration between the military, academia, and the private sector.³³⁾ This collaboration is essential for accelerating AI research and development, ensuring that cutting-edge technologies can be rapidly integrated into military operations.³⁴⁾ The JAIC was tasked with developing AI capabilities that enhance mission outcomes, improve operational efficiency, and provide a strategic advantage over adversaries.³⁵⁾ In June 2022, the JAIC, along with the Defense Digital Service and the Office of Advancing Analytics, was integrated into the Chief Digital and Artificial Intelligence Office (CDAO).³⁶⁾

A significant component of the US strategy for AI warfare is the emphasis on autonomous systems.³⁷⁾ The DoD is investing heavily in the development of

/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF.

³¹⁾ Vergun, D. "Pentagon Official Lays Out DOD Vision for AI." *U.S. Department of Defense*, (2024.07.05). <https://www.defense.gov/News/News-Stories/Article/Article/3682355/pentagon-official-lays-out-dod-vision-for-ai/>.

³²⁾ Defense Innovation Board. "AI Principles: Recommendations on the Ethical Use of Artificial Intelligence by the Department of Defense.", (2019). https://media.defense.gov/2019/oct/31/2002204458/-1/-1/0/dib_ai_principles_primary_document.pdf.

³³⁾ Vergun, D. "Joint Artificial Intelligence Center Has Substantially Grown to Aid the Warfighter." *U.S. Department of Defense*, (2020.11.10). <https://www.defense.gov/News/News-Stories/Article/Article/2418970/joint-artificial-intelligence-center-has-substantially-grown-to-aid-the-warfigh/>.

³⁴⁾ National Security Commission on Artificial Intelligence. Final Report., (2021). <https://www.nsc.ai.gov/2021-final-report/>

³⁵⁾ Ibid.

³⁶⁾ Judson, J. "Say Goodbye to JAIC and DDS as Offices Cease to Exist as Independent Bodies June 1." *Breaking Defense*. (2022.05.31.). <https://breakingdefense.com/2022/05/say-goodbye-to-jaic-and-dds-as-offices-cease-to-exist-as-independent-bodies-june-1/>.

³⁷⁾ Department of Defense. Directive 3000.09: Autonomy in Weapon Systems, (2023). <https://www.esd.whs.mil/>

autonomous vehicles, drones, and robotic systems that can operate independently or in coordination with human operators.³⁸⁾ These systems are designed to perform a wide range of tasks, from reconnaissance and surveillance to combat and logistics support.³⁹⁾ By deploying autonomous systems, the military aims to reduce the risk to human soldiers, enhance operational flexibility, and increase the effectiveness of military operations in complex and contested environments.⁴⁰⁾

Advanced robotics represents another critical area of focus.⁴¹⁾ The integration of AI with robotics technology facilitates the development of sophisticated systems capable of executing complex tasks with a high degree of precision and reliability. These AI-driven robotic systems can be employed for a variety of applications, including explosive ordnance disposal, search and rescue missions, and battlefield logistics. The use of advanced robotics not only enhances the capabilities of the military but also mitigates the risks associated with dangerous and high-stakes operations.

3) Structural and Organizational Changes of Military for Future AI Warfare

The integration of AI into military operations necessitates significant structural and organizational changes within the DoD. These changes are aimed at enhancing the military's ability to rapidly adopt and effectively utilize AI technologies, ensuring that the US maintains its strategic advantage in an era of

portals/54/documents/dd/issuances/dodd/300009p.pdf.

³⁸⁾ Bajak, F. "Pentagon Pushes AI Research Toward Lethal Autonomous Weapons." *CBS News*. (2024.05.05). <https://www.cbsnews.com/sanfrancisco/news/pentagon-pushes-ai-research-toward-lethal-autonomous-weapons/>.

³⁹⁾ Defense Innovation Board. (2019). Op.cit.

⁴⁰⁾ Etzioni, A. and Etzioni, O. "The Pros and Cons of Autonomous Weapon Systems." *Military Review*. (2017. May/June). <https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/May-June-2017/Pros-and-Cons-of-Autonomous-Weapons-Systems/>.

⁴¹⁾ Horowitz, M. C., et. al. "Artificial Intelligence and International Security." Center for a New American Security, (2018). <https://www.cnas.org/publications/reports/artificial-intelligence-and-international-security>.

rapidly evolving technological advancements. That said, the DoD has not yet significantly modified its traditional organizational frameworks and command structures to fully harness the potential of AI and meet the demands of future warfare.

One of the most notable structural changes had been the establishment of specialized organizations and centers dedicated to AI, technological innovation, and the rapid acquisition of technology. The Joint Artificial Intelligence Center (JAIC) is a prime example of this shift. The JAIC served as the central hub for AI initiatives within the DoD, coordinating efforts across different branches of the military and ensuring a unified approach to AI development and deployment. This centralized structure was intended to allow for efficient resource allocation, streamlined decision-making processes, and the ability to rapidly scale successful AI applications across various military domains. By consolidating AI efforts under a single entity, the goal was to effectively drive innovation and ensure consistency in AI integration.

That said, while JAIC was meant to consolidate efforts, a vast array of organizations associated with AI developments reside in each of the different services. For example, the Navy AI Task Force, Army Artificial Intelligence Task Force, and the Department of the Air Force AI Accelerator are all AI-specific initiatives meant to identify opportunities, develop technology, and integrate that technology into the service's operations. Given the role that each service plays, what technologies are adapted, how they are integrated, and the extent of that integration could vary significantly.

Additionally, the creation of new roles and positions focused on AI expertise is crucial for the successful implementation of AI technologies. The DoD is actively recruiting and training personnel with specialized skills in AI, machine learning, data science, and related fields.⁴²⁾ This includes establishing career paths and promotion opportunities for AI experts, ensuring that the military can attract and

⁴²⁾ Department of Defense. (2018). Op.cit.

retain top talent. By embedding AI specialists within operational units, the DoD can facilitate the seamless integration of AI tools and systems into everyday military operations. This approach also promotes a culture of innovation, where personnel at all levels are encouraged to explore and experiment with AI technologies.

Another significant organizational change that has yet to materialize but is likely if the benefits of AI are to be fully realized, is the adaptation of command-and-control structures to accommodate AI-driven decision-making. Traditional hierarchical command structures, which rely on linear chains of command and manual information processing, are being re-evaluated in favor of more flexible and dynamic models.⁴³⁾ AI technologies enable faster data processing and real-time situational awareness, allowing for decentralized decision-making and greater autonomy at lower levels of command. This shift will empower field commanders to make rapid, informed decisions based on AI-generated insights, enhancing operational agility and responsiveness. Again, many of these structural and organizational changes have yet to take shape. Rather, the focus has been on standing up acquisition, innovation, and administrative groups to identify opportunities.

4) The Governance for AI Military Technology Innovation

The governance of AI military technology innovation in the United States is another critical aspect of national security strategy, reflecting the need to balance rapid technological advancement with ethical considerations and operational effectiveness. DoD faces the complex challenge of fostering innovation while ensuring that these powerful technologies are developed and deployed responsibly. This requires a governance framework that addresses the

⁴³⁾ Black, J., Lucas, R., Kennedy, J., Hughes, M., Fine, H. "Command and Control in the Future - Concept Paper 1: Grappling with Complexity." RAND Corporation, (2024). https://www.rand.org/content/dam/rand/pubs/research_reports/RRA2400/RRA2476-1/RAND_RRA2476-1.pdf.

unique demands of AI, including the necessity for close collaboration between the military and civilian sectors, rigorous testing and evaluation of AI systems, and the establishment of robust ethical guidelines and oversight mechanisms. While a comprehensive framework is not necessarily yet in place, there are a series of documents that currently guide the development of AI by DoD.

First, the 2018 DoD AI Strategy emphasized governance mechanisms to ensure responsible development and integration of AI technologies within the military. Governance in the strategy focuses on establishing organizational structures, such as calling for the creation of the JAIC. The strategy also outlines the need for ethical frameworks and proper risk management, ensuring that AI systems are reliable, transparent, and accountable. The strategy also stresses the importance of continuous management by senior DoD leadership to ensure alignment with national security goals and ethical principles throughout the lifecycle of AI systems.⁴⁴⁾

DoD Directive 3000.09 (2012, updated in 2017 and 2023) governs the development and use of autonomous and semi-autonomous weapon systems within DoD. A key aspect of this directive is the establishment of governance frameworks that ensure human oversight in the use of force, reflecting concerns over the ethical and legal implications of autonomous systems. The directive mandates that autonomous weapon systems be designed to operate under the principle of “appropriate levels of human judgment” in the use of lethal force, providing a safeguard to prevent unintended or unethical consequences (DoD Directive 3000.09, 2023, pg.3). The governance structures outlined in this document include required reviews and approvals at multiple levels within the DoD before AI/autonomous systems can be deployed, ensuring compliance with the Law of Armed Conflict, and other legal obligations. The directive emphasizes the importance of testing, verification, and validation to ensure the reliability, traceability, and controllability of autonomous systems (DoD Directive 3000.09, 2023).

⁴⁴⁾ U.S. Congress. National Defense Authorization Act for Fiscal Year 2021. Public Law 116-283, U.S. Statutes at Large (2021). 134: 3388-3973. <https://www.congress.gov/bill/116th-congress/house-bill/6395>.

Responsible AI Strategy and Implementation Pathway (2022) is another key document guiding the development and governance of AI for DoD.⁴⁵⁾ The document specifies several core tenets for the development of AI, including governance, building trust, testing and evaluation, acquisition, workforce development, ethical and risk management, and requirements validation. On the governance front, it calls for the governance structures to be updated to provide continuous oversight of any new technologies implemented.⁴⁶⁾

The National Defense Authorization Act (NDAA), an annual U.S. federal law that specifies the budget, expenditures, and policies of DoD, is another document that provides governance of military technology. Each year, Congress passes the NDAA to authorize programs and set policy priorities for the U.S. military and defense agencies, while also legislating provisions that address emerging technology, cybersecurity, AI, and defense modernization efforts, guiding how the military and related agencies implement new strategies and technologies. For example, the 2021 NDAA and the 2023 NDAA both established organizations with DoD for developing AI technology (JAIC and CDAO) and reinforced AI oversight by mandating specific funding and accountability measures for AI development, including provisions for data management, cybersecurity, and AI testing.

While not an official governing entity, one guiding document for this governance comes from the Defense Innovation Board, an advisory body established to provide DoD with independent recommendations on how to accelerate innovation and integrate cutting-edge technology into military operations and strategy. This document, entitled “AI Principles: Recommendations on the Ethical Use of Artificial Intelligence by the Department of Defense” lays out a series of recommendations on how DoD can develop and use the artificial intelligence based on the ethical principles.⁴⁷⁾

⁴⁵⁾ Department of Defense. “Responsible AI Strategy and Implementation Pathway” (2022) , <https://media.defense.gov/2022/Jun/22/2003022604/-1/-1/0/Department-of-Defense-Responsible-Artificial-Intelligence-Strategy-and-Implementation-Pathway.PDF> , accessed on 2024/12/28

⁴⁶⁾ Ibid., pg. 9

Finally, effective governance in this domain also involves reforming traditional defense acquisition processes to better align with the rapid development cycles typical of AI technologies. The DoD has recognized that conventional procurement methods are often too slow and rigid to keep pace with the fast-evolving technological landscape.⁴⁸⁾ Consequently, the governance framework includes initiatives aimed at streamlining acquisition processes, promoting innovation, and ensuring that the military can efficiently integrate AI technologies into its operations. These efforts are essential for maintaining the U.S. military's strategic advantage in an increasingly complex global security environment.

Defense Technology Ecosystem (including Civil-Military Fusion)

One of the key elements in the governance of AI military technology is the strategic integration of civilian and military efforts, often referred to as civil-military fusion. This approach is crucial for maintaining technological superiority in an era where the pace of AI development is largely driven by the private sector and academia. Civil-military fusion enables the DoD to leverage civilian innovations and expertise, integrating them with military research and development efforts to produce cutting-edge technologies for defense applications.

The defense technology ecosystem, particularly the concept of civil-military fusion, plays a pivotal role in the United States' strategy to maintain technological superiority in military operations. Civil-military fusion refers to the integration of civilian and military technological innovations to enhance defense capabilities. This approach leverages the rapid advancements and expertise found within the

⁴⁷⁾ Defense Innovation Board, "AI Principles: Recommendations on the Ethical Use of Artificial Intelligence by the Department of Defense". (2019). https://media.defense.gov/2019/oct/31/2002204458/-1/-1/0/dib_ai_principles_primary_document.pdf

⁴⁸⁾ Kendall, F. *Better Buying Power: Implementation Guidance*. Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, (2016). <https://dod.defense.gov/Portals/1/Documents/pubs/Getting-Acquisition-Right-Jan2017.pdf>.

private sector and academia, integrating them with military research and development efforts to create cutting-edge technologies for defense applications.⁴⁹⁾

One of the core elements of this ecosystem is the collaboration between DoD and private tech companies. The Defense Innovation Unit (DIU) exemplifies this collaboration, acting as a bridge between the military and Silicon Valley. The DIU identifies and funds promising technologies developed by private companies that have potential military applications. This partnership allows the DoD to tap into the innovative spirit and technical prowess of the commercial tech sector, accelerating the development and deployment of advanced technologies. By working closely with private enterprises, the military can benefit from the agility and creativity that characterize the civilian tech industry.⁵⁰⁾

In addition to partnerships with private companies, the DoD also collaborates extensively with academic institutions. Universities and research labs are integral to the defense technology ecosystem, conducting foundational research in areas such as artificial intelligence, robotics, and cybersecurity. Programs like the National Defense Education Program (NDEP) and the Minerva Research Initiative foster these collaborations, funding research projects that align with defense priorities. By supporting academic research, the DoD not only advances its technological capabilities but also helps cultivate a pipeline of skilled scientists and engineers who can contribute to future defense innovations.

The integration of civilian and military technological advancements is also facilitated by initiatives aimed at reforming the defense acquisition process. Traditional defense procurement methods are often slow and cumbersome, hindering the rapid adoption of new technologies. To address this, the DoD has implemented the Better Buying Power (BBP) initiative, which seeks to streamline acquisition processes and promote innovation. BBP encourages the adoption of

⁴⁹⁾ Allen, G., & Chan, T. Artificial Intelligence and National Security. *Harvard Kennedy School Belfer Center*, (2017). <https://www.belfercenter.org/publication/artificial-intelligence-and-national-security>.

⁵⁰⁾ Defense Innovation Unit. Annual Report', (2020). <https://www.dau.edu/cop/ot/documents/diu-fy20-annual-report>.

commercial best practices, the use of modular and open-system architectures, and the fostering of competitive prototyping. These reforms enable the DoD to more effectively integrate cutting-edge civilian technologies into military systems, ensuring that the military can keep pace with the fast-evolving technological landscape.⁵¹⁾

The civil-military fusion approach also emphasizes the dual-use nature of many advanced technologies. Technologies developed for civilian use, such as artificial intelligence, cyber tools, and autonomous systems, often have significant military applications. The DoD actively seeks to identify and repurpose these dual-use technologies to enhance military capabilities.⁵²⁾ This strategy not only maximizes the return on investment in research and development but also ensures that the military can leverage the latest technological advancements to maintain a strategic edge.

In conclusion, the defense technology ecosystem, underpinned by civil-military fusion, is a cornerstone of the United States' strategy to maintain technological superiority in defense. By fostering collaboration between the DoD, private tech companies, and academic institutions, the military can accelerate the development and integration of cutting-edge technologies. Initiatives aimed at reforming the acquisition process and establishing public-private research consortia further enhance this ecosystem, ensuring that the US military remains at the forefront of technological innovation. This integrated approach not only strengthens national defense but also drives broader technological advancements that benefit both the civilian and military sectors.⁵³⁾

⁵¹⁾ Kendall, F. (2017). *Getting Defense Acquisition Right. Better Buying Power: Implementation Guidance*. Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, <https://dod.defense.gov/Portals/1/Documents/pubs/Getting-Acquisition-Right-Jan2017.pdf>.

⁵²⁾ Defense Innovation Unit. (2020). Op.cit.

⁵³⁾ National Security Commission on Artificial Intelligence. (2021). Op.cit.

Process or structure in the militarization of AI technologies

The militarization of AI technologies by the United States military and DoD is a comprehensive process that involves several critical steps and organizational structures designed to ensure effective integration, ethical deployment, and operational superiority.⁵⁴⁾ This process is characterized by a collaborative approach, rigorous testing, and continuous adaptation to evolving technological and strategic landscapes.

The DoD's approach to AI militarization involves a rigorous testing and evaluation process to ensure that AI technologies are reliable, secure, and effective in operational settings. This process includes the development of AI prototypes, which are subjected to extensive simulations and field tests to assess their performance under various conditions.⁵⁵⁾ For instance, Project Maven, an initiative aimed at integrating AI into intelligence, surveillance, and reconnaissance (ISR) operations, underwent extensive testing to ensure its algorithms could accurately process and analyze vast amounts of video data from drones.⁵⁶⁾ By rigorously testing AI systems before deployment, the DoD can identify and address potential issues, ensuring that AI technologies meet the high standards required for military applications.⁵⁷⁾

Ethical considerations and governance are also components of the DoD's approach to AI militarization. The DoD has established ethical guidelines and oversight mechanisms to ensure that AI technologies are developed and deployed responsibly.⁵⁸⁾ This includes maintaining a "human in the loop" approach for critical decision-making processes, particularly in the context of autonomous weapons systems. The DoD's Directive 3000.09, for instance, mandates that

⁵⁴⁾ Allen, G., & Chan, T. (2017). Op.cit.

⁵⁵⁾ Scharre, P. (2018). *Army of None: Autonomous Weapons and the Future of War*. W. W. Norton & Compan.

⁵⁶⁾ Project Maven. (2017). "Project Maven to Deploy Computer Algorithms to War Zone by Year's End." Department of Defense, <https://www.defense.gov/News/News-Stories/Article/Article/1254719/project-maven-to-deploy-computer-algorithms-to-war-zone-by-years-end/>.

⁵⁷⁾ Cummings, (2020)

⁵⁸⁾ Department of Defense. (2020). Ethical Principles for Artificial Intelligence. https://www.ai.mil/docs/Ethical_Principles_for_Artificial_Intelligence.pdf.

autonomous and semi-autonomous weapons systems must be designed to allow human operators to exercise appropriate levels of judgment and oversight.⁵⁹⁾ By prioritizing ethical governance, the DoD aims to mitigate the risks associated with AI technologies and maintain public trust and international compliance.⁶⁰⁾

In summary, the militarization of AI technologies by the U.S. military and the DoD involves a multifaceted process that includes establishing specialized organizations, rigorous testing and evaluation, collaboration with industry and academia, acquisition reform, and ethical governance. This comprehensive approach ensures that AI technologies are effectively integrated into military operations, enhancing the capabilities of the U.S. military while addressing the ethical and practical challenges posed by AI.⁶¹⁾ Through these efforts, the DoD aims to maintain its strategic advantage and ensure the responsible use of AI in defense applications.

5) The Educational Innovation for Future AI Warfare

Educational innovation is a cornerstone of the United States military's strategy to integrate AI into future warfare effectively. As AI technologies continue to evolve and become, potentially, more integral to military operations, there is a pressing need to cultivate a workforce that is proficient in AI and related fields. This involves not only training current military personnel but also developing a pipeline of new talent equipped with the necessary skills and knowledge to leverage AI technologies effectively.⁶²⁾

DoD has initiated several programs to enhance AI literacy and technical expertise within the military. One such effort is the implementation of

⁵⁹⁾ Department of Defense, (2012).

⁶⁰⁾ Scharre, P. (2018). Op.cit.

⁶¹⁾ National Security Commission on Artificial Intelligence. (2021). Op.cit.

⁶²⁾ Defense Science Board. "Summer Study on Autonomy." Office of the Under Secretary of Defense for Acquisition, Technology and Logistics. (2016).

specialized training programs that focus on AI, machine learning, data science, and cybersecurity. These programs are designed to provide military personnel with a deep understanding of AI technologies and their applications in various operational contexts. For instance, the DoD's Digital Modernization Strategy emphasizes the importance of continuous learning and professional development, encouraging service members to engage in AI-related education and training throughout their careers.⁶³⁾

As discussed above, partnerships with academic institutions are also critical to the DoD's educational innovation strategy. By collaborating with universities and research centers, the military can tap into not only cutting-edge research to help usher along technology development but also gain expertise and training from leading scholars in AI and related disciplines. These partnerships not only enhance the military's capabilities in AI immediately but also help to develop a new generation of AI experts who can contribute to national security.

In addition to formal education and training programs, the DoD is leveraging experiential learning opportunities to enhance AI proficiency. This includes incorporating AI simulations and wargaming exercises into military training curricula.⁶⁴⁾ These practical exercises allow personnel to gain hands-on experience with AI tools and systems, developing tactics and strategies for AI-enabled warfare in a controlled environment. By simulating real-world scenarios, service members can better understand the capabilities and limitations of AI technologies, preparing them to use these tools effectively in actual operations.

The DoD is also investing in initiatives to attract and retain top AI talent. Recognizing the competitive nature of the tech industry, the military is exploring innovative approaches to recruitment and career development. This includes

⁶³⁾ Department of Defense. DoD Digital Modernization Strategy. (2019). <https://media.defense.gov/2019/jul/12/2002156622/-1/-1/1/dod-digital-modernization-strategy-2019.pdf>.

⁶⁴⁾ Coombs, R.A. "AI Integration for Scenario Development: Enhancing Wargaming and Training with Artificial Intelligence." *Military Review*, (2024). <https://www.armyupress.army.mil/Journals/Military-Review/Online-Exclusive/2024-OLE/AI-Integration-for-Scenario-Development/>.

offering competitive compensation packages, creating clear career paths for AI specialists, and providing opportunities for continuous learning and professional growth. Additionally, the DoD is fostering a culture of innovation within the military, encouraging personnel to experiment with new ideas and technologies and to contribute to the development of AI solutions that can enhance mission outcomes.⁶⁵⁾

Educational innovation for future AI warfare also involves addressing ethical considerations and fostering an understanding of the responsible use of AI. The DoD is incorporating ethical training into its AI education programs, emphasizing the importance of transparency, accountability, and compliance with international laws and norms. By instilling a strong ethical foundation, the military aims to ensure that AI technologies are used in ways that align with American values and support global stability and security.⁶⁶⁾

Talent Ecosystem

DoD places significant emphasis on cultivating a leading AI workforce as part of its broader strategy to integrate artificial intelligence into military operations. Recognizing the transformative and rapidly advancing nature of AI, the DoD is committed to adapting its culture, developing new skills, and streamlining approaches to attract, train, and retain AI talent. This involves a multi-faceted approach that includes comprehensive training programs, strategic partnerships, and innovative recruitment strategies aimed at ensuring that the DoD remains at the forefront of AI development and application.⁶⁷⁾

One of the key components of the DoD's strategy is offering comprehensive AI training to its existing workforce. The DoD plans to invest in AI education programs designed to help personnel keep pace with the latest developments in the field. These programs will be tailored to various levels of expertise, from

⁶⁵⁾ National Security Commission on Artificial Intelligence. (2021). Op.cit.

⁶⁶⁾ Department of Defense. (2020). Op.cit.

⁶⁷⁾ National Security Commission on Artificial Intelligence. (2021). Op.cit.

junior personnel to senior leaders, and will leverage a combination of digital content and in-person instruction from leading AI experts. By providing access to curated learning experiences, the DoD aims to equip its workforce with the knowledge and skills necessary to adapt to new roles and effectively implement AI technologies in their operations. This focus on continuous learning is critical for maintaining a skilled and knowledgeable workforce capable of leveraging AI to enhance mission outcomes.⁶⁸⁾

In addition to training its existing workforce, the DoD is also focused on attracting top AI talent from outside the military. This involves creating streamlined, non-traditional pathways for bringing world-class AI professionals into service. By offering competitive compensation packages, clear career paths, and opportunities for continuous professional development, the DoD aims to attract individuals with critical AI skills, such as machine learning engineers, data scientists, and AI product managers. These efforts are designed to complement the existing workforce, creating a modern, agile, and AI-advantaged team with a deep passion for addressing the nation's most pressing challenges.⁶⁹⁾

Building a culture that embraces experimentation and innovation is also essential for developing a leading AI workforce. The DoD is working to create an environment that encourages appropriate risk-taking and rapid learning through experimentation. This involves running daily experiments, iterating based on user feedback, and continuously adapting AI technologies to improve their effectiveness. By promoting a culture of innovation, the DoD aims to harness the creativity and ingenuity of its personnel, driving advancements in AI and ensuring that the military remains agile and responsive in a rapidly changing technological landscape.⁷⁰⁾

In conclusion, the DoD's efforts to develop talent and cultivate the next

⁶⁸⁾ Department of Defense. (2019). Op.cit.

⁶⁹⁾ National Security Commission on Artificial Intelligence. (2021). Op.cit.

⁷⁰⁾ Joint Artificial Intelligence Center. DoD AI Education Strategy, (2020), https://www.ai.mil/docs/2020_DoD_AI_Training_and_Education_Strategy_and_Infographic_10_27_20.pdf.

generation of AI practitioners are comprehensive and forward-thinking. Through a combination of extensive training programs, strategic partnerships with academia and industry, innovative recruitment strategies, and a culture of experimentation, the DoD is positioning itself to effectively integrate AI into its operations. These initiatives are essential for maintaining the United States' strategic advantage in AI-enabled warfare and ensuring that the military is prepared to leverage AI technologies to enhance national security and defense capabilities.

6) The Discourse on Ethics and Regulations of AI: the "human in the loop"

The integration of AI into military operations has sparked significant ethical debates, particularly concerning the role of the "human in the loop" in decision-making processes. The "human in the loop" concept refers to the requirement that human operators remain involved in critical decisions, especially those related to the use of lethal force. The U.S. military has consistently emphasized the importance of maintaining human oversight over AI systems, particularly in lethal autonomous weapons systems (LAWS), to ensure that ethical standards and international laws are upheld.⁷¹⁾

From a military perspective, the "human in the loop" is not merely a safeguard against potential AI malfunctions but also a critical component of ethical warfare. DoD has explicitly stated that AI systems must be designed and deployed in ways that allow for human judgment in the use of force decisions. This policy aligns with the U.S. military's commitment to the Law of Armed Conflict (LOAC), which mandates that combatants distinguish between combatants and non-combatants and that the use of force is proportional and necessary.⁷²⁾

The DoD's Ethical Principles for AI emphasize that AI systems should be

⁷¹⁾ Scharre, P. (2018). Op.cit.

⁷²⁾ Department of Defense. (2020). Op.cit.

responsible, equitable, traceable, reliable, and governable. These principles are designed to ensure that AI systems enhance, rather than replace, human decision-making. The emphasis on traceability and reliability underscores the importance of human involvement in monitoring and controlling AI actions, particularly in complex and unpredictable combat environments. By keeping a human in the loop, the military aims to maintain accountability for decisions made by AI systems, ensuring that they can be audited and traced back to human operators.⁷³⁾

Moreover, the U.S. military's approach to AI ethics reflects broader concerns about the potential for AI to undermine human dignity and moral agency. The involvement of humans in the loop is seen as essential to preserving the moral responsibility of military personnel. As AI technologies become more sophisticated, there is a growing discourse on how to balance the efficiency and speed offered by AI with the need to maintain human control and ethical oversight. The U.S. military's stance is that while AI can assist in decision-making, final authority must rest with human operators to ensure that actions are consistent with ethical standards and national values.⁷⁴⁾

The discourse on the "human in the loop" also touches on the need for robust regulations and frameworks governing the use of AI in warfare. The U.S. military acknowledges the rapid pace of AI development and the challenges this poses to existing regulatory frameworks. Consequently, there is an ongoing effort within the DoD to develop and implement guidelines that ensure AI systems are used in ways that are both legally and ethically sound. This includes the development of AI systems that can be reliably controlled and understood by human operators, as well as the creation of accountability mechanisms to address potential misuse.⁷⁵⁾

In conclusion, the U.S. military's perspective on the "human in the loop"

⁷³⁾ *ibid.*

⁷⁴⁾ Brundage, M., et. al. "The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation." arXiv:1802.07228, (2018), <https://arxiv.org/abs/1802.07228>

⁷⁵⁾ Cummings, 2020

discourse is shaped by a commitment to ethical warfare and compliance with international laws. By emphasizing the necessity of human oversight in AI-driven decision-making processes, the military seeks to ensure that the use of AI in combat does not compromise ethical standards or diminish human accountability. As AI technologies continue to evolve, the military's approach will likely involve ongoing revisions to ethical guidelines and regulations to address emerging challenges while maintaining the fundamental principle that humans must retain control over critical military decisions.

7) Conclusion

As the United States military continues to explore and expand its use of AI, the future of warfare will be shaped by advancements in this technology, the extent to which remains to be determined though, AI's ability to process vast amounts of data, optimize logistics, and enhance both cybersecurity and intelligence surveillance will be critical in maintaining parity with adversaries with similar speed of combat operations. There is a recognition developing that these advancements must be carefully governed, ensuring that AI systems are reliable, secure, and ethically aligned with international standards. By fostering a culture of innovation and building a robust talent ecosystem, the U.S. military is positioning itself to fully realize the potential of AI. The lessons learned from conflicts in Ukraine and Israel underscore the transformative potential of AI across various domains, from intelligence gathering to autonomous systems. The United States military's strategic vision for AI highlights the importance of maintaining a technological edge through the restructuring of command frameworks, fostering civil-military partnerships, and ensuring ethical governance of AI systems. While these technologies, organizational changes, and operational expertise will be implemented slowly, AI has the potential to redefine how the U.S. military operates, ensuring that it maintains its strategic advantage in an increasingly complex global security environment.

2

Russian AI Military Innovation

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1) The Perception of AI and the Future of Warfare

Background to AI evolution and AI perceptions in the Soviet Union and Russia

In both political and military circles, the topic of artificial intelligence (AI hereafter) has been present for many years. As early as the 1950s, during the first “AI wave”, Soviet scientists created the first experimental translation software for English to Chinese languages. In the 1970s, a Soviet chess program “Kaissa” was created and subsequently beat the US chess program during the World Championship in 1974.⁷⁶⁾ However, there was a long pause when it came to AI research and development, not least due to the fall of the Soviet Union in 1991. There were hardly any publications on AI and the topic did not enter the public domain until 2013. It was then that online publications related to AI started appearing, however, these were not dealing with military AI, but rather with educational and banking sectors.⁷⁷⁾ In practical terms, there seemed to have been little research done in comparison to the likes of China and the United States (which ranked first and second) with Russian academic publications and citations on AI between 1996 and 2017 amounting to thirty-third and forty-second places, respectively.⁷⁸⁾

⁷⁶⁾ Eduard M. Proydakov, “Sovremennoe Sostoyanie Iskusstvennogo Intellekta,” *Naukovedcheskiye Issledovaniya*, (2018). no. 2018, p.135-142, <https://doi.org/10.31249/scis/2018.00.09>.

⁷⁷⁾ See, for instance,

⁷⁸⁾ Forrest E. Morgan, Benjamin Boudreaux, Andrew J. Lohn, Mark Ashby, Christian Curriden, Kelly Klima, and Derek Grossman, (2020). *Military Applications of Artificial Intelligence: Ethical Concerns in an Uncertain World*, Santa Monica, CA: RAND Corporation, p. 94.

From 2017 onward, however, the topic of AI started gaining more traction, becoming one of the key elements in Russia's political and military thinking. The importance of AI for Russia's national security was expressed by Russian President Vladimir Putin on multiple occasions. Thus, Russia was driven into this technological competition between superpowers, namely, China and the United States, making AI development a priority. In other words, ensuring its national security and maintaining Russia's place in the world would not be possible without entering AI competition, the thinking went. And without such competition, as the newly appointed Defense Minister and former First Deputy Chairman of the Government, Andrei Belousov noted, the development would not have been possible.⁷⁹⁾ Already in 2017, several large investment funds such as Sber were willing to increase their investments in AI research and development. After all, AI has already been in use by many sectors, including financial and retail.⁸⁰⁾ Although it could be said the military sector was lagging then. For instance, during the *Armiya-2017* forum, the intellectualization of military aviation systems was the only topic related to AI.⁸¹⁾ The rest of the innovations focused on many different areas, including robotics and munitions.⁸²⁾ It should, however, be noted that using AI in other sectors vital to Russia's economy would lead to optimization of production and workflows, resulting in a growth of Russia's GDP. Thus, a strong economy would allow the Kremlin to allocate more resources to its military-industrial complex, including the integration of AI into military systems, as discussed further below.

In 2018, the Russian Ministry of Defense (MoD) in collaboration with the Ministry

⁷⁹⁾ Vedomosti, "Andrei Belousov: Dvizhushchei Siloy Tekhnologicheskogo Razvitiya Yavlyatsya Konkurentsya," (2024.04.10). https://www.vedomosti.ru/press_releases/2024/04/10/andrei-belousov-dvizhushchei-siloi-tehnologicheskogo-razvitiya-yavlyatsya-konkurentsya.

⁸⁰⁾ Taufik Khisamov, "Gonka Tekhnologii. Kak Iksusstvennyi Intellekt Pomogaet Biznesu," *Forbes.ru*, (2017. 12.20). <https://www.forbes.ru/tehnologii/354727-gonka-tehnologiy-kak-iskusstvennyy-intellekt-pomogaet-biznesu>.

⁸¹⁾ Russian Ministry of Defense, "Na Forume Armiya-2017 Obsydyat Perspektivnye Tekhnologii Intellektualizatsii Aviatsionnykh Komplexov," (2017.08.25) https://function.mil.ru/news_page/country/more.htm?id=12139767@egNews

⁸²⁾ Dmitri Litovkin, (2017.08.28) "Armiya-2017: Ot Idei do Tanki," *Izvestiya*, <https://iz.ru/638219/dmitrii-litovkin/armiya-2017-ot-idei-do-tanki>.

of Education and Science and the Russian Academy of Sciences, organized the first of its kind conference “Artificial Intelligence: Problems and Prospective Solutions.” In his opening speech, the then Minister of Defense, Sergei Shoigu, encouraged joint military and civilian scientific collaboration together with state and industrial enterprises with a focus on robots and unmanned system complexes as well as new AI technologies.⁸³⁾ As one of the main outcomes of the conference, the MoD created a 10-point plan to pave the way forward to facilitate such collaboration:⁸⁴⁾

- Form a consortium on big data analysis and AI involving leading scientific, educational, and industrial entities;
- Create a repository of analytical algorithms and programs for evaluating solutions for automated systems;
- Develop a state system for training and retraining AI specialists, including secondary education opportunities for other professionals;
- Establish a laboratory at VIT “ERA” for testing advanced AI software and hardware;
- Create a National Center for Artificial Intelligence to foster scientific foundations and innovative infrastructure;
- Organize comprehensive research on AI development trends and monitor global AI advancements;
- Arrange war games to evaluate the impact of AI on military operations;
- Develop a system for evaluating the compliance of intelligent technologies with required standards.
- Review these recommendations at the International Military-Technical Forum “Armiya-2018” and the International Forum “National Security Week;”

⁸³⁾ TASS, “Shoigu Prizval Voennyykh I Grazhdanskikh Uchenykh Sovmestno Razrabatyvat’ Robotov I Bepilotnikov,” (2018.03.14). <https://tass.ru/armiya-i-opk/5028777>.

⁸⁴⁾ Ministry of Defense, “Konferentsiya “Iskusstvennyi Intellekt: Problemy I Puti ikh Resheniya – 2018”, (2018)., <https://mil.ru/conferences/is-intellekt.htm>, date accessed May 30, 2024.

- Hold an annual conference on AI.

These recommendations aimed to unify efforts between civilian and military scientific work to advance Russia's military AI capabilities.⁸⁵⁾ They were reinforced by Putin's emphasis on the need for the military-industrial complex to focus on producing "smart" and high-precision missiles and ammunition. He argued that "smart," high-precision ammunition not only boosted the capabilities of current and future weapons systems but also significantly reduced costs.⁸⁶⁾ Speaking at a meeting with the MoD and defense industry leaders in Anapa, he highlighted the "Era military innovation Technopolis,"⁸⁷⁾ which would be fully operational by the end of 2019, acting as a key player in creating military AI through collaboration with scientists and graduates of technical universities.⁸⁸⁾ As one Russian military analyst suggested, "Era" Technopolis would become Russia's path to military AI, noting the importance of rapid progress to stay competitive with the USA and China.⁸⁹⁾ In July 2022, Putin signed a federal law regulating the relations between different components of the Technopolis, namely research institutions, educational facilities, state corporations, industrial enterprises, defense companies, among others.⁹⁰⁾

While there is no publicly available data related to investments into R&D of military AI, state-owned corporations such as Rostec corporation disclosed that several of its subsidiaries including the Kalashnikov and Tecmash enterprises, High Precision Systems holding, and TsNIITochMash company were developing AI-based weapons, including fire systems, allowing not only for replacement of

⁸⁵⁾ Ibid.

⁸⁶⁾ Angelina Galinina, Dmitry Lyudmitsky and Roman Kretsul, "Oruzhie Razuma: Rossiiskii Put' k Voennomu Iskusstvennomu Intellectu," *Izvestiya*, (2018.11.22). <https://iz.ru/815370/angelina-galanina-dmitrii-liu-dmirskii-roman-kretcul/oruzhie-razuma-rossiiskii-put-k-voennomu-iskusstvennomu-intellektu>.

⁸⁷⁾ See, Ministry of Defense, "O Teknopolise," <https://mil.ru/era/about.htm>. date accessed May 27, 2024.

⁸⁸⁾ The Kremlin. "Presentaiton of Era Innovation Technopolis." (2018.02.23). <http://www.en.kremlin.ru/events/president/news/56923>.

⁸⁹⁾ Galinina, Lyudmitsky and Kretsul, (2018.11.22). Op. cited.

⁹⁰⁾ The Kremlin, "Law on Era Military Innovation Technopoli.," (2022.07.14). <http://en.kremlin.ru/acts/news/68890>.

human operators but also for greater controllability.⁹¹⁾ For instance, by mid-2018, Kalashnikov had developed a self-learning module – based on neural networks – for solving a number of battlefield tasks. This module was said to be capable of analyzing the environment, mimicking a human brain with the ability to discern between “unarmed” and “non-dangerous” persons or civilians.⁹²⁾

The same year, “Armiya-2018” focused almost exclusively on integrating AI into the military domain, including information security, national security, unmanned aircraft, robotics, etc. The forum would offer a venue for the Main Directorate of Research Activities and Technological Support of Advanced Technologies of the MoD (GUNID MO RF) to draw on the leading AI research from state-owned companies which are key players in Russia’s AI R&D.⁹³⁾

Yet, 2018 was an important year in exploring all possibilities of AI integration with one important area being the information spectrum which does not exclusively relate to the military. The then Deputy Minister of Defense, Yuri Borisov, stressed the importance of AI technologies to counteract the threats in the information and, especially, cyber-space. He said, “[t]oday all battles are not played out on the battlefield, they are first played out in the information space. Whoever can control it, who can organize counteraction in the right way, is the winner today.”⁹⁴⁾ In a similar fashion, Aleksandr Losev writing for the *Arsenal Otechestva* – a military journal – suggested that AI will be able to create advantages in information collection and processing, especially, in the field of military intelligence. In information wars, as Losev posited, AI could supplement information space with large volumes of synthetic data to confuse adversaries and create political risks.⁹⁵⁾ In other words, the benefits of using AI for

⁹¹⁾ TASS, “V Rossii Testiruyut Oruzhye s Iskusstvennym Intellectom.” (2019.02.26). <https://tass.ru/armiya-i-opk/6157919>.

⁹²⁾ TASS, “Rostec: Rossiya Uzhe Imee Narabotki Po Samoobuchayushhemusya Oruzhiyu s Iskusstvennym Intellectom.” (2018.06.06). <https://tass.ru/armiya-i-opk/5268765>.

⁹³⁾ Stephanie Petrella, Chirs Miller & Benjamin Cooper, “Russia’s Artificial Intelligence Strategy: The Role of State-Owned Firms,” *Orbis*, (2020.11). pp. 76-79.

⁹⁴⁾ Ministry of Defense, “Razvitiye Iskusstvennogo Intellekta Neobkhodimo Dlya Uspeshnogo Vedeniya Kibervoyny,” (2018.03.14). https://function.mil.ru/news_page/person/more.htm?id=12166660@egNews.

⁹⁵⁾ Aleksandr Losev, “Voennyi Iskusstvennyi Intellect,” *Arsenal Otechestva*, (2017). no. 6(32), <https://arsenal>

information operations – whether in the military domain or otherwise – have been recognized early on; although, in 2018, this discussion was theoretical, yet not for long. Major General Vasilii Burenok, too, stresses the importance of AI algorithms which can be used to gather intelligence, analyze data and produce content in the context of information warfare. Burenok does not refer, however, to Russia's ability to leverage AI for information warfare. Rather he cautions that other countries – most notably NATO – could use AI to hyperpower their information operations.⁹⁶⁾

In 2019, Putin issued decree No. 490 on the development of AI, approving thereby the National Strategy for the Development of Artificial Intelligence for the period until 2030. The focus of this would be on scientific research into AI, an increase in the availability of the necessary IT equipment, as well as personnel training.⁹⁷⁾

In December 2020, during the annual meeting with the MoD board, Putin explicitly addressed the need for AI's integration into the military domain, including robotic systems, unmanned aerial vehicles (UAVs), and automated control systems, stressing that “[s]uch weapons significantly increase the potential of units...[and] will largely determine the outcome of the battle in the near future.”⁹⁸⁾ The military went even further as to argue that AI integration into military systems would be essential for securing future peace and stability.⁹⁹⁾

Subsequently, by 2021, the leadership of the Russian MoD started to prioritize the development of AI technologies. To oversee the state of scientific R&D, and to determine priority tasks and directions for future research, GUNID MO RF

-otechestva.ru/article/990-voennyj-iskusstvennyj-intellekt.

⁹⁶⁾ Vasilii Burenok, “Primeneniye Iskusstvennogo Intellekta v Voennom Dele,” *Arsenal Otechestva*, (2018) no. 1(33), <https://arsenal-otechestva.ru/article/1010-iskusstvennyj-intellekt-i-puti-resheniya>.

⁹⁷⁾ President of the Russian Federation, *Ukaz Prezidenta Rossiiskoi Federatsii ot 10.10.2019g* (2019.10.10). No. 490, <http://www.kremlin.ru/acts/bank/44731>.

⁹⁸⁾ Putin quoted in Kremlin, “Rasshirennoe Zasedaniye Kollegii Minoborony,” (2020.12.21). <http://kremlin.ru/events/president/news/64684>.

⁹⁹⁾ A. N. Sidorin and A. N. Bezrodnyi, “Perspektivy Primeneniya Tekhnologii Iskusstvennogo Intellekta v Radioelektronnoi Bor’be,” *Voennaya Mysl’*, (2021). no. 12, <https://vm.ric.mil.ru/Stati/item/367144>.

organized scientific and business programs within the International Military-Technical Forums (IMTF) *Armiya-2017*, *Armiya-2018*, *Armiya-2019*, and *Armiya-2020*. These programs focused on the “Strategy for the Development of Technologies in the Field of Artificial Intelligence to Ensure the National Security of the Russian Federation.” Additionally, AI-related issues were addressed during the *Armiya 2021 International Military Forum*.¹⁰⁰⁾

In November 2022, Putin put renewed stress on the importance of AI for Russia’s future, stating that “[t]here is fierce rivalry between states, and Russia’s place in the world, our sovereignty, the security, and viability of our country depend on what results we achieve.”¹⁰¹⁾ During the MoD Board Meeting in December 2022, Putin underscored the necessity to improve the command and communications system by integrating AI “at all levels of decision-making.”¹⁰²⁾ Thus, in January 2023, the former Defense Minister, Sergey Shoigu, announced that the Russian Armed Forces’ command and control (C2) systems would be enhanced through AI.¹⁰³⁾ These recent statements are, of course, based on the lessons learned from Russia’s war in Ukraine. Thus, there was a recognition that one of the weak areas of the Russian Armed Forces is C2.¹⁰⁴⁾ The same year, the Chief of the Russian MoD’s AI Technologies Directorate, Vasily Yelistratov, stressed that in the conditions of hybrid war¹⁰⁵⁾ – which the West wages against Russia – there is a need for intellectualization of weapons. The more intelligent the weapons can be, the fewer human losses Russia would suffer.¹⁰⁶⁾ Thus, he

¹⁰⁰⁾ V. Razikov and V. Elistratov, “Tretya Revolyutsiya,” *Armeiskii Sbornik*, (2022). no. 1, <https://army.ric.mil.ru/Stati/item/372265/>.

¹⁰¹⁾ Putin quoted in Kremlin, “Konferentsiya po Iskusstvennomu Intellektu,” *Kremlin*, (2022.11.24). <http://kremlin.ru/events/president/news/69927>. Similar statements were made by Putin in 2023 as well. See Kremlin, “Itogi Goda s Vladimirom Putinym,” *Kremlin*, (2023.12.14). <http://www.kremlin.ru/events/president/transcripts/statements/72994>.

¹⁰²⁾ Putin quoted in Kremlin, “Zasedanie Kollegii Ministerstva Oborony,” *Kremlin*, (2022.12.21). <http://kremlin.ru/events/president/news/70159>.

¹⁰³⁾ TASS, “Shoigu: Sistemu Upravleniya I Svyazi VS RF Uovershenstvuyut s Primeneniem Tekhnologiy II,” *TASS*, (2023.01.10). <https://tass.ru/armiya-i-opk/16766161>.

¹⁰⁴⁾ See Vasily Kashin, “Na Chuzhikh Oshybkakh? Real’nye Uroki SVO dlya Kitaya I Ikh Posledstviya,” *Rossiia v Globalnoi Politiki*, (2022.12.19). <https://globalaffairs.ru/articles/na-chuzhih-oshibkah/>.

¹⁰⁵⁾ This statement resonates with what the retired Colonel Aleksandr Bartosh has been arguing in his multiple publications appearing in *Voennaya Mysl’*, as explain further below.

announced the creation of a register of AI technologies for use in state defense projects.¹⁰⁷⁾

The military-technical forum *Armiya-2023* prominently featured AI technologies, according to the Major-General Alexander Osadchuk, head of the MoD's Main Department of Innovative Development (Glavnoe Upravlenie Inovatsionnogo Razvitiya MO RF or GUIR). The forum's program highlighted AI technologies and the diversification of the defense industry, including the latest advancements in control and intelligence systems, high-precision weaponry, and robotics. A significant emphasis was placed on UAVs, underscoring their rapid development in both military and civilian sectors, signaling the rise of a new, independent, high-tech industry.¹⁰⁸⁾ In other words, unlike the previous *Armiya* forums, the 2023 forum experienced a greater shift toward AI-based systems and robots.

Lessons from the war in Ukraine

One of the weaknesses identified during the early stages of the war in Ukraine was command and control (C2). Putin verbalized these problems in December 2022. The then Defense Minister, Shoigu, thus, announced that C2 would be improved by introducing AI technologies.¹⁰⁹⁾ Similar arguments have been made by various military publications laying out the details of how both automated and AI-based systems can be used at different levels of C2, taking the Airborne Forces (VDV) as an example. Such a system could imitate human cognitive functions. However, it is noted that a high-speed telecommunications network, such as 5G, would be necessary to make such a system effective.¹¹⁰⁾ To what extent the model has been incorporated remains, however, unclear.

¹⁰⁶⁾ TASS, "Russian Defense Ministry Introducing AI Technologies in the Army," *TASS*, (2022.08.25). <https://tass.com/defense/1497995>.

¹⁰⁷⁾ TASS, (2023.01.10). Op. cited.

¹⁰⁸⁾ TASS, "Artificial Intelligence Technologies Prevail on Army 2023 Agenda — Defense Ministry," *TASS*, August 15, 2023, <https://tass.com/defense/1660725>.

¹⁰⁹⁾ TASS, (2023.01.10). Op. cited.

¹¹⁰⁾ Razikov and Elistratov, (2022)

Another area that proved to be key in the war in Ukraine was UAVs both in terms of their deployment as well as the defense against them. In this area, the Russian Armed Forces were lagging during the first months of the war in Ukraine, however, throughout the war, technological adaptation has taken place. As the director of the Museum of Air Defense Forces, Yuri Knutov, stated, ultra-modern AI-based technologies were being used both in air defense systems as well as UAVs, as of 2024. Two different types of AI are used in UAVs. The first type assists in guiding the UAV to its target following target acquisition by a human operator (e.g., *Geran'-2*). An additional auxiliary function includes navigation based on machine vision. The second type provides complete operational autonomy, operating independently of satellite navigation and radio channels. This AI type is responsible for autonomous target acquisition *without* human intervention.¹¹¹⁾ Further, AI-based systems are used in larger aircraft to synthesize UAV-gathered data into a unified tactical information field and UAV control programs while allowing manual override by the pilot. In this scenario, UAVs can automatically detect objects and analyze their environment, avoiding obstacles and navigating autonomously. The goal of such a system is to incorporate UAVs into a network-centric combat system.¹¹²⁾

Already in 2021, AI-based UAVs were making their appearance. For instance, the ZALA 421-16E5G has been upgraded with software and hardware to employ neural networks that help it decode the underlying terrain to obtain information on the terrain itself and possible changes to the terrain, identify objects on the ground, and use video navigation.¹¹³⁾ Another example is Lancet drones, outfitted with AI elements, making it possible to launch Lancet swarms from different launchers. These are now able to exchange information on targets.¹¹⁴⁾ And as of

¹¹¹⁾ Ivan Potapov, "Stalo Izvesno o Dvukh Tipakh Boevogo II v Zone SVO," *Lenta*. (2024.04.04). <https://lenta.ru/news/2024/04/04/stalo-izvestno-o-dvuh-tipah-boevogo-ii-v-zone-svo/>.

¹¹²⁾ TASS, "V RF Razrabatyvayut Sistemu s II dlya Upravleniya Gruppoi BPLA pri Pilotirovanii Samolyota," *TASS*, (2023.12.19)., <https://tass.ru/ekonomika/19574151>.

¹¹³⁾ TASS, "Noveishiy Rossiiskii Bespilotnik s Gibrindym Dvigatелеm Poluchil Iskusstvennyi Intellekt," (2021. 04.15). <https://tass.ru/armiya-i-opk/11153275>.

¹¹⁴⁾ Daria Fedotova, "Ot Linii 'Surovykina' Do Iskusstvennogo Intellekta: Chemu Nauchilas' Armiya RF v 2023 Godu," *Moskovskii Komsomolets*. (2024.03.01.). <https://www.mk.ru/politics/2024/01/03/ot-linii-suro>

July 2024, the Russian military deployed *Veter* (rus. “wind”) quadcopters in Ukraine which are also equipped with AI for target designation and protection from EW interference.¹¹⁵⁾ Avoiding electronic warfare (EW) interference is especially important to ensure the proper operational capability of UAVs. As Andrei Kokoshin, a Russian military expert, notes, “AI elements are now being installed in drones, which allow them to move without a signal... Such drones are inaccessible to electronic warfare.”¹¹⁶⁾

In addition to equipping UAVs with AI, as noted, the Russian forces had to find countermeasures to the Ukrainian Armed Forces' extensive use of UAVs, especially quadcopters. Thus, the Central Design Bureau of Apparatus-Building (*Tsentral'noie Konstruktorskoe Byuro Apparatastroyeniya* or TsKBA) unveiled a new airspace control system (*sistema kontrolya vozdušnogo prostranstva* or SKVP) at the *Armiya-2022* forum, designed to track swarms of aircraft, including small drones.¹¹⁷⁾

Another significant area benefiting from AI is air defense systems. As early as 2018, the Aerospace Forces (VKS) tested an AI-based automated control system (*avtomatizirovannaya sistema upravleniya* or *ASU*) for air defense systems. The objective was to integrate the S-300, S-400, and Pantsir anti-aircraft missile and gun systems (ZRPKs), along with radar systems, into a cohesive and unified strike force,¹¹⁸⁾ facilitating thereby coordinated operations among the C2 bodies or all branches of the armed forces.¹¹⁹⁾ Such ASU was deployed in Crimea in 2018.¹²⁰⁾

vikina-do-iskusstvennogo-intellekta-chemu-nauchilas-armiya-rf-v-2023-godu.html.

¹¹⁵⁾ *Izvestiya*, “V RF Sostoyalsya Zapusk v Seriyne Proizvodstvo Novogo BPLA Veter,” *Izvestiya*, (2023.11.28). <https://iz.ru/1612025/2023-11-28/v-rf-sostoiatsia-zapusk-v-seriinoe-proizvodstvo-novogo-bpla-veter>. Ivan Potapov, “V Zone SVO Primenili Rossiiskii Veter,” *Lenta*, (2024.08.06). <https://lenta.ru/news/2024/08/06/v-zone-svo-primenili-rossiiskiy-veter-s-ii/>.

¹¹⁶⁾ *Izvestiya*, “Voennyi Ekspert Nazval Sposob Zashchity oRossiiskikh Dronov ot Sistem REB,” *Izvestiya*, (2024.04.12) <https://iz.ru/1681495/2024-04-12/voennyi-ekspert-nazval-sposob-zashchity-rossiiskikh-dronov-ot-sistem-reb>.

¹¹⁷⁾ Ivan Potapov, “V Rossii Predstavili Sistemu Slezeniya za Vozdushnym Roem Dronov,” *Lenta*, (2022.08.19). <https://lenta.ru/news/2022/08/19/drones/>.

¹¹⁸⁾ Kruglov, Aleksandr, Ramm, Aleksei & Dmitriev, Evgenii, “Sredstva PVO Obyedinyat Iskusstvennym Intellektom,” *Izvestiya*, (2018.05.02). <https://iz.ru/733333/aleksandr-kruglov-aleksei-ramm-evgenii-dmitriev/sredstva-pvo-obediniat-iskusstvennym-intellektom>.

In short, AI enables clear identification, processing and distribution of targets in air defense systems such as Buk and missile systems such as Tor. These are equipped with the Kupol radar detection and target designation system, as well as an automated system that allocates targets between them based on the threat level, allowing coordinated and efficient operation.¹²¹⁾ As one Russian military expert put it, “[a] person does not have time to perform all the necessary actions, aim a missile, make calculations, but AI does.” However, a human is still in the loop even if Russian air defense systems have integrated AI.¹²²⁾ As of 2024, AI has been introduced into systems such as Pantsir-S1, S-300, S-400, and S-350 Vityaz.¹²³⁾

A further area that has seen the integration of AI is electronic warfare (EW). Thus, several EW systems have already been upgraded with AI. Further, neural networks are expected to be integrated into UAV-based EW systems to enable object recognition and autonomous group organization, according to Yuri Lastochkin, head of the Russian Armed Forces’ EW forces. He noted that AI in EW systems already handles tasks like signal processing and pattern recognition, with neural networks being the first to be implemented. These networks will soon allow UAVs to autonomously recognize objects, switch from pre-set routes to independent task execution, and self-organize into coordinated groups.¹²⁴⁾

EW systems remain at the forefront in terms of UAV defense. Rostec has made significant investments in military AI applications. For instance, the RB-109 Bylina EW system developed by Rostec subsidiary KRET, employs AI to prioritize

¹¹⁹⁾ See Gavrilov, Anatoli & Labunsky, Andrei, “Iskusstvennyi Intellekt dlya PVO,” *Arsenal Otechestva*, (2018). no. 3(35), <https://arsenal-otechestva.ru/article/1078-iskusstvennyj-intellekt-dlya-pvo>.

¹²⁰⁾ Kozachenko, Aleksei & Ramm, Aleksei, “Zashhitnyi Kontur: VVS I PRO Kryma Obyedinil Iskusstvennyi Intellekt,” *Izvestiya*, (2018.10.26). <https://iz.ru/800451/aleksei-kozachenko-aleksei-ramm/zashchitnyi-kontur-vvs-i-pvo-kryma-obedinil-iskusstvennyi-intellekt>.

¹²¹⁾ Azanov, Roman, ““Zhelezo s Mozgami”: Kakoe Oruzhiye Rossii Umeet “Dumat”,” *TASS*, (2018.06.13)., <https://tass.ru/armiya-i-opk/5279032>.

¹²²⁾ Belova, Natalia, “Polkovnik Rasskazal ob Ispol’zovanii II v Rossiiskikh Voiskakh,” *Lenta*, (2023.06.02). https://lenta.ru/news/2023/06/02/ii_weapon/.

¹²³⁾ Fedotova, (2024.03.01). Op. cited.

¹²⁴⁾ Yana Lomakina, “Nachal’nik Voisk REB Rasskazal o Vnedrenii Neyrosetey v Bespilotniki,” *RBC*, (2024. 04.15). <https://www.rbc.ru/rbcfreenews/661c559d9a794772d65d258a>.

and jam electronic signals. According to a Russian military expert, Bylina is expected to improve the effectiveness of existing EW systems on the battlefield by 40 percent.¹²⁵⁾ In 2024, several fully autonomous AI-based EW systems were deployed to Ukraine. The first – Solaris-N – was designed to suppress Ukrainian kamikaze drones and reconnaissance UAVs to protect industrial and strategic facilities. This is being used in the Rostov region,¹²⁶⁾ especially given the frequency of Ukrainian attacks on industrial facilities on Russian territory.¹²⁷⁾ In May 2024, a new mobile AI-based anti-drone electronic warfare system, “Abzats,” was unveiled and has already been deployed in Ukraine. *Absatz* is fully autonomous and capable of disrupting the entire frequency spectrum utilized by unmanned aerial vehicles, including those with pseudo-random frequency hopping systems.¹²⁸⁾

Perhaps the most opaque area is the use of AI in missiles and missile systems,¹²⁹⁾ such as the Iskander-M operational-tactical missile system. A “target image” can be programmed into the homing head of the Iskander-M missile system, allowing the Iskander-M missile to reach its designated target while bypassing decoys and false constructs intended to simulate key objects or control points.¹³⁰⁾ Another example is the Navy’s anti-ship cruise missile, Granit. During a salvo, e.g., against a strike aircraft carrier group, the missiles autonomously distribute targets among themselves. They determine which missiles will engage the aircraft carrier

¹²⁵⁾ TASS, “Novyi Kompleks REB Sozdan v RF v Ramkakh Opytno-Konstruktorskoj Raboty “Bylina,”” <https://tass.ru/armiya-i-opk/4420619>; Izvestiya, (2023.10.06). “Ekspert Otsenil Rost Effektivnosti Sredstv REB pod Upravleniyem “Byliny” na 40\$”. <https://iz.ru/1584983/2023-10-06/ekspert-otcenil-rost-effektivnosti-sredstv-reb-pod-upravleniem-byliny-na-40>.

¹²⁶⁾ Grishchenko, Nikolai, “Donskie Voennye Poluchili Roboty REB dlya Bor’by s Dronami Kamikadze,” Rossiiskaya Gazeta, (2024.01.21). <https://rg.ru/2024/01/21/reg-ufo/donskie-voennye-poluchili-roboty-reb-dlia-borby-s-dronami-kamikadze.html>.

¹²⁷⁾ See, for instance, Reuters, “Ukrainian Drone Attacks Russian Oil Refineries and Infrastructure,” (2024.06.18) <https://www.reuters.com/world/europe/ukrainian-drone-attacks-russian-oil-refineries-infrast-structure-2024-06-18>.

¹²⁸⁾ Iskusstvennyi Intelpekt Rossiiskoi Federatsii, “V Rossii Sozdali Peredvizhnyuyu REB-Sistemu “Absatz”, Osnashchennuyu II,” ai.gov.ru, (2024.05.24). <https://ai.gov.ru/mediacenter/v-rossii-sozdali-peredvizhnyuyu-reb-sistemu-abzats-osnashchennuyu-ii/?pageStart=138>.

¹²⁹⁾ RIA Novosti, “Mnogie Rossiiskie Rakety Obladayut Iskusstvennym Intellektom,” (2020.02.14). <https://ria.ru/20200214/1564687038.html>.

¹³⁰⁾ Azanov, (2018.06.13). Op. Cited.

directly and which will target the accompanying cruisers, frigates, and destroyers within the formation.¹³¹⁾

Another important area for Russia's military operations is logistics. To improve logistics, especially, casualty evacuation (CASEVAC) as well as improving deliveries of supplies and ammunition, Nauchno-Proizvodstvennoe Obyedinenie (NPO) "Avanti" produced two robotic systems: "Bogomol" and "Platforma-MUL" created by Tekhnopolis ERA for the Armiya-2022. The primary function of these systems is to facilitate the transportation of ammunition and the wounded; however, they can also be used as a launchpad for UAVs.¹³²⁾

Further, the use of AI for information operations and deception, especially, concerning the war in Ukraine has seen an increase since February 2022. In the military sphere, the Russians used deepfakes to confuse their adversary. For instance, in March 2022, a deepfake video of the Ukrainian President, Volodymyr Zelenskyy, was created and distributed. In the video, Zelenskyy asked his troops to surrender.¹³³⁾ And while the fake was debunked early on, it could have generated the desired military effect for the Russians, had it not been.

Outside the military sphere, there have been reports of Russia using AI for crafting its information operations in line with what Losev suggested in 2017. More specifically, the Kremlin is believed to have used for launching disinformation operations, for instance, in relation to the late Kremlin critic, Alexei Navalny who was harassed by AI-based bots.¹³⁴⁾ But OpenAI's generative AI, ChatGPT, is believed to be targeted by Russian cybercriminals who attempted to bypass OpenAI's restrictions, namely, geofencing, and use ChatGPT for

¹³¹⁾ Ibid.

¹³²⁾ Potapov, Ivan, "Rossiiskie "Bogomol" i "Platforma-MUL" Perevezut Renenykh i Boepripasy," Lenta, (2022.08.20). <https://lenta.ru/news/2022/08/20/bogomol/>.

¹³³⁾ Jane Wakefield, "Deepfake Presidents Used in the Russia-Ukraine War," BBC, (2022.03.18). <https://www.bbc.com/news/technology-60780142>.

¹³⁴⁾ Elise Thomas, "'Hey, fellow humans!': What Can a ChatGPT Campaign Targeting pro-Ukraine Americans Tell Us About the Future of Generative AI and Disinformation?" *Institute for Strategic Dialogue Global*, (2023.12.03). https://www.isdglobal.org/digital_dispatches/hey-fellow-humans-what-can-a-chatgpt-campaign-targeting-pro-ukraine-americans-tell-us-about-the-future-of-generative-ai-and-disinformation/

malicious purposes.¹³⁵⁾ While there is a market to use AI in both military and non-military information operations, it seems that here the Kremlin prefers to rely on third-party AI applications, rather than using its nascent software – if such had already been developed.

Overall, the war in Ukraine has accelerated the incorporation of AI into various military systems. It should be noted that many of these integrations were initiated prior to the conflict; however, the war has provided an opportunity to battle-test and refine these technologies.

2) Vision and Strategies for Future AI Warfare

Prospects for AI in Russia

Russia's ability to compete in the AI sphere is marked by few developments in generative AI. Instead, applied algorithmic AI is more widespread, finding applications in industry, finance, medicine, and logistics.¹³⁶⁾ The prospects for Russia leading in AI development are mixed. On one hand, Russia's education system excels in natural sciences, particularly mathematics, and IT, equipping the country well for AI development. On the other hand, the development and training of neural networks require high-performance computers with powerful video cards, which Russia does not produce domestically.¹³⁷⁾

Challenges in AI Development

One of the significant issues that Russia has been facing concerning AI R&D is related to the allocation of resources. According to the Analytical Center of the

¹³⁵⁾ Business Insider, "ChatGPT Helps Hackers Write Malicious Codes to Steal Your Personal Data," (2023.01.15). <https://www.businessinsider.in/tech/news/chatgpt-helps-hackers-write-malicious-codes-to-steal-yourpersonal-data/articleshow/97000603.cms>.

¹³⁶⁾ Igor Kalganov, "Igry Iskusstvennogo Intellekta: Kakoe Mesto v Gonke za Liderstvo v Sfere II Zaymet Rossiya," *Forbes.ru*, (2023.04.29). <https://www.forbes.ru/mneniya/488320-igry-iskusstvennogo-razuma-kakoe-mesto-v-gonke-za-liderstvo-v-sfere-ii-zajmet-rossia>.

¹³⁷⁾ Ibid.

Government of RF, entitled “Artificial Intelligence. Index 2020,” the authors have established that Russia’s GDP as of 2020 was 14 times less than the US’s GDP and 10 times less than China’s, respectively. However, Russia’s investments were 350 times less than China’s, with China leading the AI investment among the three competitors. Thus, for Russia to remain competitive, the report stressed that it would be necessary to increase the funding for all scientific research by at least 3-5 times and to put clear priorities on R&D of AI within general scientific research.¹³⁸⁾

Notwithstanding, it should be noted that Russia and China have been cooperating in several technology-related fields, including the development of AI for various sectors, including the military. The prospects of such collaboration could lead to the acceleration of Russia’s development of military AI.¹³⁹⁾

Impact of the Ukraine War

The war in Ukraine further impacted Russia’s ability to remain competitive. The brain drain that followed the war as well as the overall shortage of a skilled workforce could have a negative effect on the prospects of – general and military – AI development and integration.¹⁴⁰⁾ To offset the first problem, Russia’s Ministry of Education took the initiative to ensure proper education related to AI, even offering subsidies for prospective data sciences students.¹⁴¹⁾ This approach could help to offset the current shortage of skilled workforce, at least in the long term.

¹³⁸⁾ Vladimir Mitin, “Kitai Tratit na II v 350 Raz Bol’she Chem Rossiya,” *IT Week*, (2021.04.16). <https://www.itweek.ru/ai/article/detail.php?ID=217907>.

¹³⁹⁾ Pavlo Kryvenko, “The Power of Partnership: Russo-Chinese Tech Cooperation,” *New Geopolitics Research Network*, (2024.03.02). <https://www.newgeopolitics.org/2024/03/02/the-power-of-partnership-russo-chinese-tech-cooperation/>.

¹⁴⁰⁾ Lionel Laurent, “Brain Drain From Putin’s Russia Is Far From Over,” *Bloomberg*, (2024.02.20). <https://www.bloomberg.com/opinion/articles/2024-02-20/ukraine-war-brain-drain-from-putin-s-russia-is-far-from-over>. Valeri Vyzhutovich, “Sotsyolog Pavel Razov: Plaformennaya Zanyatost’ Daet Cheloveku Vozmozhnost’ Samomu Rasporyazhatsya Rabochim Vremenem,” *Rossiiskaya Gazeta*, (2023.04.24). <https://rg.ru/2023/04/24/rynok-truda-prezhnij-zaniatost-novaia.html>.

¹⁴¹⁾ See, for instance, 20.35 Universitet “Courses in Artificial Intelligence,” <https://ai.2035.university/>. date accessed 2024.05.26.

The short-term impacts, however, might negatively affect Russia's ability to develop AI.

Another negative effect related to the Ukraine war is Russia's ability to import high-tech components, such as Nvidia graphic cards, which in turn increased the costs of AI-based software development by 30-40% by mid-2023 (compared to mid-2022).¹⁴²⁾ While these sanctions pose a significant barrier, the Kremlin has found ways to circumvent them, importing critical components such as microchips.¹⁴³⁾ It must, however, be stressed that the US has been trying to make not only the import but also the payment for advanced electronic components more difficult for Russia.¹⁴⁴⁾ Rephrased, as long as Russia can continue importing such technologies from the West as well as Taiwan and South Korea, it stands a good chance of remaining competitive in the contemporary battlefield.

Further, international cooperation in the IT domain has suffered as a result of the Ukraine war, leading not only to the lack of knowledge exchange in the sphere of leading technologies but also to sanctions on major Russian IT companies which are now barred from working in countries like the U.S. and are, thus, forced to look for other markets, most notably in Asia.¹⁴⁵⁾ This creates a further hurdle for Russia in its pursuit of AI, requiring the stimulation of start-ups and reliance on domestic industry.

¹⁴²⁾ Kommersant, "Intellekt na Ves Zolota," *Kommersant*, (2023.07.03). <https://www.kommersant.ru/doc/6082034>.

¹⁴³⁾ Karen Gilchrist, "How U.S. Microchips are Fueling Russia's Military — Despite Sanctions," *CNBC*, (2023.08.07). <https://www.cnbc.com/2023/08/07/how-us-microchips-are-fueling-russias-military-despite-sanctions.html>.

¹⁴⁴⁾ Re-Russia, "Sanctions Game: The US Has Managed to Create Problems for the Import of Microelectronics into Russia, But Even More Importantly, to Limit the Development of its Domestic Production," *Re-Russia*, (2024.04.16). <https://re-russia.net/en/review/721/>.

¹⁴⁵⁾ Beloshitskyi, Alexei, "Tekhnologicheskii Suverenitet I Kooperatsiya v Novykh Usloviyakh," *Roscongress*, (2024.01.16). <https://roscongress.org/materials/tekhnologicheskii-suverenitet-i-kooperatsiya-v-novykh-usloviyakh/>.

Major Players and Economic Outlook

Despite all the challenges, Russia still has major players such as Sberbank which are not only investing but also implementing AI technologies. According to the first Deputy Chairman of the Board of Sberbank, Aleksandr Vedyakhin, AI is integrated into 85% of Sber's processes and is expecting some USD 5.6 million in profits in 2024.¹⁴⁶⁾ All this will inevitably strengthen Russia's economy with the International Monetary Fund's 2024 forecast for Russia's GDP growth to 3.2% due to war-related government spending and investments coupled with oil exports.¹⁴⁷⁾

Such growth will create new opportunities for the development of the tech sector. As the Scientific Director of the Quantum Information Technologies Group of the Russian Quantum Center, MIPT, Alexei Fedorov stated, Russia – despite the sanctions regime – has managed to reduce the gap with other world powers in terms of advanced technologies, confirming that Russia is already using quantum computing, albeit at a small scale.¹⁴⁸⁾

Further, the IT sector has shown a degree of resilience and growth, which creates a promising outlook. Government initiatives such as grants, loans and tax incentives for IT companies helped ease the impact of the sanctions. Further, the shift from reliance on Western IT solutions (e.g., cloud services) helped bolster the domestic industry and increase technological sovereignty.¹⁴⁹⁾

Government Initiatives, Investments and Infrastructure

In terms of government investments and education, by 2023, according to the Deputy Prime Minister for Tourism, Sport, Culture, and Communications, Dmitry Chernyshenko, 93.5 billion rubles (approximately \$1bn) had been allocated to six

¹⁴⁶⁾ Vedomosti, (2024.04.10). Op. cited.

¹⁴⁷⁾ Reuters, "Russian Ministry sees 2024 GDP at 2.8%, But with Higher Inflation, Weaker Ruble," April 23, 2024, <https://www.reuters.com/world/europe/russian-ministry-sees-2024-gdp-28-with-higher-inflation-weaker-ruble-2024-04-23/>.

¹⁴⁸⁾ Vedomosti, (2024.04.10). Op. cited.

¹⁴⁹⁾ Baibekov, Shamil, (2023.06.01) "V Ramkakh Novoi Real'nosti," *Russkiy Transport*, <https://transportrussi.ru/razdely/it-tehnologii/10078-v-ramkakh-novoj-realnosti.html>.

high-tech roadmaps, over 100 AI-related higher education programs had been established. Further, the construction of sections of the backbone of Russia's quantum network was expected to be completed.¹⁵⁰⁾ In July 2023 during a meeting on AI's advancement with President Putin, the Minister of Economic Development Maxim Reshetnikov stressed the need for the integration of AI technologies into university curricula and making the AI educational module compulsory.¹⁵¹⁾ This focus on education, as noted, might help Russia to solve the existing skilled workforce problem (for a more detailed discussion, see *Education* section further below).

For 2024, it is projected that the top 100 IT companies will increase their revenue by 2.5 times (to 5.3 trillion rubles or 59.89 billion USD) due to AI technologies.¹⁵²⁾ These companies, including Sber, Rostelekom, Rossel'mash, MTS, and Megafon, are leaders in implementing AI solutions and are therefore critical to Russia's development and integration of AI.¹⁵³⁾

Russia is also focusing on developing the necessary computing infrastructure, particularly increasing the power and availability of supercomputers to universities leading AI R&D. The Ministry of Economic Development highlighted the need for tens of thousands of graphics cards for power-intensive processes like machine learning.¹⁵⁴⁾ Vitaly Lopota, former head of the Directorate of Robotics Programs at Technopolis Era, stated that "[t]o create AI ... it is necessary to create a quantum computer at the very least... Its capabilities in terms of calculations and modeling will be several orders of magnitude higher than the

¹⁵⁰⁾ Ministry for Economic Development, "Andrei Belousov Provel Prezidium Pravitel'stvennoi Komissii po Modernizatsii Ekonomiki I Innovatsionnomu Razvitiyu Rossii," (2023.07.14). https://www.economy.gov.ru/material/news/andrey_belousov_provel_prezidium_pravitelstvennoy_komissii_po_modernizatsii_ekonomiki_i_innovatsionnomu_razvitiyu_rossii.html.

¹⁵¹⁾ Ministry for Economic Development, "Izucheniye II-Teknologiy v Rossiiskikh Vuzakh Mozhet Stat' . (2023. 07.20). Obyazatel'nyy," https://www.economy.gov.ru/material/news/izucheniye_ii_tehnologiy_v_rossiyskikh_vuzakh_mozhet_stat_obyazatelnyy.html

¹⁵²⁾ Oleg Kapranov, "Chernyshenko: Obyom Rossiiskogo Rynka II v 2023 Godu Dostig Pochti 650 Mlrd Rubley," *Rossiiskaya Gazeta*, (2024.01.24). <https://rg.ru/2024/01/21/chernyshenko-obem-rossiiskogo-rynka-ii-v-2023-godu-dostig-pochti-650-mlrd-rublej.html>.

¹⁵³⁾ Ibid.

¹⁵⁴⁾ Ibid.

highest-speed computers available in the world today. The leading positions in its creation are occupied by China, Russia, and the United States. The solution to this problem can be compared in terms of its significance to the creation of nuclear weapons in the middle of the past century. Breakthrough success of a revolutionary nature has not yet been achieved.”¹⁵⁵) Additionally, there is a recognition that Russia must also increase its domestic microchip production, especially in light of existing sanctions. As Vasily Shpak, the deputy head of the Ministry of Industry and Trade, put it, “...if there is no sovereign microelectronics, then there is no technological sovereignty. If there is no technological sovereignty, then you are very weak in terms of defense security and political sovereignty.”¹⁵⁶)

Overall, Russia’s AI landscape is marked by both challenges and opportunities. Despite hurdles like limited high-performance computing capabilities, low investment in AI R&D, and the impacts of the Ukraine war, Russia is committed to advancing its AI capabilities. Collaboration with China and a strong emphasis on natural sciences and IT in education provide a foundation for progress. Government initiatives, along with efforts by major players like Sberbank, are driving AI integration across various sectors, although the military’s efforts in the AI sphere remain rather opaque. Economic growth from government spending and investments further supports potential advancements which would, of course, benefit the military. However, challenges such as funding, infrastructure needs, and international sanctions remain significant. While Russia faces obstacles in achieving AI leadership, its strategic efforts and partnerships could enable significant growth and innovation in this field. Success will depend on Moscow’s ability to adapt and invest effectively in its own IT companies, shifting the reliance on domestic IT solutions.

¹⁵⁵) Vitaly Lapota quoted in Yuri Avdeev, “Era Mul’ tikoptynykh Bepilotnikov,” *Patriot-EXPO*, (2019.04.01). <http://www.patriot-expo.ru/2352/>.

¹⁵⁶) RIA Novosti, “Vasili Shpak: Bez Suverennoi Mikroelektroniki Ne Byvaet Suvereniteta,” *RIA Novosti*, November 11, 2023, <https://ria.ru/20231101/shpak-1906499130.html>.

3) The Governance for Military AI Technology Innovation

Russian Ministry of Defense as the epicenter for military AI governance

The MoD, in collaboration with the Russian Academy of Sciences, financial development institutions, leading research centers, and universities, has established an innovation system involving over 1,200 entities from 25 regions, with 151 cooperation agreements. The system's primary goal is to create conditions for effectively countering external threats with minimal resources. GUNID MO RF is responsible for organizing these innovative activities.¹⁵⁷⁾

Within the MoD, research and innovation initiatives are structured into two primary categories: the Military Scientific Committee (Voenno-Nauchnyi Komitet) and MoD Research Organizations. The Military Scientific Committee, established in October 1999, focuses on providing scientific foundations for the development, training, use, and support of the Armed Forces. Its tasks include planning and coordinating scientific research across the MoD, the Russian Academy of Sciences, and other relevant organizations. The Committee is also responsible for enhancing the military-scientific complex, developing research facilities, automating research processes, and fostering international military-scientific cooperation.¹⁵⁸⁾

To better appreciate the tasks of the research institutions, the following passages briefly outline the tasks of each, specifically focusing on their involvement in the development of AI. Some of the institutions have been a part of the MoD before introducing AI-research, others have been created specifically to focus on AI.

¹⁵⁷⁾ Ministry of Defense, "Struktura I Realizatsiya Innovatsionnykh Deyatel'nostei," *Ministry of Defense*, retrieved from <https://mil.ru/mission/innovacia/struct.htm> on 2024.06.27.

¹⁵⁸⁾ Ministry of Defense, "Voenno-Nauchnyi Komitet Vooruzhennykh Sil Rossiiskoi Federatsii," *Ministry of Defense*, retrieved from https://ens.mil.ru/science/military_scientific_committee.htm on 2024.06.27.

National Defense Management Center

Already in 2014, the Kremlin established the National Defense Management Centre (*Natsional'nyi Tsentri Upravleniya Oboronoj*, NTSUO), the key military command and control hub to coordinate the actions of the Russian Armed Forces and ensure their combat readiness. The center maintains a centralized combat command system, monitors troop grouping in strategic directions, and manages military aviation and Navy operations. Further, it provides the MoD with updates on global military-political and domestic socio-political situations. To this end, the center operates a supercomputer, which the former Defense Minister Sergei Shoigu claimed can “predict armed conflict developments based on historical experience.”¹⁵⁹⁾

This predictive ability is based on specialized AI-based software developed for the NTSUO by RTI in 2020. The software was designed to support decision-making by processing large quantities of data to ascertain the availability of forces and resources. Further, NTSUO's AI is used for emergency forecasting based on historical data to predict floods and fires to improve the efficiency of the Ministry of Emergency Situations, the National Guard, and the MoD.¹⁶⁰⁾

The Main Directorate for Innovative Development of the Ministry of Defense of the Russian Federation (Glavnoe Upravleniye Innovatsionnogo Razvitiya Ministerstva Oborony Rossiiskoi Federatsii or GUIR MO RF)

The Main Directorate for Innovative Development of the Ministry of Defense of the Russian Federation (GUIR MO RF) fosters innovation within the defense sector by supporting and executing scientific, technical, and innovative programs. GUIR advances high-tech military products, creates a technological reserve, and

¹⁵⁹⁾ Gazeta, “Natsional'nyi Tsentri Upravleniya Oboronoj Rossiiskoi Federatsii,” *Gazeta*, retrieved from [https://www.gazeta.ru/tags/organization/ntsuo_rf.shtml?updated June 24, 2024](https://www.gazeta.ru/tags/organization/ntsuo_rf.shtml?updated=June+24,+2024),

¹⁶⁰⁾ M. Sineva, “Gendirektor RTI: Mnogie Zarubezhnye Partnyory Khotyat Kupit' Nashi Radiolokatsionnye Stantsii,” *TASS*, (2020.01.22). <https://tass.ru/interviews/7570557>.

provides high-tech equipment and scientific information to military bodies. It analyzes advanced technologies from educational, scientific, and industrial organizations in Russia and maintains an information resource on these innovation.¹⁶¹⁾ GUIR also implements innovative programs, introducing advanced technologies into defense applications. It also organizes congress and exhibition activities, coordinates the “Congress and Exhibition Center Patriot,” manages the “Military Innovation Technopolis ERA,” and oversees systems to counter foreign robotic complexes in the Russian Armed Forces.¹⁶²⁾

Further, GUIR holds meetings with the Defense Commission on Innovative Projects and Technologies (Komissiya Minoborony Rossii po Innovatsionnym Proektam I Tekhnologiyam) aimed at solving military technological problems posed by the war in Ukraine, fostering thereby co-operation between the military industry, organizations, industrial enterprises, and educational institutions. For instance, in June 2024, during one such meeting at the Congress and Exhibition Center “Patriot”, GUIR cohosted a specialized exhibition dedicated to technical solutions in AI and robotics, among other areas.¹⁶³⁾

The Main Directorate of Scientific Research Activities and Technological Support of Advanced Technologies of the Russian MoD (Glavnoye Upravleniye Nauchno-Issledovatel'skoi Deyatel'nosti I Tekhnologicheskogo Soprovozhdeniya Peredovykh Tekhnologiy Minoborony RF)

The Main Directorate of Scientific Research Activities (GUNID MO FR) was established in February 2013 and is responsible for identifying, selecting, and supporting innovative projects for the Armed Forces. It reports directly to the

¹⁶¹⁾ Ministry of Defense, “Glavnoye Upravleniye Innovatsionnogo Razvitiya Ministerstva Oborony Rossiiskoi Federatsii,” *Ministry of Defense*, retrieved from https://structure.mil.ru/structure/ministry_of_defence/details.htm?id=11376@egOrganization on 2024.06.26.,

¹⁶²⁾ Ministry of Defense, “Glavnoye Upravleniye Innovatsionnogo Razvitiya.”

¹⁶³⁾ Department of Information and Mass Communication of the MoD, “V Konressno-Vystavochnom Tsentre “Patriot” Sostoyalos' Zasedaniye Komissii Minoborony Rossii po Innovatsionnym Proektam I Tekhnologiyam,” *Ministry of Defense*, (2024.06.21). https://function.mil.ru/news_page/organizations/more.htm?id=12517450@egNews.

Deputy Minister of Defense. Over the past decade, GUNID has been responsible for organizing international military-technical forums, such as the annual *Armiya* forum, and exhibitions. It is also tasked with creating favorable conditions for the development of advanced weapons and military and special equipment.¹⁶⁴⁾

46th Central Scientific and Research Institute of the MoD (46 Tsentral'nyi Nauchno-Issledovatel'skiy Institut Ministerstva Oborony or TsNII MO RF)

The Central Scientific Research Institute (TsNII MO RF) plays a pivotal role in enhancing the weapons systems of the Armed Forces. It is instrumental in supporting the State Armament Program, advising on the state defense order, and standardizing military supplies. The 46th TsNII leads technological development programs, undertakes high-tech defense projects, and promotes Russian scientific achievements.¹⁶⁵⁾

TsNII's contributions include the development of automated systems for managing weapons and military equipment and the creation of specialized software for automated program documentation. Noteworthy achievements encompass high-precision weapons and conceptualizations of new missile and radar systems. The institute collaborates with various defense research institutes and industrial enterprises, conducting research projects for the Main Armament Directorate and the General Staff.¹⁶⁶⁾

Institut General'nykh Konstruktorov I Rukovoditelei Prioritetnykh Tekhnologicheskikh Napravleniy

In January 2015, Vladimir Putin signed a decree initiating the role of the

¹⁶⁴⁾ Department for Information and Mass Communication of MoD, "Glavnomu Upravleniyu Nauchno-Issledovatel'skoi Deyatel'nosti Minoborony Rossii – 8 Let," *Ministry of Defense*, (2021.02.12). https://function.mil.ru/news_page/country/more.htm?id=12343872@egNews.

¹⁶⁵⁾ Ministry of Defense, "46 Tsentral'nyi Nauchno-Issledovatel'skiy Institut Ministerstva Oborony Rossiiskoi Federatsii," *Ministry of Defense*, retrieved from <https://ens.mil.ru/science/SRI/information.htm?id=11391@morfOrgScience>. on 2024.06.26.

¹⁶⁶⁾ Ibid.

Institute of General Designers (IGK), tasking it with organizing the development of strategically important weapons systems. General designers were expected to have extensive authority to secure resources for their projects and charged with creating the latest weaponry for the Russian military. The Kremlin's renewed focus on the IGK aimed to transform the domestic military-industrial complex.¹⁶⁷⁾

While the IKG does not solely focus on AI, it plays a role in advancing research in key areas such as high-performance computing technologies, including supercomputers, as part of a collaborative effort between the MoD, the IKG, the Ministry of Industry and Trade, Roscosmos, Rosatom, and other stakeholders in the state weapons program.¹⁶⁸⁾

ERA Military Innovation Technopolis

In 2018, ERA, as noted, was created on the Anapa coast (of the Black Sea) to fulfill the role of a key player in the development of military AI and as a hub for scientists and graduates of technical universities.¹⁶⁹⁾ All key development matters are submitted to ERA's Council which includes representatives from the MoD, state corporations, and defense industry enterprises as well as scientific schools. It is ERA where new developments start with an idea and finish with a sample.¹⁷⁰⁾ ERA conducts not only research but also regular exhibitions to connect scientists with defense corporations.

By 2021, ERA comprised eight scientific companies and sixteen research areas, focusing not only on AI (including pattern recognition, neural networks, and intelligence data processing) but also on robotics, information security, nanotechnology, and spacecraft. These areas are constantly expanding.¹⁷¹⁾

¹⁶⁷⁾ A. Petrov, "Po Ukazu Prezidenta: V Rossii Vozvrashhayetsya Institut Genkonstruktorov," *Rosinform*, (2016. 02.01). <https://rosinform.ru/predpriyatiya/786908-v-rossii-vozhvrashchaetsya-institut-genkonstruktorov/>.

¹⁶⁸⁾ A. Dianov, "Akademik Krasnikov Rasskazal o Sud'be Rossiiskoi Mikroelektroniki," *Rossiiskaya Gazeta*, (2017.03.19). <https://rg.ru/2017/03/19/akademik-krasnikov-rasskazal-o-sudbe-rossijskoj-mikroelektroniki.html>.

¹⁶⁹⁾ The Kremlin. (2018.02.23). Op cited.

¹⁷⁰⁾ Yuri Gavrilov, "Voennomu Tekhnopolisu "ERA" Ispolnilos' 5 Let," *Rossiiskaya Gazeta*, (2023.03.01.) <https://rg.ru/2023/03/01/voennomu-tehnopolisu-era-ispolnilos-5-let.html>.

Further, ERA coordinates the development of defense-related educational programs.¹⁷²⁾ By 2023, ERA created more than 2000 specialized jobs, collaborating with sixteen industrial enterprises, and started hosting a research and production platoon under the Kalashnikov concern.¹⁷³⁾

Directorate for the Development of AI (Upravleniye Razvitiya Iskusstvennogo Intellekta)

In August 2022 it became known that the Russian MoD established a department focused on AI (Upravleniye po Rabote s Iskusstvennym Intellectom) to enhance the integration of AI technologies in weapon development, focusing on advancing military and special equipment.¹⁷⁴⁾ This was confirmed by GUIR's Major General during the "Artificial Intelligence: National Consolidation for Creation" plenary session at the "Armiya-2022" forum.

Already in May 2021, Mikhail Osyko, a member of the board of the Military-Industrial Commission under the government, stressed that with the formation of such a department, a new concept of "military AI" would soon appear.¹⁷⁵⁾

Advanced Research Foundation

In October 2012, Russia established the Advanced Research Foundation (*Fond Perspektivnykh Issledovaniy* or FPI (Фонд перспективных исследований)¹⁷⁶⁾

¹⁷¹⁾ V. Sosnitsky, "Voennyi Tekhnopolis "ERA": Kulibiny I Lomonosovy ne Perevelis' na Rusi," *Ezhenedel'nik Zvezda*, (2021.04.19) <https://zvezdaweekly.ru/news/20214161212-dg6Mv.html>.

¹⁷²⁾ Ibid.; A. Zakvasin & E. Komarova, "Novaya ERA: Kak Minoborony Rossii Razvivaet Unikal'nyi Voennyi Tekhnopolis," *Russia Today*, (2019.04.16). <https://russian.rt.com/russia/article/621873-rossiya-tehnopolis-era-minoborony>.

¹⁷³⁾ Gavrilov, (2023.03.01) Op. Cited.

¹⁷⁴⁾ TASS, "V Minoborony FR Sozdali Upravleniye po Rabote s Iskusstvennym Intellectom," *TASS*, (2022.08.17). <https://tass.ru/armiya-i-opk/15492531>.

¹⁷⁵⁾ TASS, "Minoborony k 1 Dekabrya Sozdast Upravlenie dlya Raboty s Iskusstvennym Intellectom," *TASS*, (2022.05.31) <https://tass.ru/armiya-i-opk/11515073>.

¹⁷⁶⁾ FPI, "About," *FPI*, <https://fpi.gov.ru/about/>. Accessed on 2024.06.15.

analogous to the United States Defense Advanced Research Project Agency (DARPA).¹⁷⁷ The FPI concentrates on promoting research in defense and state security areas, focusing on areas such as AI – since 2015 the task was set to create an AI-based operator¹⁷⁸ – chemical, biological, medical, physical, technical, and informational. In 2015, the National Center for the Development of Technologies and Basic Elements of Robotics (*Natsional'nyi Tsentr Razvitiya Tekhnologiy I Bazovykh Elementov Robototekhniki*) was created within the FPI.¹⁷⁹ The establishment of the National Center sought to address the need for coordinated efforts among developers, manufacturers, and customers of robotics. Before its formation, the lack of a unified information field led to inefficient resource distribution and suboptimal results. The center would thus facilitate collective access to research outcomes and technologies, enhancing the overall effectiveness of the robotics community in Russia. The tasks of this Center include the development of military, special, and dual-use robotic complexes.¹⁸⁰

Over the past decade, FPI's initiatives have progressively expanded in critical areas. Notably, the development of quantum computing, AI, and autonomous control technologies for robotic systems has reached advanced stages.¹⁸¹ In 2019, for instance, FPI prepared a proposal for the MoD for the standardization of AI, most notably as far as speech and facial recognition were concerned.¹⁸²

The FPI has also established over 100 research and design laboratories in collaboration with leading enterprises of the military-industrial complex, technical universities, scientific institutions, and high-tech private companies.

¹⁷⁷ RIA Novosti, "He'll be Back: Iskusstvennyi Intellekt Nadeyutsya Sozdat' v RF za 10 Let," RIA Novosti, (20 15.05.29). <https://ria.ru/20150529/1067078798.html>.

¹⁷⁸ Ibid.

¹⁷⁹ RIA Novosti, "V FPI Rasskazali o Proektakh v Oblasti Iskustvennogo Intellekta," *RIA Novosti*, (2019.02.20). <https://ria.ru/20190220/1551137812.html>; RIA Novosti, "V Rossii Budet Sozdan Natsional'nyi Tsentr po Robototekhnike," *RIA Novosti*, (2015.12.16) . <https://ria.ru/20151216/1343033478.html>.

¹⁸⁰ I. Korotchenko, "Aleksei Kononov: «Nasha Zadacha – Sozdat' Obsshuyu Informatsionnuyu Sredu Dlya Razrabotchikov, Proizvoditelei i Zakazchikov Robototekhniki," *Natsional'naya Oborona*, (2016). <https://2009-2020.oborona.ru/includes/periodics/maintheme/2016/1017/114619580/detail.shtml>.

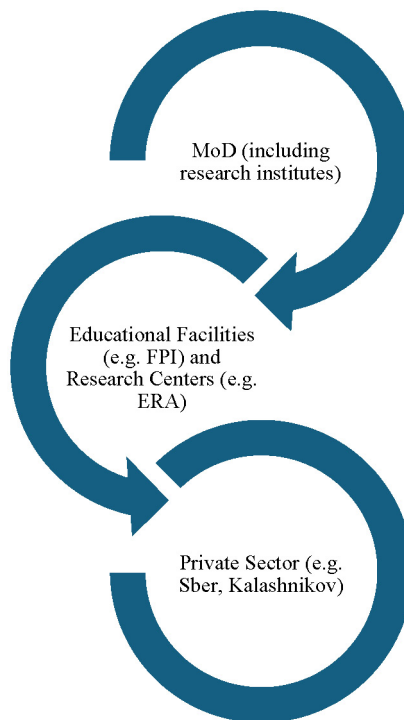
¹⁸¹ M. Sineva, "Gendirektor FPI: Grigoriev: Segodnya Realizuem Bolee 20 Krupnykh Nauchno-Tekhnicheskikh Proektov," *TASS*, (2023.02.01). <https://tass.ru/interviews/16919605>.

¹⁸² RIA Novosti, (2019.02.20). Op. Cited.

Approximately 3,000 highly qualified specialists have been involved in these efforts. These teams operate independently of the FPI and contribute to Russia's technological sovereignty.¹⁸³⁾

To effectively recruit the best personnel in the field of AI, FPI holds competitions at what is known as the Russian Silicon Valley, namely, the Skolkovo Start-up Village. In 2019, for instance, an IT company “Infosistemy Djet” became one of the contest's winners by developing a system based on a neural network to identify network attacks.¹⁸⁴⁾

The structure of AI governance is depicted below:



[Figure 2–1] Relationship between the MoD, educational facilities and private sector

¹⁸³⁾ Sineva, (2023.02.01) Op. cited.

¹⁸⁴⁾ Infosistemy Djet, “IT-Kompaniya «Infosistemy Djet» Postroila Neyroset’ Vyyavlyayushhuyu Setevye Ataki dlya Fonda Perspektivnykh Issledovaniy,” *Infosistemy Djet*, (2019.06.18). <https://jet.su/press-center/news/it-kompaniya-infosistemy-dzhet-postroila-neyroset-vyyavlyayushchuyu-setevye-ataki-dlya-fonda-perspek/>.

Enhancing Cooperation for the Military AI

In 2020, to enhance cooperation with organizations such as Rosatom, the MoD streamlined the processes for reviewing, accepting, and implementing prospective projects relevant to the interests of the MoD and the Armed Forces. This optimization, encompassing the entire innovation lifecycle, allows organizations to propose projects to the MoD or enables the military command authority to independently identify projects of interest. Within this lifecycle, Technopolis ERA and the Defense Commission hold crucial roles: ERA is responsible for testing the results of prospective projects, while the Defense Commission focuses on organizing the implementation of these projects.¹⁸⁵⁾

The central role of ERA as an innovator and hub for private-public cooperation should be duly noted. In 2021, for instance, ERA has been developing algorithms for autonomous control of (copter-type) UAVs in unknown environments, including an automatic landing system for UAVs to be used in contested environments. To this end, ERA cooperated with the private sector. For instance, “Element” and “STC” companies have been conducting tests of a mobile information platform “QUARTZ” based on the Russian operating system “Aurora.” Yet another innovation by ERA scientists was the development of software for preparing data for training neural networks (e.g., for generating all-angle images of military equipment).¹⁸⁶⁾

Further, the MoD and its departments (such as GUR) dedicated to innovation hold regular competitions to promote innovations and benefit from the newest technologies. For instance, in January 2024, the MoD held a competition entitled “Breakthrough into the Future” (*Proryv v Budushhee*) directed at representatives of research and educational organization of the MoD and scientific research companies of the Armed Forces.¹⁸⁷⁾ The MoD also implements job fair initiatives

¹⁸⁵⁾ Ministry of Defense, “Realizatsiya Innovativnykh Proektov,” *Ministry of Defense*, retrieved from <https://mil.ru/innovacia/razrabotki/glider.htm> on 2024.06.26. ,

¹⁸⁶⁾ Sosnitsky, (2021.04.19). Op. cited.

¹⁸⁷⁾ Ministry of Defense, “V Minoborony Rossii Proidet Konkurs Innovatsionnykh Proektov “Proryv v Budushhee”,” *Ministry of Defense*, (2024.01.18). <https://mil.ru/more.htm?id=12496468@egNews>.

for employees of Technopolis ERA. This initiative allows them to further develop their skills by choosing to work with organizations within Russia's military-industrial complex, ensuring continuous skill enhancement.¹⁸⁸⁾

In addition to these efforts, in September 2022, the Kremlin established a National Center for the Development of AI (*Natsional'nyi Tsentr Razviniya Iskusstvennogo Intellekta*).¹⁸⁹⁾ While this Center is dedicated to civilian applications of AI, it is possible for the MoD, as noted, to tap into the Center's resources if necessary.

How to apply AI technology to the military (process or structure in the militarization of AI technologies)

Before discussing the applications of AI in military systems it should be noted that several military writings on the topic point out definitional issues, trying to establish a viable framework for understanding military AI as to facilitate integration. For instance, E. V. Zabegalin from the 4th Central Research Institute of the MoD, notes that the integration of AI into Russia's military requires strong regulatory oversight, but unclear definitions of terms like "AI" and "robot" at the governmental level hinder effective regulation. Precise definitions, especially in the military domain, are, therefore, needed.¹⁹⁰⁾ One of the solutions suggested by the author includes the classification of military AI by technical types:

- AI integrated into automated control systems (ACS) for military purposes (MP);
- AI integrated into information systems (IS), information and calculation systems (ICS), and hardware-software complexes (HSC) for MP;
- AI integrated into robotic complexes and systems (RC and RS) for MP;

¹⁸⁸⁾ Department of Information and Mass Communication of the MoD, "Na Vystavke "Den' Innovatsiy v Voennom Innovatsionnom Tekhnopolise ERA" Otkryta Yarmarka Vakansiy Dlya Molodykh Uchenykh," *Ministry of Defense*, (2024.04.28). <https://mil.ru/more.htm?id=12465593@egNews>.

¹⁸⁹⁾ National Center for the Development of AI, "NCPII," retrieved from <https://ai.gov.ru/ncpii/> on 2024.06.26.

¹⁹⁰⁾ E. V. Zabegalin, "K Voprosu ob Obosnovanii Termina "Voennyi Iskusstvennyi Intellekt," *Sistemy Upravleniya, Svyazi i Bezopasnosti*, no. 1 (2022): 141-142, <https://sccs.intelgr.com/archive/2022-01/06-Zabegalin.pdf>.

- AI integrated into other models, complexes, and systems of military equipment that are neither ACS MP, nor IS, ICS, and HSC MP, nor RC and RS MP;¹⁹¹⁾

A further classification includes military AI divided into purposes of military equipment:

- AI integrated into weaponry;
- AI integrated into support equipment for combat operations that is not weaponry;
- AI integrated into equipment for information warfare;
- AI integrated into equipment for testing ranges;
- AI integrated into training equipment;
- AI integrated into IS, ICS, HSC for military education;
- AI integrated into IS, ICS, HSC for military science.¹⁹²⁾

Similar issues with definition were pointed out by Sidorin and Bezrodnyi. To successfully integrate AI into military systems, the authors suggest the following categorization of “military” AI: weak AI designed to solve specific problems in a limited context; strong AI capable of addressing a wide array of issues across different contexts; and super AI capable of outperforming human cognition *across all tasks and contexts*. These types correspond to different levels of cognitive tasks, namely, information perception, comprehension (decision-making), and action (implementation).¹⁹³⁾

One of the proponents of using AI in the military domain, Major General Vasilii Burenok, the head of the 46th Central Research Institute of the MoD,¹⁹⁴⁾ has, too,

¹⁹¹⁾ Ibid.

¹⁹²⁾ Ibid.

¹⁹³⁾ A.S. Sidorin and A.N. Bezrodnyi, “Perspektivy Primeneniya.”

¹⁹⁴⁾ Ministry of Defense, “Burenok Vasilii Mikhailovich,” <https://structure.mil.ru/management/info.htm?id>

grappled with the definitional issue of AI. In his article in *Voennaya Mysl'* published in 2021, he tried to distinguish between AI and automation, arguing that combat situations are inherently unique and unpredictable, making it difficult to develop universal algorithms for troop control. As a result, automation is mainly used to provide initial data for commanders' decision-making processes. Nevertheless, both automated control systems and AI are increasingly being applied to a broader range of military functions beyond just troop and weapon control. Some of the key areas, according to him, include:¹⁹⁵⁾

[Table 2–1] Areas of Application of Military AI adapted and condensed from Burenok's list

Area of Application	Task Description
Military Construction Management	Overseeing the development and organization of military infrastructure.
Combat Readiness and Weapon Systems Development	Ensuring military units are prepared for operations and advancing weapon technology.
Operational Management	Managing equipment, troops, and formations in wars and conflicts.
Logistics	Coordinating supply chains and resource allocation
Infrastructure Monitoring	Coordinating supply chains and resource allocation.
Autonomous Weapons and Robotics	Developing autonomous and semi-autonomous robotic systems.
Intelligence and Surveillance	Gathering and processing information for operational support.
Command and Control	Enhancing decision-making and command execution during battles.
Research, Design and Development	Innovating new military technologies and equipment; Analyzing technical data to identify future weapon trends.
Information and Cyber Security	Engaging in cyberattacks, defending against cyber threats, and conducting information warfare.
Information Integration	Creating a comprehensive battlefield picture, analyzing enemy actions, and planning troop movements.
Predictive Analysis	Forecasting military-political situations and hostile actions through data analysis.
Maintenance and Supply	Planning for equipment upkeep and supply chain management.

=10333707%40SD_Employee date accessed May 5, 2024.

¹⁹⁵⁾ Vasili M. Burenok, "Iskusstvennyi Intellekt v Voennom Protivostoyanii Budushchego," *Voennaya Mysl'*, (2021) no. 4, 107-109. Similar areas of application are suggested by Nikitin and Shumilov in "Proryv v Boevoi Effektivnosti."

AI in military affairs is increasingly seen as crucial for enhancing capabilities across various domains, according to Burenok. It can be utilized in self-learning systems to analyze and predict geopolitical developments, assess threats, estimate the likelihood and methods of enemy attacks, evaluate potential damage to infrastructure and forces, and guide the development of the Armed Forces and weapons systems. More specifically, Burenok stresses the need for developing intelligent information systems for real-time situation assessment and combat control, multi-agent modeling for evaluating military equipment effectiveness, and systems for processing unstructured scientific and technological data. Accordingly, priority areas should include AI-driven systems for threat classification and target identification, group control technologies for robotic units, particularly in managing “swarms” of UAVs across various domains – which have already been developed and tested as discussed in the previous section – and systems for optimal target distribution that enable rapid and adaptive responses to enemy threats in real-time.¹⁹⁶⁾

Another area of priority as pointed out by Sidorin and Bezrodnyi is EW. They argue AI extends beyond the traditional scope of automated command and control systems, where AI primarily supports auxiliary calculations and information exchange. Instead, AI's ability to handle repetitive cognitive tasks previously managed by human operators can significantly enhance the efficiency and accuracy of EW operations. The integration of AI at all levels of EW is presented as crucial for increasing combat effectiveness, minimizing troop losses, and ensuring command superiority in current and future conflicts, including multi-domain, network-centric, hybrid, and “mosaic” warfare.¹⁹⁷⁾

Closely related to EW is the use of AI in information operations. Indeed, AI can be an asset in information operations, as noted earlier, this area remains little discussed in Russian military literature, from the perspective of how the Russian military could utilize AI for information operations.

¹⁹⁶⁾ Ibid. pp.111-112.

¹⁹⁷⁾ Sidorin and Bezrodnyi, (2021) Op. cited.

Overall, as noted in the previous section, in Russia, AI development is most prominent in military command and control systems for centralized planning and coordination across various domains, including air, space, sea, ground, cyber, and electromagnetic fields. AI-integrated weapon control systems are extensively utilized in missile defense (BMD) and air defense to accelerate data processing from aerospace control and missile warning systems and automate defense equipment management. For instance, radar stations employ AI to detect and classify military objects, including small targets. The Russian Aerospace Forces use an operational-tactical automated control system with AI to manage S-300 and S-400 complexes, Pantsir anti-aircraft systems, and other airspace control equipment to analyze real-time situations, identify target parameters, and propose solutions.¹⁹⁸⁾

Additionally, AI is used in robotic systems both on and off the battlefield. Examples include UAVs (e.g. Okhotnik), autonomous ground vehicles (e.g., Uran-9), and autonomous surface and underwater vehicles (e.g., Poseidon which is also nuclear-capable).¹⁹⁹⁾ Military logistics systems also benefit from using neural networks to optimize delivery routes and manage stocks of ammunition and materiel, thereby reducing supply time and costs. One example is the KamAZ-5350 unmanned truck.²⁰⁰⁾ And, as noted, several EW systems are now equipped with AI.

It appears, thus, that the Russian military in collaboration with the private sector has managed despite the earlier discussed issues to integrate AI into a number of military systems. This integration was perpetuated by the war in Ukraine which gave the military the possibility to test and refine systems as well as gather vital battlefield data for training and refining AI algorithms used in

¹⁹⁸⁾ A. Nikitin and V. Shumilov, "Proryv v Boevoi Effektivnosti," *Armeiskii Sbornik*, (2024.05.23) no. 5, <https://army.ric.mil.ru/Stati/item/577042/>; N. P. Romashkina, "Iskusstvennyi Intellekt dlya Voyny i Mira: Podvodya Itogi Goda," *IMEMO*, (2023.12.25). <https://www.imemo.ru/publications/policy-briefs/text/artificial-intelligence-for-war-and-peace-summing-up-the-year>.

¹⁹⁹⁾ Ibid.

²⁰⁰⁾ Nikitin and Shumilov, (2024.05.23) Op. cited.

military equipment. Overall, the integration of AI has been both horizontal and vertical with strategic-level autonomous weapons (*Poseidon*) and early-warning systems as well as operational and tactical-level integrations, including logistical systems and UAVs.

4) The Educational innovation for future AI warfare: Talent Ecosystem

At the time of writing, educational adjustment remains a key topic in Russia to further AI research (see Government Initiatives, Investments and Infrastructure). The discourse related to AI in education relates to two aspects. The first deals with improving education by integrating AI into the educational system.²⁰¹⁾ The second aspect is focused on education related to creating and using AI tools. While the earlier aspect focuses on both schools and universities, the latter relates mostly to university education.

In order to better appreciate this necessity for educational reforms, it should be noted that technical education has always played a prominent role both in the Soviet Union and later in Russia.²⁰²⁾ In this context, the focus on technical education with the focus on AI started already in 2012. One particular research foundation – the Russian version of DARPA – FPI has been actively collaborating with higher education institutions. In 2020, institutions affiliated with the Ministry of Education and Science, alongside universities, participated in implementing one-third of the FPI's projects. These included participants from leading enterprises from both the military-industrial complex and civilian sectors, as well as universities, including Saratov State University, Southern Federal University, National Research University MIPT, Bryansk State Technical

²⁰¹⁾ See Iskusstvennyi Intellekt v Rossiiskoi Federatsii, "Obrazovaniye," *ai.gov.ru*, n.d., retrieved from <https://ai.gov.ru/ai/education/> on 2024.08.21.

²⁰²⁾ See, for instance, Brian Simon, "Polytechnical education in Soviet schools," *The Vocational Aspect of Secondary and Further Education*, (1954) Vol. 6, no. 12, 3-13. DOI: 10.1080/03057875480000011; V. S. Smirnov, "Advanced Technical Education in The Soviet Union," in *Employment Problems of Automation and Advanced Technology*, ed. J. Stieber (London: Palgrave Macmillan, 1966), 237-253. https://doi.org/10.1007/978-1-349-00444-7_16.

University, and MSTU Bauman. This collaboration has resulted in significant breakthroughs in several initiatives. FPI's strategic focus on university collaboration has proven highly effective, demonstrating the value of integrating academic research with applied technological development.²⁰³⁾

Such cooperation between the public and private sectors in terms of education remains critical. When it comes to the impact of education on the development of military AI, there is a recognition that the successful development of AI lies in enhancing collaboration with lead military and special equipment designers, technology leaders, and the broader scientific community, including academic and industrial research institutions, higher education, and leading defense industry enterprises.²⁰⁴⁾ Similar line of thinking was shared by General Osadchuk in his 2023 interview related to a 2023 Congress dedicated to AI, stressing the importance of exploring the integration of AI into the education system, the role of national platforms and frameworks in training, and the developmental pathways for AI specialists as to establish the necessary competencies required for specialists to effectively contribute to the advancement of AI in the country – including military AI.²⁰⁵⁾

At the government level, in 2020, the Russian government launched an AI development project as part of the “Digital Economy” national program – which was meant to end in 2024. The project was launched in 2021 (Decree of the Government of the Russian Federation of May 21, 2021 No. 767). The project outlined measures to support AI development companies and their partners, enhance domestic AI solutions, improve educational and scientific frameworks, and build infrastructure to facilitate domestic AI advancement. In 2024, the integration of the AI project into the national data economy initiative was extended until 2023 by a Presidential decree.²⁰⁶⁾ While this initiative includes

²⁰³⁾ Emelyanekov, “Fond.”

²⁰⁴⁾ Sineva, (2023.02.01) Op. cited.

²⁰⁵⁾ Ministry of Defense, “Interviyu Nachal’nika Glavnogo Upravleniya Innovatsionnogo Razvitiya Ministerstva Oborony Rossiiskoi Federatsii General-Mayora A. V. Osadchuka po Tematike MFTF “Armiya-2023,” *Ministry of Defense*, (2023). <https://mil.ru/army2023/statements/more.htm?id=12468862@egNews>.

aspects other than education, it would have an impact on the educational sector and promote further collaboration between universities and the private sector, offering grants for joint research.²⁰⁷⁾ For instance, in 2024, Alexey Levchenko, Deputy Director of the Department of State Policy in Higher Education at the Ministry of Education and Science, stated that approximately 90 AI specialist training programs had been developed across 16 universities. Additional programs are anticipated to be established as part of the federal project “Iskusstvennyi Intellekt,”²⁰⁸⁾ although no exact timeline has been provided.

Already in 2023, the Russian government initiated a series of reforms in the educational sector to further integrate AI into higher education as well as foster education of AI professionals with the inclusion of digital education programs to broaden the pool of students, enabling remote education.²⁰⁹⁾ Further, innovative solutions have been introduced to decrease the load on university teachers. For instance, scientists created a virtual computer science teacher in collaboration with Bauman Moscow State Technical University and the Moscow Institute of Physics and Technology. This AI-based “teacher” helps assess student skills, analyze code (in various programming languages), and suggest learning paths.²¹⁰⁾ The success of these initiatives is, however, too early to assess and will depend on how effective the reforms will be implemented as well as how much financing will be allocated to these.

Lastly, Moscow does not only focus on domestic efforts to enhance AI

²⁰⁶⁾ Rostransnadzor, “Do 2030 Goda Budet Prodlen Federal’nyi Proyeckt po Razvitiyu II,” *Rostransnadzor*, (2024.02.19).<https://rostransnadzor.gov.ru/news/5950>; TASS, “V Rossii Federal’nyi Proyeckt Po Razvitiyu II Prodlevayetsya do 2030 Goda,” *TASS*, (2024.02.15). <https://tass.ru/obschestvo/20000485>.

²⁰⁷⁾ Iskusstvennyi Intellekt v Rossiiskoi Federatsii, n.d. Op Cited.

²⁰⁸⁾ Dmitry Bevza, “Kak Iskusstvennyi Intellekt Menyaet Obuchenie v Shkole I Universitete,” *Rossiiskaya Gazeta*, (2024.01.31) <https://rg.ru/2024/01/31/kak-iskusstvennyj-intellekt-meniaet-obuchenie-v-shkole-i-universitete.html>.

²⁰⁹⁾ J. Dunaeva, “Artificial Intelligence: Features of Russian Digital Education Strategy,” in *Proceedings of Topical Issues in International Political Geography*, ed. R. Bolgov, et al (Springer, Cham: Springer Geography, 2024), 329-337. https://doi.org/10.1007/978-3-031-50407-5_27.

²¹⁰⁾ Ivan Chernousov, “Uchitel’ Koda: V Rossii Sozdali Virtual’nogo Prepodavatelya-Programmista,” *Izvestiya*, (2023.12.06). <https://iz.ru/1615704/ivan-chernousov/uchitel-koda-v-rossii-sozdali-virtualnogo-prepodavatelya-programmista>.

education. Instead, it also collaborates with countries like China. In 2024, for instance, both countries conducted a seminar on AI education and the promotion of AI talents at the university level. This event was the first of its kind, featuring some of the key educational facilities and private AI players, such as ITMO University, Tsinghua University (one of China's leading universities), Yandex, Sber, and Gazprom Neft.²¹¹⁾

All in all, there is an increased focus on integrating AI into the educational sector as well as cooperation between private and public sectors as well as international cooperation related to the optimization of educational programs. Despite the issues outlined in an earlier section, the Russian government appears to be making advances in terms of education, however, it is difficult to assess what impact it has on military AI despite the recognition of the importance of government initiatives, including financing discussed earlier in this chapter.

5) The discourse and strategy for the “human in the loop”

Ethical concerns for the use of AI in general are reflected in Russia's legislature and guidelines on the research and development of AI. Thus, in the civilian sphere, there is a clear recognition of stages during which AI could present potential risks.

In 2021, for instance, Russia's Federal Agency for Technical Regulation and Metrology, Rosstandart, created a national standard on AI to ensure trust in the system as well as the quality of AI systems being developed.²¹²⁾ This standard the Code of Ethics in the Sphere of AI (*Kodeks Etiki v Sfere II*) – has thus been signed by the largest Russian IT companies, however, it remains advisory in nature.²¹³⁾

²¹¹⁾ Marina Belyaeva, “Mass & Quality: How Russia and China Transform Education With AI,” ITMO News, (2024.01.24). <https://news.itmo.ru/en/education/cooperation/news/13589/>.

²¹²⁾ Rosstandart, (2021.03.01) *Natsional'nyi Standart Rossiiskoi Federatsii, Sistemy Iskusstvennogo Intellekta. Spobosy Obespecheniya Doveriya*. GOST R 59276-2020 (Moscow: Standartinform.), <https://docs.cntd.ru/document/1200177291>.

²¹³⁾ Alena Svetunkova, “II v Zakone: Chto Takoe Etika Iskusstvennogo Intellekta,” *Izvestiya*, (2023.10.23). <http://www.izvestiya.ru/news/2023/10/23/etika-iskusstvennogo-intellekta/>.

By mid-2023, the agency created 61 different regulations on the use of AI in different fields, from navigation to aviation to medicine.²¹⁴⁾ While the various standards address an array of characteristics associated with AI, there is a lack of definition of military AI and a corresponding standard.

As far as military AI is concerned, of course, it could be argued that there might be an overlap given that private companies also partake in the development of AI for military purposes. Notwithstanding, no clear guidelines for military AI exist, at least not in the public domain. This has triggered some musings from military personnel and commentators. For instance, Aleksandr Losev, writing for the *Arsenal Otechestva*, suggests that, indeed, there could be a risk that an AI-based weapon could fire at friendly forces. However, such issues can be mitigated by introducing a “target library” as well as facial recognition and machine intelligence to limit AI actions. He further dismisses the potential concerns about AI-based systems being hacked by adversaries and misused given that AI could generate its own algorithms for self-protection.²¹⁵⁾ Losev, thus, does not see any ethical issues with military AI that could not be mitigated. The importance of using AI in the military sphere outweighs the potential ethical concerns, for “[t]he integration of AI into conventional weapons [would] act as a strategic deterrent alongside nuclear weapons...”²¹⁶⁾ As one western expert argues, ethical and moral concerns will not constrain Russia’s development of military AI and autonomous weapons systems – quite the opposite.²¹⁷⁾

A somewhat different view is held by the former Deputy Director of FPI and chairman of the Technical Committee for Standardization 164 (*Tekhnicheskiiy Komitet po Standartizatsii 164*) “Iskusstvennyi Intellekt,” Sergei Garbuk, who

ps://iz.ru/1585111/alena-svetunkova/ii-v-zakone-chto-takoe-etika-iskusstvennogo-intellekta.

²¹⁴⁾ See, Rosstandart, “Standarty po Napravleniyu “Iskusstvennyi Intellekt”, <https://www.rst.gov.ru/portal/gost/home/standarts/aistandarts> date accessed 2024.05.26.

²¹⁵⁾ Aleksandr Losev, “Voennyi Iskustvennyi Intellekt,” *Arsenal Otechestva*, (2017) no. 6(32), <https://arsenal-otechestva.ru/article/990-voennyi-iskustvennyi-intellekt>.

²¹⁶⁾ Losev, “Voennyi Iskustvennyi Intellekt.”

²¹⁷⁾ K. Zysk, “Defence Innovation and the 4th Industrial Revolution in Russia,” *Journal of Strategic Studies*, (2020). Vol. 44, no. 4, p.552. <https://doi.org/10.1080/01402390.2020.1856090>.

suggested that “wars” against AI based robots are from the realm of fantasy. However, Garbuk admits that there are several technological challenges in developing an AI based operator. One of these is the creation of a system that *must* have a value framework, allowing it to discern between good and bad without unnecessary moral dilemmas.²¹⁸⁾

Notwithstanding the seeming optimism regarding the integration AI into military equipment as far as ethical matters are concerned, there is a recognition that AI could potentially pose ethical and legal issues, especially, concerning the International Humanitarian Law (IHL).

For instance, as early as 2016, Russian military experts, talking about third-generation combat robots, i.e., autonomous robots with elements of AI, pointed out a number of risks including intentional or accidental loss of communications and hijacking of control²¹⁹⁾ – contradicting Losev’s position. Thus, they argue that there need to be regulations in the area of control systems and cybersecurity of such systems. They also caution that combat robots would increase military potential, leading to a threat to the balance of power in various regions and increasing the risk of conflicts. Thus, there is a need to address these problems to avoid the outlined risks.²²⁰⁾ In 2021, Major General Burenok – a proponent of military AI – expanded the number of threats posed by military AI that require addressing.²²¹⁾ These explicit threats in relation to the compliance with core principles of IHL which include no harm to civilians, discrimination, and proportionality include:

- Responsibility, i.e., in case an AI-based system commits a war crime, it is impossible to establish a clear responsibility – a problem that remains unsolved.

²¹⁸⁾ RIA Novosti, (2015.05.29) Op cited..

²¹⁹⁾ Vadim B. Kozyulin and Albert R. Efimov, “Novyi Bond – Mashina s litsenziei na Ubiistvo,” *Indeks Bezopasnosti*, (2016) no. 1(116): pp.55-56. <https://pircenter.org/wp-content/uploads/2023/01/2016-SI-RUS-Kozyulin-Efimov.pdf>.

²²⁰⁾ Ibid. p.56.

²²¹⁾ Vasili M. Burenok, “Problemy Primeneniya Sistem s Iskusstvennym Intellectom v Voennom Dele,” *Izvestiya Rossiiskoi Akademii Raketnykh i Artilleriiskikh Nauk*, (2021). p. 3.

- Development of military AI by rogue states or terrorist organizations that do not subscribe to or respect IHL. This calls for the need to establish international agreements to prevent such developments and prosecute the responsible party.
- Unlike Garbuk, Burenok sees a risk of a potential attack on AI system which could result in the introduction of malicious code. He argues that there is no evidence that “strong” AI has the ability to fend off such attacks. Thus, there is a need to ensure that military AI is secure from potential hacker attacks.
- Given that AI systems have become more sophisticated, resembling human intelligence, there is a need to ensure safe operation of AI in adverse conditions, e.g., electronic warfare or physical damage which Burenok believes to be able to cause something akin to a “mental breakdown.”
- Advanced/“strong” AI’s ability to self-improve is a risk ipso facto if left unchecked. However, it is problematic to develop software-based or technical solutions that would create safe boundaries to limit AI’s self-improvement.
- Similar to Garbuk, Burenok is concerned with AI acting inhumanely, especially, towards adversary medical personnel, facilities, and/or vulnerable individuals (e.g., wounded or surrendering). Thus, there is a need to ensure that AI systems can distinguish between combatants and non-combatants in complex scenarios.²²²⁾

As one Russian legal expert suggests, there is no need to develop new international agreements,²²³⁾ especially given the lack of definitional consensus

²²²⁾ Ibid. pp. 4-5.

²²³⁾ Petr M. Morkhat, “K Voprosu o Sootvetstvi Avtonomnykh Intellekтуal’nykh Sistem Vooruzheniya Printsypam Mezhdunarodnogo Gumanitarnogo Prava,” *Vestnik Voennogo Prava*, (2018). no. 2: pp.58-65. <https://m>

and differing views as well as the complexities of legal processes. Instead, an additional protocol to the Convention on Certain Conventional Weapons (CCW) of 1980 – to which he refers as the Convention on “*Inhumane*” Weapons – could be adopted.²²⁴⁾ It is, however, unknown, to what extent the problems highlighted by Burenok are addressed at the national level. Notwithstanding the criticisms of Russia being “unethical” with lethal autonomous weapons systems (LAWs) – which would be AI-based – there exists a clear recognition of problems associated with AI-based systems, both lethal and non-lethal.

6) Conclusion

Russia’s development and integration of military AI into its weapons systems has seen mixed success. While there has been significant attention on education and R&D as well as collaboration with the private sector in this area, Russia still faces several critical challenges, exacerbated by the war in Ukraine since February 2022. Key issues include a “brain drain” that, while possibly reversible in the long term, continues to hinder short-term capabilities. More pressing, however, is the impact of sanctions, particularly on microelectronics imports, resulting in hardware shortages and excessive prices despite efforts to bypass restrictions.

Notwithstanding these challenges, Russia’s collaboration with the private sector has enabled notable progress in AI integration across various military systems. The war in Ukraine has provided valuable data for training AI algorithms, fostering innovations not only in military AI but also in robotics, such as UAVs, and EW. AI integration has occurred at the strategic, operational, and tactical levels, with ongoing advancements particularly evident at the latter two levels.

illaw.ru/uploads/2018/05/morhat.pdf.

²²⁴⁾ Ibid.

While obstacles, such as hardware limitations and sanctions, continue to slow comprehensive AI adoption across all levels, Russia's progress is notable due to its fewer ethical constraints on military AI development. Although military publications recognize the risks associated with AI, and there are regulatory frameworks for civilian AI, no such guidelines exist for AI in weapons systems. For now, however, it appears that human oversight remains part of the process, though this may evolve as technologies advance. Thus, all in all, Russia is well positioned to make advances in military AI, even if it might not be able to outperform its competitors, e.g., China.

3

Chinese AI Military Innovation

NATIONAL ASSEMBLY FUTURES INSTITUTE

Jungmi Cha

1) Introduction : China's Strong Military Dream and AI

China's Ambition for a Strong Military and the Pursuit of New-Quality Combat Capabilities

“Rich countries and strong military-these are the two cornerstones for the Chinese Great Rejuvenation.”²²⁵⁾ These are the Xi Jinping’s words on the strong military dream. It is a Chinese Dream of achieving the great rejuvenation of the Chinese nation by 2049 and China's armed forces include their dream of making the military strong as part of the Chinese Dream.²²⁶⁾ In the 19th CPC National Congress, Xi Jinping pledged to make sure that by 2020, the PLA will basically achieve its mechanization and informatization, and gain substantial improvement in strategic capabilities. Xi also set a midterm goal for the Chinese military-to complete the PLA’s modernization by 2035 as well as a long-term goal-to become a world class military power by 2050.²²⁷⁾

China has regarded technological advancement as the most critical factor in building world-class military forces. It has pursued the concept of “science and technology strengthening military power” (*keji qiangjun*). Xi Jinping stressed that “we must keep it firm in our minds that technology is the core combat capability,

225) 人民日报, “沿着中国特色强军之路阔步前进——党中央、中央军委领导推进国防和军队建设70年纪实。” (2019.09.28). <https://baijiahao.baidu.com/s?id=1645920941470993060&wfr=spider&for=pc>

226) 中华人民共和国国务院新闻办公室, “国防白皮书全文” (2015.5.) http://www.81.cn/dblj/2015-05/26/content_6507373.htm

227) China Daily, “PLA to be world-class force by 2050.” (2017.10.27.). http://www.chinadaily.com.cn/china/2017-10/27/content_33756453.htm

encourage innovations in major technologies, and conduct innovation independently.²²⁸⁾ The White Paper of "China's National Defense in the New Era" published in July of 2019 also emphasized that cutting-edge science and technology such as artificial intelligence, quantum information, big data, cloud computing, and the Internet of Things must be rapidly applied to the military field and the international military competition pattern is undergoing historic changes with a new round of scientific and technological revolution and industrial transformation. This defense white paper argued that the trend toward long-range, precise, intelligent, stealth and unmanned weapons and equipment is becoming more pronounced. It also noted that the informationized warfare has accelerated, and the intelligentized warfare is beginning to emerge.²²⁹⁾

With intensifying geopolitical competition and emerging technological breakthroughs, China has introduced the new terms on economic and military build-up, such as 'New Quality Productivity(*xinzhishengshanli*)' and 'New Quality Combat Capability(*xinzhizhandouli*).' Xi Jinping emphasized at the plenary meeting of the PLA and the Armed Police Force delegation at the Second Session of the 14th National People's Congress on March 7th 2024 that strategic capabilities in emerging fields are an important part of the national strategic system and capabilities.²³⁰⁾ The issues of "new-quality operational forces" and "new-quality combat capabilities" are currently key focal points and hot topics in theoretical research of the Chinese military. "New quality(*xinzh*)" refers to new domains, new forces, and the corresponding new capabilities emerging from areas such as space, cyber, deep sea, polar regions, intelligence, and unmanned systems.²³¹⁾ An article in the *PLA Daily* titled "Seek New Quality Combat

228) Xijingsping, "Secure a Decisive Victory in Building a Moderately Prosperous Society in All Respects and Strive for the Great Success of Socialism with Chinese Characteristic for a New Era." The Address of the 19th National Congress of the Communist Party of China. (2017.10.18.) http://www.xinhuanet.com/english/download/Xi_Jinping%27s_report_at_19th_CPC_National_Congress.pdf

229) 国务院新闻办公室.《新时代的中国国防》白皮书全文. (2019.07.24.). http://www.mod.gov.cn/regulatory/2019-07/24/content_4846424.htm

230) 中国新闻网, "习近平: 充分解放和发展新质战斗力," (2024.03.07) <https://baijiahao.baidu.com/s?id=1792873631676470316&wfr=spider&for=pc>

231) 解放军报, "从无人装备到智能算法, 解放军报整版关注'新质战斗力'" (2024.07.11.) <https://news.qq.com/rain/a>

Capabilities From Emerging Fields” stated that emerging fields are a relative concept that evolve continuously with technological advancements. Technologies such as AI, big data, blockchain, cyberspace, deep ocean exploration, and aerospace are considered emerging fields. They drive new, high-quality productive forces and accelerate the development of advanced combat capabilities. This suggests that these new combat capabilities are inextricably linked to what the PLA refers to as “informatization” and “intelligentization.”²³²⁾

Military intelligentization(*junshi zhinnenghua*) has been the key discourse in China’s strong military dream. In the report of the 19th National Congress of the Communist Party of China, President Xi emphasized the need to accelerate the development of military intelligence.²³³⁾ China’s preparation for future warfare emphasizes ‘AI+’ and highlights the construction of command systems based on new technologies such as ‘artificial intelligence algorithms’ and ‘big data’, as well as innovations in various aspects from military training to talent development.²³⁴⁾

Chinese PLA’s need for military intelligentization has been strongly reinforced by lessons learned from the Ukraine war. Insights are being drawn from both Russia’s failures and successes, shaping China’s development strategies for intelligent warfare. It is anticipated that China will enhance its information and intelligence-based military capabilities while strategically pursuing hybrid and gray zone warfare from a long-term perspective. Wang Haijiang, the commander of China’s Western Theater Command, emphasized the emergence of a new form of ‘hybrid warfare’ that intertwines military, political, financial, technological, network, and cognitive wars.²³⁵⁾ The editorials in the *PLA Daily* frequently

/20240711A016I500

232) Ying-yu Lin, “China’s AI-driven ‘new quality combat capabilities’ in the Taiwan Strait,” *Think China*, <https://www.thinkchina.sg/politics/chinas-ai-driven-new-quality-combat-capabilities-taiwan-strait> (2024.06.21).

233) 石纯民, “军事智能化时不我待.” 中国军网, (2017.12.11). http://www.81.cn/gfbmap/content/2017-12/11/content_193967.htm

234) 曾海清, “智能化时代呼唤训练向“智”转型,” 中国军网 国防部网, (2022.07.21.) http://www.81.cn/jfjbmap/content/2022-07/21/content_320291.htm

235) 正观新闻, “西部战区上将司令员汪海江: 依托一体化国家战略体系和能力提升战区备战打仗水平,” (2023.05.15). <https://baijiahao.baidu.com/s?id=1765923704686837773&wfr=spider&for=pc>

analyze the lessons of the Ukraine war from various angles, including intelligentization, unmanned systems, and cognitive warfare. An article in *PLA Daily* states that the Ukraine war demonstrates how artificial intelligence is progressively integrating with modern warfare. It suggests that artificial intelligence will play an immeasurable role in the military field in the future and will even have a profound impact on military transformation.²³⁶⁾

China argues that AI technology is a crucial support for enhancing strategic capabilities in emerging fields. It emphasizes the importance of deeply understanding artificial intelligence as a revolutionary technological force. China advocates for accurately identifying changes, responding scientifically, and proactively seeking transformations. It aims to explore strategies to win future wars and secure a strategic advantage in the rapidly evolving realm of intelligent warfare.²³⁷⁾ China has recognized the opportunities AI technology could provide for competing with US military capabilities and winning future wars.

2) Vision and Strategies of Chinese AI military Innovation

The report from the 20th National Congress of the Communist Party emphasizes the need to gain a good grasp of the characteristics of informatized and intelligent warfare and the laws that govern it, provide new military strategic guidance, and develop strategies and tactics for a people's war. It also emphasizes the need to establish a strong system of strategic deterrence, increase the proportion of new-domain forces with new combat capabilities, speed up the development of unmanned, intelligent combat capabilities, and promote coordinated development and application of the network information system.²³⁸⁾

²³⁶⁾ 澎湃新闻·澎湃防务, “俄乌冲突两周年 | 引发军事变革的武器和技术①: AI狂飙,” (2024.02.27). https://www.thepaper.cn/newsDetail_forward_26470186

²³⁷⁾ 曾海清, “解放军报刊文: 人工智能改变未来战争制胜机理,” 解放军报, (2024.05.02). <https://new.qq.com/rain/a/20240502A011W400>

²³⁸⁾ Central Committee of CPC, “Full text of the report to the 20th National Congress of the Communist Party of China,” (2023.08.23). <https://www.idcpc.org.cn/english2023/tjzl/cpcj/20thPartyCongrsshReport/>

China has outlined a new “three-step” development for China's national defense and military modernization which involves realizing the centennial goals of PLA by 2027, essentially achieving modernization of PLA by 2035, and constructing a world-class military force by the mid-21st century. The Chinese military emphasizes that achieving the centennial goals by 2027 is a critical milestone for reaching its long-term objective of becoming a world-class military power.²³⁹⁾

As a latecomer to military modernization, China is likely to pursue modernization through simultaneous rather than sequential stages. Recent official documents and articles increasingly use the term “quantum leap” (*kuayueshi fazhan*) to describe the PLA's modernization efforts. In the Communiqué of the fifth plenary session of the 19th Central Committee of the Communist Party of China in 2020, China emphasized accelerating integrated development in “mechanization,” “informatization,” and “intelligentization,” while comprehensively strengthening military training and preparation.²⁴⁰⁾

China believes it can leverage AI technology to narrow the gap between its military capabilities and those of the United States.²⁴¹⁾ China's *New Generation Artificial Intelligence Development Plan*, published in 2017, also emphasized promoting various AI technologies to be rapidly integrated into the field of national defense innovation. China's strategy of strengthening its military power is becoming more focused on the technological build-up and its dual use for military power and economic growth. This strategical focus is reflected in the government and military system for the military technology governance. *Strategy(zhanlvexue)*, published by the National Defense University of China in

²³⁹⁾ 人民日报, “确保如期实现建军一百年奋斗目标,” (2023.06.02). <https://baijiahao.baidu.com/s?id=1767556651813760259&wfr=spider&for=pc>

²⁴⁰⁾ Liu Caiyu, “China's centennial goal of building a modern military by 2027 in alignment with national strength: experts,” *Global Times*, 2020.10.31. <https://www.globaltimes.cn/content/1205238.shtml>

²⁴¹⁾ Gregory C. Allen. “Understanding China's AI Strategy.” *Center for a New American Security*. (2019.02.06.). https://www.cnas.org/publications/reports/understanding-chinas-ai-strategy?utm_medium=email&utm_campaign=Understanding%20Chinas%20AI%20Strategy%20White%20Paper%20Rollout%20Media&utm_content=Understanding%20Chinas%20AI%20Strategy%20White%20Paper%20Rollout%20Media+CID_eecdd0d32a84c74e153b8409074cd04e&utm_source=Campaign%20Monitor&utm_term=Read%20the%20full%20paper

2020, presented space warfare, cyber warfare, deep sea warfare, polar warfare, biological warfare, and intelligence warfare as emerging combat fields.²⁴²⁾ Intelligence warfare has been identified as a key domain for China's strategic preparedness to win the future warfare.

The concept of "winning the informatized local war" highlighted in China's 2019 Defense White Paper, has evolved recently to emphasize "informatized local war with intelligent characteristics" as intelligence elements are incorporated. Liu Lijiao and Tang Jian from the Chinese Naval Research Institute have analyzed that "maritime intelligent operations" are already beginning to emerge. They predict that unmanned and intelligent equipment systems will expand the scope of combat to include not only land, sea, and airspace operational theaters, but also allow for operations in deep sea, polar regions, and outer space. They emphasize the necessity of preparing for these developments, indicating a significant shift towards more advanced, diverse operational environments facilitated by rapid technological advancements in military capabilities.²⁴³⁾ The most fundamental change in intelligent maritime warfare is that unmanned swarming operations, combined manned-unmanned operations, and all-domain intelligent joint operations will become typical of maritime operations.²⁴⁴⁾ In 2023, the Central Military Commission of China published and distributed the book titled "*Xi Jinping Strong Military Thought Study Outline*" across the entire military. This study outline underscores the objectives of the new era to achieve strong military goals and emphasizes the comprehensive construction of the PLA as a world-class military force, aligning with the ongoing strategic advancements in military technology and capabilities.²⁴⁵⁾ The "Xi Jinping Strong Military Thought Study Outline" specifically clarifies the strategic guidelines for preparedness as

242) 环球时报, "中国发展空天一体战 是决定未来战争'胜负手'" (2014.04.22). <http://mil.news.sina.com.cn/2014-04-22/0857775441.html>

243) 刘丽娇, 唐剑. "海上智能化作战怎么打." 解放军报. (2021.04.29.) http://www.81.cn/bz/2021-04/29/content_10030358.htm

244) 中国指挥与控制学会. "关于未来智能化海战的思考." (2021.04.27). https://www.sohu.com/na/463233448_358040

245) 新华社, "经中央军委批准《习近平强军思想学习纲要(2023年版)》印发全军," (2023.08.01). <https://baijiahao.baidu.com/s?id=1773016661689703996&wfr=spider&for=pc>

focusing on the study of and preparation for "winning the informatized local war with intelligent characteristics."²⁴⁶

China is also expected to strengthen its A2/AD (Anti-Access/Area Denial) capabilities in preparation for intelligentized and informatized maritime local warfare. As information warfare and intelligent warfare become more prominent, the core of China's anti-access area denial strategy is increasingly focused on crippling and disrupting information systems. This approach has been identified as a primary strategic task. Liu Huaqing, in 1993, discussed the importance of information warfare and electronic warfare as demonstrated in the Gulf War, highlighting the necessity for advanced technology. At the same time, he noted that all advanced technological weapon systems have vulnerabilities and that methods can be found to counter these sophisticated weapon systems. This reflects a dual focus on leveraging advanced technologies while also developing strategies to exploit potential weaknesses in such systems.²⁴⁷

While China has placed a strong emphasis on military intelligentization and has made substantial investments in military technologies, there remains an acknowledgment that the country is not yet fully prepared and continues to face significant challenges. In a recent publication by PLA Daily, China highlighted the difficulties in achieving its centennial goals by 2027, emphasizing the challenges in fully integrating AI into military operations. Wang Xing, a brigade commander of the 81st Army Group, argues that the PLA's understanding of intelligent warfare is still based on some basic knowledge and shallow concepts due to the incomplete informatization transformation and the late start of intelligent transformation. He pointed out that there is insufficient research on intelligent-specific concepts and content such as deep learning, knowledge graphs, human-computer interaction, and mixed reality, making it difficult to develop strong practical guidance for the intelligent training of the troops. Wang

²⁴⁶ 习近平强军思想研究中心, “从学理上把握习近平强军思想的科学体系,” 光明网, (2024.01.04). https://news.gmw.cn/2024-01/14/content_37087338.htm

²⁴⁷ 刘华清, “坚定不移地沿着建设有中国特色现代化军队的道路前进,” 人民网, (1993.05.20). http://www.china.com.cn/guoqing/2012-09/12/content_26748029.htm

made a point that the most urgent need for the intelligent training transformation of the troops is to introduce concepts, popularize common sense, and provide guidance.²⁴⁸⁾

In light of perceived deficiencies within the Chinese People's Liberation Army (PLA) in the domain of artificial intelligence (AI) military competition, there has been an expedited impetus towards intelligentization. During the plenary meeting of the delegations from the PLA and the People's Armed Police Force (PAP) at the second session of the 14th National People's Congress, six military legislators deliberated on a range of topics, including the enhancement of defense capabilities within cyberspace, the integration of AI technologies, and the advancement of unmanned combat systems. Subsequent to the meeting, both lawmakers and political advisors from the PLA and PAP advocated for the pivotal integration of technology as the fundamental component of core combat capabilities, aiming to substantially augment strategic capacities in emerging sectors. Consequently, the Chinese military is compelled to advance technological innovations and their applications, promoting an effective technological provision that aligns with the requisites of new qualitative combat capabilities.²⁴⁹⁾ The discourse within military circles suggests a consensus that unmanned intelligent forces will predominantly shape future battlefields, and intelligent warfare will increasingly become the focal point of future military engagements.²⁵⁰⁾ This has prompted an ongoing transformation within the Chinese military in terms of force structure, technological advancements, weapon systems, and personnel development, all oriented towards preparing for intelligentized warfare.

²⁴⁸⁾ 王星, “加快推进军队智能化转型发展,” 中国科技网. (2023.08.08). <https://www.stdaily.com/index/kejixinwen/202308/1d5be9dc751a4765aa56188731b738ee.shtml>

²⁴⁹⁾ Liu Xuanzun “Chinese military aims to boost strategic capabilities in emerging areas such as AI, unmanned tech,” *Global Times*. (2024.03.10). <https://www.globaltimes.cn/page/202403/1308558.shtml>

²⁵⁰⁾ 王星, (2023.08.08). Op. cited.

3) Transformation of Chinese Military Organizations for Future AI warfare

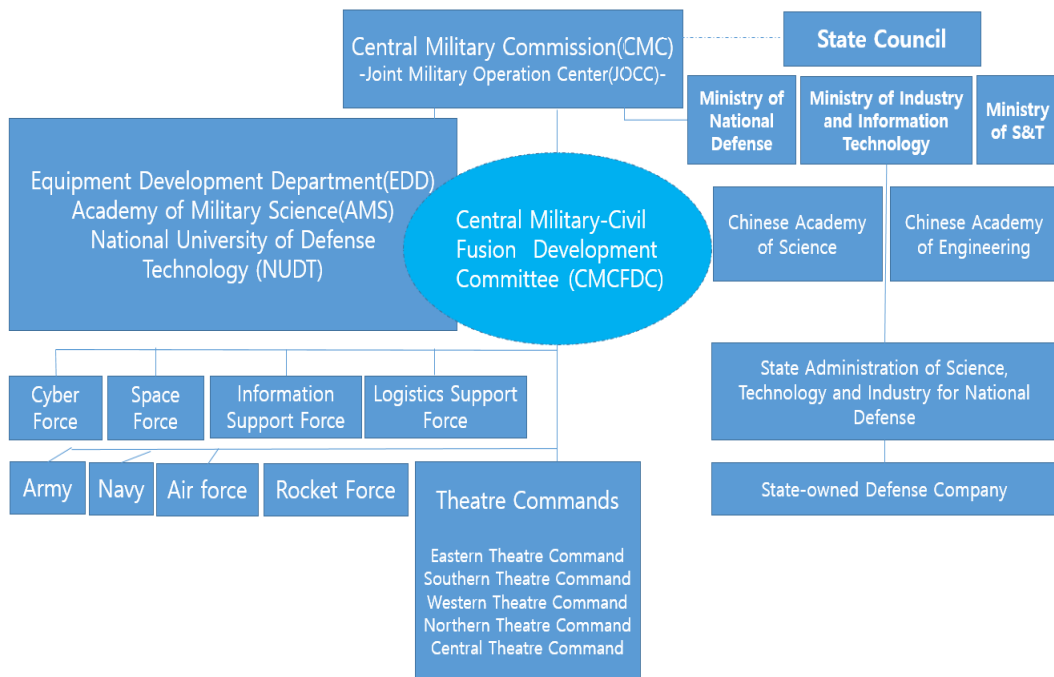
In the era of intelligence, Chinese PLA has been pursuing the transformation of military structures such as "human-machine intelligence". Facing intelligent warfare, the organizational form of the military has accelerated its transformation and evolution, demonstrating a new development trend. China will continue to develop its military organizations to achieve comprehensive transformation and adaptation in terms of structure, mechanisms, and functions, fully meeting the requirements of the future era of intelligent warfare.²⁵¹⁾ The limitations exhibited by the Russian military during the Ukraine War serve as pivotal lessons, prompting deeper reflection on China's capacity to effectively engage in and prevail in future conflicts. The structural modifications within the Chinese PLA, coupled with the integration of AI technologies, have not yet been clearly defined. Nevertheless, it is evident that there are ongoing investigations and modifications concerning military organization in response to the demands of intelligentized warfare.

Even if there are no noticeable changes in the PLA's organization directly related to AI military innovation, significant transformations are occurring within the PLA's command operations, equipment, and training. Enhancing intelligent and unmanned capabilities remains pivotal in Chinese military innovation. Intelligent technologies are being extensively applied across all phases of military operations—observation, judgment, decision-making, and action—with the goal of expanding operational ranges to include space, cyberspace, and distant seas. The process of intelligentization has been implemented across every military unit and various levels of command. 'Intelligent weapons' are recognized as crucial elements in establishing future military capacity. Artificial intelligence, exemplified by machine learning, is adept at detecting concealed elements in extremely complex battlefields.²⁵²⁾

251) 周慧, “军事论坛 | 智能化时代军队组织形态变革新趋势,” 中国军网-解放军报, (2024.06.18.). http://www.81.cn/xxqj_207719/xxjt/11/16323494.html

252) 齐磊, 田峰. “无人智能作战：改变海战的新引擎,” 学习时报, (2024.04.08). <https://baijiahao.baidu.com/s?id=17>

Recent changes in the Chinese military organization may be considered transformative measures to accelerate military intelligitization. In April 2024, China disbanded the PLA Strategic Support Force eight years after its establishment, reorganized the Cyber Force and Space Force, and newly established an Information Support Force. This Information Support Force may be considered as the representative unit tasked with transforming the PLA into an AI-centric military force. Its missions are not yet clearly defined. However, various open sources indicate that this unit is designed to handle the various tasks for intelligent warfare operations.



[Figure 3-1] Chinese Military Structure and Military Technology Eco system²⁵³⁾

95735920398727271&wfr=spider&for=pc
²⁵³⁾ This organizational chart is based on the author's analysis with reviewing the various of open source references.

China is making significant investments in AI for military purposes. China is planning to apply the AI technology for the military use in various ways. Even though there is no single unit with total responsibility for the development and application of AI military technology or AI-based operations, most units within the PLA have actively pursued military modernization through the application of AI technology. The structure of the Chinese PLA will keep in adjusting with the development of AI technology. The three forces—cyber force, space force, and information support force— are likely to play key roles in driving the PLA's intelligence- and information-based modernization under the guidance of the Central Military Commission.

4) Chinese Eco system for AI military S&T : Development and Security Integration (*fazhan-anquan tongchou*) and Military-Civil Fusion (*Junminronghe*)

The Chinese ecosystem for AI military technology has evolved to increasingly involve private actors and leverage civilian capabilities. Historically, the Chinese military has led many technological breakthroughs, including advancements in space and nuclear technology. With its vision of military intelligentization, the Chinese PLA has emerged as one of the key players in the development and application of AI technology in military fields. However, the current ecosystem for military AI is characterized by a more comprehensive and balanced military-civil fusion system. With the rise of civilian capabilities in AI technology, defense-related AI has been developed through diverse mechanisms that foster collaboration between the military and civilian sectors. Recognizing that breakthroughs in core technologies are essential for advancing military intelligence, China has been strengthening military-civil fusion to mobilize societal resources and enhance its military intelligence capabilities.²⁵⁴⁾ The PLA

²⁵⁴⁾ 肖天亮主编『战略学』, 国防大学出版社, (2020), 175-180.

has been sourcing AI systems from a wide array of vendors. According to research by the Center for Security and Emerging Technology (CSET), China has actively pushed to diversify the PLA's vendor base. By 2016, more than one thousand private companies had obtained research and production licenses, representing a 127% increase since the end of the 11th Five-Year Plan in 2010.²⁵⁵⁾

The military-civil fusion for the next defense technology has been the main task of Chinese defense strategy. In the report of the 19th National Congress of the Communist Party of China, Xi puts emphasis on the military and civilian integration and the mutual exchange of military technology and civilian technology.²⁵⁶⁾ The acceleration of military-civil fusion in China is driven by the recognition that AI is a crucial dual-use technology capable of driving future economic growth and military power. Xi Jinping has referred to these as "New Quality Productivities" (*xinzhi shengchanli*) and "New Quality Combat Capabilities" (*xinzhi zhandouli*). AI represents a key technology that serves both development (*fazhan*) and security (*anquan*), aligning with Xi Jinping's emphasis on integrating development and security as a central tenet of his statecraft. The importance of this integration is highlighted in *The Total National Security Paradigm: A Study Outline*, published in 2022 by the Central National Security Commission. This document underscores that development and security are like two wings of a bird or two wheels of a cart, emphasizing their interdependence. One of the Chinese Communist Party's core principles in governing China is the integration of development and security.²⁵⁷⁾

AI technology development has thus been prioritized for both military modernization and economic growth. Cheung (2018) described China under Xi

²⁵⁵⁾ Margarita Konaev, Ryan Fedasiuk, Jack Corrigan, Ellen Lu, Alex Stephenson, Helen Toner, and Rebecca Gelles, "U.S. and Chinese Military AI Purchases: An Assessment of Military Procurement Data between April and November 2020," *CSET*. (2023.08)

²⁵⁶⁾ 谢地, 荣莹. "新中国70年军民融合思想演进与实践轨迹." 『学习与探索』(2019.06). 11.

²⁵⁷⁾ Office of the Central National Security Commission (中央国家安全委员会办公室). *The Total National Security Paradigm: A Study Outline* 〈总体国家安全观学习纲要〉. (2022.04.14.). <https://www.strategictranslation.org/articles/chapter-five-uphold-the-integrated-planning-of-development-and-security-on-the-necessary-requirements-of-national-security-in-the-new-era>

Jinping as a "Techno-Security State" (TSS), a security-maximizing state that builds power and prestige on a robust economic and technological foundation. This concept aligns with China's strategy of prioritizing development efforts to meet national security demands, with a strong focus on cultivating strategic science, technology, and industrial capabilities.²⁵⁸⁾ Chinese AI military innovation serves as a prominent example of this Techno-Security State model. The country's military intelligence strategy can be characterized as a dual-use approach aimed at simultaneously bolstering military capabilities and driving economic growth

Within the frameworks of military-civil fusion and the integration of development and security, the Chinese defense AI ecosystem appears to be distributed across various key entities, including the PLA, state-owned defense industries, research institutes, private companies, and universities. While the Central Military Commission (CMC) oversees overall strategies for military intelligentization, several entities under its authority—such as the Equipment Development Department, the Academy of Military Science (AMS), and the National University of Defense Technology (NUDT)—along with individual branches of the military, including the Army, Navy, Air Force, Space Force, Cyber Force, and Information Support Force, have been actively engaged in diverse AI-related acquisitions and research and development (R&D). These efforts also involve innovating their respective missions and organizational structures to adapt to advancements in AI technology.

China established the Central Commission for Integrated Military and Civilian Development (CCIMCD) in 2017. In the same year, the Chinese government issued "Opinions on the Deeper Integration of Civil-Military Fusion in the Defense Science and Technology Industry."²⁵⁹⁾ Subsequently, on March 2, 2018, Xi Jinping chaired the third meeting of the CCIMCD, where he emphasized the

²⁵⁸⁾ Taiming Cheung. "China's Rise as a Global Military Technological Power: Geo-Strategic and Geo-Economic Implications." (2018). https://chairestrategique.univ-paris1.fr/fileadmin/chairestrategiesorbonne/Conference_2018/Documents/Tai_Ming_Cheung_-_Chaire_des_Grands_Enjeux_Strategiques_2018.pdf

²⁵⁹⁾ 国务院办公厅. "国务院办公厅关于推动国防科技工业军民融合深度发展的意见" (2017.12.04.). http://www.gov.cn/zhengce/content/2017-12/04/content_5244373.htm

strategic importance of "unifying" (*yitihua*) national power by reducing barriers between the commercial economy and the defense industrial base.²⁶⁰⁾

The 2016 PLA reforms also initiated significant organizational restructuring to align with the goals of military intelligentization and information warfare. As part of these reforms, the Academy of Military Science (AMS) and the National University of Defense Technology (NUDT) underwent reorganization. AMS established eight new research institutes, including the National Defense Engineering Research Institute, the Systems Engineering Research Institute, and the National Defense Science and Technology Innovation Research Institute.²⁶¹⁾ Among these, the National Defense Science and Technology Innovation Institute (NDS&T Innovation Institute) is tasked with advancing new defense strategies. Under the NDS&T Innovation Institute, five specialized research centers have been established, including the Artificial Intelligence Research Center and the Unmanned Systems Technology Research Center.²⁶²⁾ This institute plays a leading role in fostering research collaborations with civilian sectors, bridging the gap between military and civil innovation.²⁶³⁾

There are AI military-related entities operating under the National Administration (*Guowuyuan*). The Ministry of Science and Technology, in collaboration with the Science and Technology Commission of the Central Military Commission, released the "*Special Plan for the Integration of Military and Civilian Development under the 13th Five-Year Plan*." This plan outlined measures to promote the integration of science, technology, and defense, focusing on enhancing national defense and military modernization while driving technological innovation.²⁶⁴⁾

²⁶⁰⁾ Lorand Laskai. "Civil-Military Fusion and the PLA's Pursuit of Dominance in Emerging Technologies." *The Jamestown Foundation*. (2018.04.09). . <https://jamestown.org/program/civil-military-fusion-and-the-plas-pursuit-of-dominance-in-emerging-technologies/>

²⁶¹⁾ 晨阳新闻资讯. "新组建的军事科学院下属八个研究院全部亮相." (2018.10.11). <http://www.chenyang88.com/mil/152967.html>

²⁶²⁾ 工信人才网. "军事科学院国防科技创新研究院." 企业简介 <http://www.miitjob.cn/company/company-show.php?id=7122>

²⁶³⁾ 中国军网. "军科院国防科技创新研究院多措并举集聚顶尖人才." (2018.02.04). http://www.81.cn/jwgz/2018-02/04/content_7931564.htm

China established the State Administration of Science, Technology and Industry for National Defense (SASTIND) under the Chinese Ministry of Industry and Information Technology in 2008. SASTIND's responsibilities extend to the coordination and promotion of the development of defense technology and oversee the state-owned defense industries. SASTIND was originally under the Chinese Central Military Commission, but after the government reform in 2008 it moved to the ministry of industry and information technology. This shows that the military industry and technology are more integrated into the civil side.

State owned Defense Industries have played an important role in innovating the AI technology. On June 9th 2023, a subsidiary of the China Electronics Technology Group Corporation (CETC) officially launched its latest generative artificial intelligence model, "Xiaohe." Designed to support special scenarios and assist in decision-making processes, the AI model Xiaohe aims to digitize Chinese government entities and enterprises.²⁶⁵⁾ CETC is also responsible for the network security and information technology. The China Aerospace Science and Technology Corporation (CASC) has been expanding the military technology related to the UAV.²⁶⁶⁾ The Aviation Industry Corporation of China (AVIC) is the most dominant provider of military UAV systems in China and an important supplier of industrial UAV systems.²⁶⁷⁾ AVIC established the UAV System Co. in 2018. It aims to improve R&D and manufacturing strength and system integration services to create a new era, as a world-class UAV system specialization company.²⁶⁸⁾ Similarly, the China Aerospace Science and Industry Corporation (CASIC) has increased its focus on AI technology. CASIC Intelligent Robot Co. was formally

264) 军委科学技术委员会, "十三五 科技军民融合发展专项规划." (2017.08.23). http://www.mod.gov.cn/topnews/2017-08/23/content_4789729.htm

265) 中国电科, "中国电科发布生成式人工智能大模型"小可," (2023.06.10). <https://mp.weixin.qq.com/s/jxqAGaYATlW6nQu1Cz7myQ>

266) 国家国防科技工业局. (2018.06.06). "中国"彩虹"无人机飞上"世界屋脊" <http://www.sastind.gov.cn/n127/n209/c6801808/content.html>

267) The Aviation Industry Corporation of China. "Military Aviation and Defense-Unmanned Aerial Vehicles." <http://www.avic.com/en/forbusiness/militaryaviationanddefense/unmannedaerialvehicles/index.shtml>

268) 国家国防科技工业局. "中航(成都)无人机系统股份有限公司成立." (2018.12.16) <http://www.sastind.gov.cn/n112/n117/c6804942/content.html>

established in 2015 to advance the integration of AI into its operations.²⁶⁹⁾

These state owned defense corporations have led diverse collaborative research with universities. CASIC and Tsinghua University signed strategic cooperation agreements for cooperation on the next generation of information network systems, drone technology, and AI manufacturing.²⁷⁰⁾ CETC signed a strategic cooperation agreement with Beijing Normal University to deepen the cooperation in the fields of artificial intelligence.²⁷¹⁾ The open-source nature of foreign AI software has provided a platform for the People's Liberation Army (PLA) to advance its AI capabilities for military applications. PLA-affiliated experts have been optimizing Meta's Llama, the open-source AI model for military and security purposes. In the military domain, Llama is being studied to explore the potential for LLMs to support electronic warfare and self-defense jamming strategies, including by experts from the Aviation Industry Corporation (AVIC), one of the PRC's top defense conglomerates.²⁷²⁾

The development of AI military technologies in China has been primarily driven by PLA-affiliated entities, national research institutes, and government initiatives, with increasing engagement from private sector enterprises and Universities. This collaboration reflects a strategic emphasis on military-civil fusion as a practical framework for advancing the next generation of AI-driven military innovations.

²⁶⁹⁾ Jungmi Cha "China's RMA in 4th Industrial Revolution Era: Pursuing the Military Intelligence through the Civil-Military Integration," *National Security and Strategy* (2020), 20-1.

²⁷⁰⁾ 航天科工. "航天科工与清华大学签署战略合作协议." (2019.05.09.). <http://www.sastind.gov.cn/n112/n117/c6806262/content.html>

²⁷¹⁾ 中国电科. "中国电科与北京师范大学签署战略合作协议." (2019.01.30.). <http://www.sastind.gov.cn/n112/n117/c6805322/content.html>

²⁷²⁾ Sunny Cheung, "PRC Adapts Meta's Llama for Military and Security AI Applications," *The Jamestown Foundation*. (2024.10.31).

5) The Educational innovation for future AI warfare: MCF Talent Eco system

Chinese *PLA daily* argues that talent is the key factor in promoting the high-quality development of the PLA, winning military competition and taking the initiative in future wars. It emphasizes that China should firmly grasp the development trend of intelligent warfare, accelerate the leapfrog development of talent construction, and provide strong intellectual support for winning future wars.²⁷³⁾ Chinese newspaper *Guangming* also argues that in the “New quality combat capability”, people are still the most core, active and decisive subject. It says that new quality combat capability will inevitably give birth to and call for new military talents.²⁷⁴⁾ China has placed the cultivation of intelligent military talent as a top priority, essential for building a strong military through talent in the new era. China has emphasized that winning in intelligent warfare urgently requires military personnel to transition from a focus on physical and technical skills to one centered on knowledge and intelligence.²⁷⁵⁾

Experts at the Military Talent Development Research Center of the Academy of Military Sciences argue that China needs a comprehensive talent development plan that closely monitors the evolving trends of future warfare, which is expected to be increasingly unmanned and intelligent. They argue that the Chinese PLA should leverage practical platforms provided by local scientific research institutes, large enterprises, and institutions to conduct relevant training for military talent. These measures aim to enhance professional skills and advance literacy in cutting-edge science and technology.²⁷⁶⁾ The National University of Defense Technology (NUDT) was reorganized in 2017 to align with the goals of military intellectualization and informatization. AI defense

273) 余建明, “赢得智能化战争人才优势,” 解放军. (2024.04.25.). http://www.81.cn/yw_208727/16303418.html

274) 姬建春, “新质战斗力呼唤新型军事队伍,” 光明网24. (2024.07.27.). <https://baijiahao.baidu.com/s?id=1803866788734787681&wfr=spider&for=pc>

275) 中工网, “以智能化为方向加快军事人员现代化,” (2023.04.23). <https://www.workercn.cn/c/2023-04-03/7790029.shtml>

276) 吴志忠, 赵礼, 王达, “为充分解放和发展新质战斗力提供人才支撑,” 解放军报,. (2024.10.14). https://military.cnr.cn/jq/20241014/t20241014_526938649.shtml

technology has since become a central focus of its research and education efforts. NUDT's Institute of Intelligent Science serves as a representative unit for innovative education and research in this domain. The institute has established specialized units dedicated to advancing military intellectualization, including the Unmanned Systems Innovation Team and the Robotics Research Center.²⁷⁷⁾ It has also introduced new curricula, such as Intelligent Robot Systems, to support these initiatives.²⁷⁸⁾

Universities have played a pivotal role in cultivating AI defense talent. Northwestern Polytechnical University (NPU) has established a distinctive and independent training model for developing national defense science and technology professionals. NPU has designed over 400 national defense courses and has deeply integrated national defense and military education into its programs. Additionally, NPU has proactively introduced new undergraduate majors, including Flexible Electronics, Robotics Engineering, and Artificial Intelligence, to align with emerging defense needs. NPU has co-built talent training bases with more than 100 national defense and military industry institutes, established a multi-level, multi-type, and full-coverage practical training system for college students in military industry institutes.²⁷⁹⁾

In the era of AI-driven warfare, the distinction between military and civilian roles is increasingly blurred. China's "new quality combat capabilities" require not only the development of advanced combat talents but also the cultivation of skilled civilian professionals. The talent ecosystem for these capabilities operates on two key dimensions: the innovation of military education to develop new quality combat talents and the mobilization and training of civilian talent. This approach is grounded in the concept of Military-Civil Fusion (MCF), which extends beyond technological and R&D collaboration to encompass the training and exchange of expertise across military and civilian sectors.

277) 解放军报, “国防科技大学智能科学学院着力推进科技创新; 做新时代军事智能化发展的开拓者。” (2017.12.05.). http://navy.81.cn/content/2017-12/05/content_7855748.htm

278) 中国大学MOOC, “智能机器人系统_国防科技大学” <https://www.icourse163.org/course/NUDT-1205969803>

279) 中国新闻报, “西北工业大学着力构建特色鲜明的国防科技人才自主培养模式——铸国之重器 育国之栋梁”。 (2023.09.22.). https://www.sohu.com/a/722656246_121124030

China will work to establish uniform military and civilian standards for infrastructure, key technological areas, and major industries. It will explore methods for training military personnel in civilian educational institutions, developing weaponry and equipment through national defense industries, and outsourcing logistics support to civilian systems.²⁸⁰⁾ China has placed significant emphasis on developing training models for military-civilian integrated artificial intelligence (AI) science and technology talent. The country is committed to further strengthening the military-civil fusion system as a key strategy for educating and cultivating defense AI professionals.

6) The discourse and strategy for the human in the loop

China has demonstrated a dual approach to artificial intelligence (AI) in the military domain by emphasizing both technological advancements and the necessity of human oversight. Despite significant innovations in military intelligence and the automation of weapon systems, China is expected to maintain human control as a decisive factor on the battlefield, distinguishing its approach from that of other nations. Chinese President Xi Jinping highlighted this stance, stating: "On the issue of winning wars, people are the decisive factor. No matter how the conditions of the times develop or how warfare evolves, this will never change. Under intelligent conditions, humans remain in the central position and play a decisive role."²⁸¹⁾ This perspective aligns with the "Decision" of the Third Plenary Session of the 20th CPC Central Committee, which proposed improving the development and management mechanisms for generative AI and establishing an AI security supervision system. President Xi further emphasized adhering to a human-oriented approach, ensuring AI serves the greater good, and strengthening AI governance within the framework of the United Nations.²⁸²⁾

280) 新华社, “中国的军事战略.”. (2015.05.26.). http://www.mod.gov.cn/affair/2015-05/26/content_4588132_3.htm

281) 吴定平, 曹二刚, “智能化条件下军队党的领导和党的建设,” 中国社会科学网.. (2023.04.27.). https://www.cssn.cn/jssx/jsx_xxqj/202304/t20230427_5625373.shtml (accessed Oct 20, 2024)

282) 朱步樓, “堅持以人為本 引導智能向善: 提高人工智能安全治理水平,” 人民日報, (2024.08.25). <http://theory.people>.

The PLA Daily has also published warnings about the dangers of AI militarization, including the potential for combat robots to "reverse" their intended functions. These articles stress that AI designers, manufacturers, and users must adopt global, multi-dimensional, and forward-looking approaches to prevent unintended consequences.²⁸³⁾

Historically, China has emphasized the Communist Party's absolute control over the military and a centralized decision-making system on the battlefield. Under Xi Jinping, this centralized command system, led by the Central Military Commission, has been further strengthened. The PLA views the Party's leadership as the foundation and soul of its military. Regardless of technological or intelligence advancements, military organizations and personnel at all levels must remain under the Party's absolute leadership. This principle is fundamental to strengthening Party leadership and ensuring proper governance in the era of military intelligentization.²⁸⁴⁾ The Chinese PLA has emphasized the importance of political work and fundamental guarantee for the party to lead and control the army even in the AI military era.

In this context, the Chinese discourse of "human in the loop" can be interpreted as keeping "the party in the loop." The Chinese PLA has recently been forced include the Chinese theoretical and operational principle of 'Human in the loop (*renzaihuiru*)'. Chinese Military Eagle Think Tank published the column on the human in the loop in intelligent naval warfare. It argues that the development level of intelligent technology cannot meet the requirements of the fully autonomous mode of combat platforms, and the control mode of intelligent combat platforms cannot be separated from human operation and human assistance. It explains that no matter how future wars evolve, they all aim to achieve certain political intentions and are therefore still a confrontation

com.cn/BIG5/n1/2024/0805/c40531-40292548.html

²⁸³⁾ 北京日报客户端, "解放军报:警惕战斗机器人"反戈一击," (2024.03.26.). <https://baijiahao.baidu.com/s?id=1794546081885643650&wfr=spider&for=pc>

²⁸⁴⁾ 吴定平 曹二刚, (2023.04.27). "智能化条件下军队党的领导和党的建设," 中国社会科学网, April 27, 2023. https://cssn.cn/jsx/jsx_xxqj/202304/t20230427_5625373.shtml (accessed Oct 20, 2024)

between people on both sides of the war.²⁸⁵⁾

Wu Dingping and Cao Ergang of Chinese Army Engineering University emphasize the importance of the ‘human in the loop’ principle. They recognize the closed loop of “human-intelligent platform-human” and argue that Chinese PLA must firmly grasp the decisive role of “human,” ensuring that all actions remain under human command. They outline three core principles of “human in the loop” approach. First, “no one on the front line, human in the back (前线无人、后方有人)”, we must highlight the dominance of people. It should be clearly seen that unmanned combat, from technical development to combat application, cannot be separated from human factors, and humans are still the “master switch” in the entire chain of unmanned combat. Second, “weapons are unmanned, platforms are manned (武器无人、平台有人)”, and the unmanned system must always obey the command of the Party. Third is “autonomous unmanned, intelligent connected manned (自主无人、智联有人)”, it means that the intention of the Party Committee must be implemented.²⁸⁶⁾

China has been expanding its diplomatic efforts to lead global norms and standards. In December 2021, China submitted the “Chinese Position Paper on the Military Application of AI” to the 6th Review Conference of the UN Convention on Certain Conventional Weapons. China emphasized that this is the first time in the international community that it has put forward a plan to regulate the military application of AI.²⁸⁷⁾ In this position paper, China put forward eight demands, including “opposing the pursuit of military superiority using AI technology and opposing the use of AI to threaten the sovereignty and territorial security of other countries,” and called for consensus and discussion in the international community.²⁸⁸⁾ On November 16th, 2022, Chinese Ambassador for Disarmament

285) 军鹰智库, (2023.03.23.). “智能化海战”人在回路中“运用研究,” http://www.360doc.com/content/23/0323/11/1073243468_1073243468.shtml

286) 吴定平, 曹二刚, (2023.04.27). Op. cited.

287) 中国军网. “中国首次就规范人工智能军事应用问题提出倡议.” (2021.12.13.). http://www.81.cn/jfjbmap/content/2021-12/15/content_305249.htm (accessed Oct 21, 2024)

288) 外交部. “中国关于规范人工智能军事应用的立场文件.” (2021.12.14.). https://www.fmprc.gov.cn/web/wjb_67308/5/zzjg_673183/jks_674633/jksxwlb_674635/202112/t20211214_10469511.shtml (accessed Oct 21, 2024)

Li Song led a delegation to attend the 2022 Conference of States Parties to the United Nations Convention on Certain Conventional Weapons held in Geneva, and submitted the “China's Position Paper on Strengthening the Ethical Governance of Artificial Intelligence” to the conference.

China has been actively participated in international discussions on global AI governance. On October 18th, 2023, China's “Global Initiative on Artificial Intelligence Governance” was released. The regular press conference of the Chinese ministry of National Defense reported that it is important to prevent malicious use of artificial intelligence technology, especially research and development and use in the military field.²⁸⁹⁾ China has actively sought to participate in global multilateral consultations on the responsible use of military AI. In September 2024, a Chinese delegation attended the second “Responsible Use of Artificial Intelligence in the Military Field” Summit held in Seoul. Earlier, in November 2023, Chinese representatives also participated in the AI Safety Summit hosted by the United Kingdom. These engagements highlight China's effort to position itself as a key player in shaping international norms and standards for the responsible use of AI in military and broader security domains.

7) Conclusion

China's pursuit of military intelligentization (*junshi zhinnenghua*) reflects a transformative approach to warfare, heavily influenced by advances in artificial intelligence and lessons from global conflicts. Anchored in strategic initiatives like “New Quality Productivity” and “New Quality Combat Capability,” the Chinese PLA has placed significant emphasis on integrating AI into the military domain. Recent organizational changes, including the establishment of the Information Support Force, highlight a deliberate effort to prepare for intelligentized warfare by leveraging cutting-edge technologies to enhance

²⁸⁹⁾ 清华大学人工智能国际治理研究院, “国防部发声人工智能军事应用, 中国愿按照“以人为本”“智能向善”原则” (2023.12.02). <https://hub.baai.ac.cn/view/33102>

situational awareness, decision-making, and combat efficiency.

China's military-civil fusion ecosystem has been a pivotal factor in advancing AI-driven military innovations. By mobilizing state-owned defense industries, national research institutions, private enterprises, and universities, China has fostered a comprehensive talent development pipeline to equip its forces with the expertise required for modern intelligent warfare. This focus on cultivating "new-quality operational forces" underscores the PLA's recognition of the centrality of talent and knowledge in future conflicts, where unmanned and intelligent systems are expected to dominate.

Despite these advancements, China's approach maintains a strong emphasis on human oversight and Party leadership, aligning with its doctrine that humans remain the decisive factor in warfare. This principle ensures centralized control and reflects a cautious stance toward the risks posed by autonomous systems in military applications. Furthermore, China's engagement in global dialogues on the ethical use of AI in warfare signals its aspiration to shape international norms while safeguarding its strategic interests.

In summary, China's journey toward military intelligentization is characterized by a blend of technological innovation, organizational restructuring, and ideological continuity. While challenges remain, including incomplete informatization and the nascent stage of intelligent transformation, China's comprehensive efforts position it to emerge as a key player in the evolving landscape of intelligent warfare.

4

Indian AI Military Innovation

NATIONAL ASSEMBLY FUTURES INSTITUTE

Sunil Tyagi, Anil Golani

1) The Perception on AI and the Future of Warfare

Lessons from Ukraine War

There is an opportunity for India to learn from Ukraine's experience. There are three key lessons from Ukraine's innovations to guide India's approach to current and future conflicts.

The Role of Public-Private Partnerships. Ukraine's agile public-private partnerships have increased flexibility and responsiveness to a rapidly changing battlefield. Innovation works from multiple channels: private industry needs a pathway to inject solutions, and operational units need to be able to identify requirements. Ukraine is leveraging both mechanisms through innovation hubs like Brave1 and from the bottom-up with soldiers procuring off-the-shelf technology. Ukraine's nimble innovation architecture has enabled advancements in all warfare domains.

The private sector has appetite for risk, utilizing agility and market incentives to develop cutting-edge innovations in a way that publicly funded institutions cannot match. India hasn't yet understood the value of such collaborations, investing heavily in the Indian Defense Research and Development Organization (DRDO). There is a need to investigate how engagements with the private sector can be streamlined. Further, there are multiple "innovation" centers within the Indian Military and MoD coupled with the complicated procedures of defense acquisition and contracting, making rapid and agile involvement of private players difficult. India should consider how to allow more direct and flexible

engagement with the private sector in AI based defense technology. A thorough streamlining of regulatory requirements is required to leverage the full benefit of innovation for defense outcomes.

Conventional Warfare Matters. Emerging applications of technology are removing some of the asymmetric advantages between more established militaries and smaller forces. The importance of traditional military might, however, cannot be discounted. Russia's successful defensive entrenched positions rely on traditional conventional warfare: mines, tanks, sniper posts, and layered lines of defense. To attempt to break through Russian lines, Ukraine has merged innovative technology with conventional warfare: small drones conducting reconnaissance for tanks and Starlink connecting units along the front lines. But Ukraine's desperate need for tanks in the counteroffensive shows traditional warfare still has a role and sheer numbers still matter. Both Russia and Ukraine are employing a strategy of attrition – slowly and steadily degrading the enemy's personnel and supplies – the same strategy used in wars spanning back hundreds of years. As British General Sir Patrick Standards put it: "You can't cyber your way across a river."²⁹⁰ Technology and traditional warfare are linked in the battlespace, evermore in the 21st century.

Employing HUMINT. Local civilians represent increasingly valuable partners to military forces. While India's counterterrorism operations since the 1980s have tried to rely on the goodwill of the citizens, Ukraine showcases the power of a mobilized civilian population armed with technology. Clever use of social media apps like TikTok, Telegram and Twitter (the 3Ts) by the Ukrainian civilian population under occupied territories has been transforming the tactical battlespace like never before²⁹¹). The Ukrainian population acts as one large 'sponge' for collecting intelligence on Russian movements and deployments.

²⁹⁰ Future Soldier, "General Sir Patrick Sanders Opens the RUSI Land Warfare Conference with His Speech," (2022.06.28). <https://www.army.mod.uk/news-and-events/news/2022/06/rusi-land-warfare-conference-cgs-speech/>.

²⁹¹ Emmanuel Selva Royen, "From Civilian Sleuths to Military Strategy: Role Of OSINT In The Russia-Ukraine War and Lessons For India," *CENTRE FOR JOINT WARFARE STUDIES*, Issue Brief, (2023.08.06)., 1–21, https://cenjows.in/pdf-view/?url=2023/08/Emmanuel_Royen_Issue_Brief_August_2023.pdf&pID=20847.

Ukraine's tech-savvy citizenry with smartphones has turned the state into a large, distributed and open-source network for information collation. The presence of motivated citizens with smartphones on and around the battlefield provides a wider scope of intelligence collection than any traditional means. The Ukrainian government, for its part, has taken a step further by allowing its citizens to post pictures and videos of troop movements, geo-tagged on its country-wide public service app called DIIA, for instant use by military units on the battlefield. Leveraging HUMINT resources will require the support of local populations and ways to ingest and act on new data sources. Soft power will continue to be a critical component of any effective military campaign, alongside technology solutions that can bring civilian forces into the fight.

Addressing Threats to India's AI Defense Capabilities

India faces several critical threats as it advances its AI-driven defense initiatives, requiring careful navigation to maintain its strategic edge in a rapidly evolving global landscape.

- (a) **China's Rapid AI Advancements:** China's aggressive AI ambitions, with a goal to become the global leader by 2030, are supported by substantial investments and vast data resources. China is advancing military applications of AI, including autonomous drones, space-based AI systems, and advanced missile technology. Its centralized governance allows quicker implementation of AI projects, bypassing ethical and legal challenges. To counter this, India is investing adequately (within constraints) in indigenous AI development and strengthening international alliances, ensuring it can keep pace with adversaries' technological advancements.
- (b) **Political Instability:** While India has enjoyed political stability at the national level for the past two decades, a return to coalition governments, similar to those seen in the 1990s, could disrupt long-term defense projects. Political instability could also lead to inconsistent resource allocation and policy

shifts, impacting critical AI initiatives. To overcome this, India has more or less established a bipartisan understanding that the development of AI technologies, especially in defense, is a national priority.

- (c) **Export Controls and Foreign Dependency:** India's reliance on foreign technology for critical AI systems presents a risk. Export controls imposed by leading AI technology providers could limit access to key components, potentially stalling development. Foreign technologies also carry embedded biases that may not align with India's national interests. India continues to prioritize indigenous development, reducing dependency on foreign technologies, ensuring self-reliance, and safeguarding national interests in the AI domain.
- (d) **Geopolitical Tensions:** Geopolitical tensions with nuclear-armed neighbors like China and Pakistan pose risks, potentially disrupting access to international collaborations and technology transfers. Border disputes could further escalate tensions, limiting partnerships critical for AI innovation. India is focusing on diplomatic efforts to manage these tensions while concurrently advancing self-reliant AI technologies to ensure continuous development and resilience even during geopolitical challenges.
- (e) **Data Security Risks:** AI systems in defense depend on large datasets, making data security a significant concern. Cyber-attacks targeting AI systems can expose sensitive military data or manipulate information to disrupt operations. Implementing stringent cybersecurity protocols and investing in indigenous countermeasures remain key strategies to protect military AI systems, ensuring the integrity and security of data across all platforms.

By addressing these threats—ranging from China's rapid technological advancements to political challenges, export controls, and data security risks—India is advancing its AI defense capabilities while ensuring resilience against conventional and emerging threats.

2) Comprehensive National AI Strategy to Fight Future AI Wars

The Role of AI in India's Defense Strategy

Artificial Intelligence (AI) is not just a technological trend for India; it's a strategic necessity. Recognizing the transformative power of AI, India has been proactive in integrating this technology into its defense strategy. Here is how AI plays a pivotal role in India's defense sector:

Strategic Importance

India's National Defense Strategy underscores AI as essential for enhancing operational preparedness and strategic capabilities. Specific goals targeted by AI integration include improving real-time decision-making, precision in military operations, and enhanced surveillance to monitor and respond to threats more effectively. AI also plays a crucial role in predictive analytics, forecasting potential security issues and enemy movements, thus bolstering proactive defense measures.

To drive these initiatives, the Indian government has committed significant resources, allocating over Rs 100 crore (1 crore =100 million) annually to AI-centric projects²⁹²). Furthermore, the establishment of the Defense Artificial Intelligence Council (DAIC) has been a critical move, tasked with spearheading AI initiatives across the defense sector. The DAIC oversees the implementation of AI projects, aligning technological advancements with defense objectives. Notable projects include the development of AI-driven surveillance systems that efficiently process and analyze vast data sets and AI-enhanced predictive maintenance systems for defense equipment, aimed at boosting operational readiness.

By strategically investing in AI and establishing dedicated oversight through the

²⁹²) Indian Aerospace & Defence (blog). "AI In Defence: A Game-Changer For Military Strategy & Security - Indian Aerospace and Defence Bulletin - News for Aerospace and Defence in India," (2023.06.30)., <https://www.iadb.in/2023/06/30/ai-in-defence-a-game-changer-for-military-strategy-security/>.

DAIC, India is ensuring that these advanced technologies are seamlessly integrated into the national defense framework, enhancing the country's ability to manage and respond to contemporary security challenges on the digital battlefield.

Decision-making and Intelligence

The integration of AI into military intelligence within the Indian defense sector has fundamentally transformed strategic decision-making processes. AI algorithms, particularly those based on neural networks and machine learning, are deployed to sift through and analyze vast amounts of intelligence data swiftly. These technologies excel in pattern recognition, enabling the identification of subtle trends and anomalies that could indicate enemy activities or shifts in strategy.

Advanced machine learning models, such as convolutional neural networks (CNNs), play a crucial role in interpreting satellite imagery and aerial reconnaissance data, detecting unusual troop movements or infrastructural developments that could signal potential threats. Similarly, predictive analytics utilize both historical data and real-time inputs to forecast enemy movements and pinpoint potential conflict hotspots, aiding commanders in making informed tactical and strategic decisions.

Advanced Technology Deployment in the Indian Army for Enhanced Decision Making

The Indian Army has made significant strides in incorporating Artificial Intelligence to streamline battlefield operations. Storm drones and drone feed analysis systems are pivotal for real-time battlefield monitoring and intelligence gathering. Additionally, AI-based Mandarin translators²⁹³⁾ and Project Prism

²⁹³⁾ Dinakar Peri, "Soon AI-Based Mandarin Translation Devices for Troops on LAC," *The Hindu*, (2022.07.11). sec. India, <https://www.thehindu.com/news/national/soon-ai-based-mandarin-translation-devices-for-troops-on-lac/article65626423.ece>.

enhance communication and target identification²⁹⁴), breaking down language barriers and improving operational accuracy.

Systems such as Project V-logger and Silent Sentry are employed to monitor activities and enhance perimeter security effectively²⁹⁵). The Intercept Management System (IMS) and Sapper Scout are integral for advanced threat detection and area surveillance, providing essential data to command units. Moreover, technologies like mine detection unmanned ground vehicles (UGVs) and swarm drones are being developed to be used for clearing minefields and conducting extensive area surveillance without direct human intervention, significantly reducing risk to human life and increasing operational efficiency.

Indian Navy's AI Initiatives to Augment Situational Awareness

In parallel, the Indian Navy's AI-driven projects aim to bolster its capabilities across various strategic and operational areas²⁹⁶). The Autonomous Fast Intercept Boat, capable of autonomous operation at speeds up to 25 mph, is being developed in collaboration with Bharat Electronics and Goa Shipyards Limited, handling tasks such as surveillance and countermeasures.

The Navy is also advancing in natural language processing with the development of offline language translator technologies for Mandarin, Hebrew, and Russian, which are vital for enhancing communication and intelligence operations. Computer vision technologies are employed for critical security applications, including biometrics and face recognition, thus strengthening the Navy's ability to monitor and secure its assets.

Project Proton transforms 2D images of handwritten text into machine

²⁹⁴ Abhinandan Mishra, "Indian Army Gets Future Ready with AI-Based Equipment," *The Sunday Guardian Live*, (2022.07.16). <https://sundayguardianlive.com/news/indian-army-gets-future-ready-ai-based-equipment>.

²⁹⁵ Prem Lal Joshi, "From a Nation of 'snake Charmers' to a Global Power: The Rise of India - Indiaweekly," *India Weekly*, (2022.12.07). <https://www.indiaweekly.biz/from-a-nation-of-snake-charmers-to-a-global-power-the-rise-of-india/>.

²⁹⁶ Nivash Jeevanandam, "Exploring the Significance of AI in the Indian Navy," INDIAai, (2023.12.05) <https://indiaai.gov.in/article/exploring-the-significance-of-ai-in-the-indian-navy>.

-readable formats, increasing the efficiency of data processing. Anwesh and Hawksecure further enhance the Navy's decision-making and cybersecurity frameworks, employing advanced AI engines for behavioral and trend analysis. Additionally, establishing a Centre of Excellence in Artificial Intelligence at INS Valsura underscores the Navy's commitment to advancing AI and machine learning technologies, with a strong inclination towards fostering partnerships with private entities to augment AI capabilities.

Military Strategy with AI-based Games

In May 2022, the Army Training Command established a significant collaboration by signing a Memorandum of Understanding (MoU) with Rashtriya Raksha University (RRU) and Tech Mahindra to develop the Wargame Research and Development Centre (WARDEC) in New Delhi. This center is dedicated to innovating within military strategies by developing new war strategies, practicing tactics, and assessing combat formations. The primary goal is to enhance warfare skills through simulated environments that allow for comprehensive tactical training and strategy development without the risks associated with live combat exercises²⁹⁷).

Lethal Autonomous Weapons (LAWS)

Lethal Autonomous Weapons Systems (LAWS) are engineered to enhance the precision, speed, and effectiveness of military responses. Capable of engaging targets based on predefined criteria and conditions, LAWS process real-time data through advanced AI algorithms, facilitating rapid responses crucial in dynamic combat environments. The deployment of such systems raises significant strategic, ethical, and operational questions. The Indian military is addressing these concerns through stringent protocols and oversight, ensuring any development or

²⁹⁷ Parth Shastri, "To Hone Defence, RRU to Help Set up Wargame Centre in Delhi | Ahmedabad News - Times of India," *The Times of India*, (2022.05.15). <https://timesofindia.indiatimes.com/city/ahmedabad/to-ho-ne-defence-rru-to-help-set-up-wargame-centre-in-delhi/articleshow/91571128.cms>.

deployment aligns with international norms and regulations.

While India continues to explore the potential benefits of LAWS, it is mindful of the global arms race in autonomous weaponry. Instead of competing on technological advancements alone, India is charting its own path. This approach focuses on developing and incorporating LAWS technology in a manner that reflects India's unique strategic needs and ethical considerations as part of the global south.

One proposed system under consideration is akin to South Korea's SGR-A1 robotic sentry, adapted with embedded proportionality considerations and capabilities for human override. Such systems could significantly aid in managing India's extensive and heavily militarized borders²⁹⁸). India's borders stretch roughly 15,106.7 km, requiring a substantial deployment of the Border Security Force (BSF), which includes over 2.5 million personnel. The financial burden of such a large force is significant, with salaries and pensions forming a major portion of the defense budget.

Employing LAWS could act as a force multiplier, supplementing human border patrols with enhanced surveillance and detection capabilities. For instance, India's recent acquisition of advanced aircraft like the MQ-1B Predator, which can autonomously track and engage targets, points towards a future where Sentry Guard Robots could be deployed along contentious borders like those with Pakistan, improving security and operational efficiency.

Cybersecurity and Information Warfare

In the evolving landscape of modern warfare, cybersecurity and information warfare are becoming increasingly pivotal. The integration of Artificial Intelligence (AI) in these domains is transforming how military operations are conducted, particularly in the areas of threat detection and response.

²⁹⁸) Sarvjeet Singh and Sharngan Aravindakshan, "Killer Robots or Soldiers of the Future: Legal Issues and India's Role in the Lethal Autonomous Weapons Debate," *Indian JL & Tech.* (2020). 16: 103.

AI's role in cybersecurity is crucial for defending against the rising threat of cyber-attacks. Machine learning algorithms are adept at detecting anomalies in network behavior, which enables the early identification of potential cyber threats. These AI systems continuously learn from new data, improving their predictive capabilities and helping to safeguard critical military networks and infrastructure.

The impact of AI extends significantly into the domain of information warfare. AI algorithms are employed to detect vulnerabilities, predict cyber-attacks, and enhance the security of critical infrastructures. By analyzing patterns and inconsistencies in data, AI helps to preemptively identify and mitigate potential breaches before they can cause harm.

In India, the government's commitment to enhancing cybersecurity is evident through its investment in AI-driven solutions. The Defense Cyber Agency, a tri-service command, plays a crucial role in coordinating these cybersecurity operations. It has been actively exploring AI technologies to bolster the nation's cybersecurity defenses²⁹⁹).

Furthermore, AI is also being leveraged in information warfare to monitor and analyze social media trends, detect disinformation campaigns, and counteract propaganda. The Indian military is developing capabilities to use AI for psychological operations, aiming to influence or disrupt the decision-making processes of potential adversaries³⁰⁰). This strategic use of AI could be transformative in grey zone warfare, where the boundaries between war and peace are blurred.

This strategic integration of AI enhances India's capabilities to respond to and manage the complex challenges of modern cybersecurity and information

²⁹⁹) Indian Aerospace and Defence Bulletin (blog), "India Reinforces Cyber Defences & Embraces AI For Modern Military Transformation - Indian Aerospace and Defence Bulletin - News for Aerospace and Defence in India," (2023.07.15) <https://www.iadb.in/2023/07/15/india-reinforces-cyber-defences-embraces-ai-for-modern-military-transformation/>.

³⁰⁰) Nihar Kulkarni, "AI for National Security: Indian Military Perspective." FINS India, (2022.10.12). <https://finsindia.org/ai-for-national-security-indian-military-perspective.html>.

warfare, ensuring that it remains prepared against both conventional and unconventional threats.

The Role of AI in India's Surveillance and Reconnaissance Operations

The Indian military is actively investing in AI-powered technologies to enhance its surveillance and reconnaissance capabilities. Here's a structured overview of how AI is integrated into these operations:

- **Data Management and ISR Capabilities:** The Indian military collects vast amounts of data daily, which might be underused. AI technologies are now being employed to sift through this data efficiently, transforming it into actionable intelligence for the armed forces. This process ensures that critical data points are utilized effectively, supporting strategic decisions and operational readiness³⁰¹).
- **Enhancing C4ISR Capabilities:** AI is playing a crucial role in enhancing the capabilities of the C4ISR systems (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) within the Indian Army. By integrating AI, these systems can process and analyze information faster, leading to more accurate and timely decisions³⁰²).
- **Funding Startups for AI Initiatives:** Recognizing the potential of innovative technology in defense, the Indian government is supporting startups focused on AI, sophisticated imaging, sensor systems, big data analytics, autonomous unmanned systems, and secure communication systems. This funding aims to foster technological advancements that can be directly applied to enhance defense operations. The program supports

³⁰¹) Shashank Reddy, "Artificial Intelligence in Defence," INDIAai, (2019.08.22). <https://indiaai.gov.in/article/artificial-intelligence-in-defence>.

³⁰²) Huma Siddiqui, "Adoption of Artificial Intelligence in Indian Army's C4ISR: Here Is What the Chief Said," News, *The Financial Express*, (2022.05.09). <https://www.financialexpress.com/business/defence-adoption-of-artificial-intelligence-in-indian-armys-c4isr-here-is-what-the-chief-said-2518093/>.

projects with budgets ranging from Rs 1.5 crore to Rs 10 crore, promoting a thriving ecosystem of defense innovation³⁰³).

- **Indian Army:** The Army is increasingly integrating AI into its C4ISR capabilities to improve operational efficiency. AI-powered drones and satellites are employed for real-time surveillance across various terrains, providing actionable intelligence that is critical in both peacetime and combat scenarios. Additionally, technologies like facial recognition and object detection algorithms are used to identify persons of interest and potential threats, enhancing the Army's capability in field operations and security measures³⁰⁴.
- **Indian Navy:** The Navy is incorporating AI and machine learning to bolster its maritime domain awareness and intelligence, surveillance, and reconnaissance (ISR) capabilities. This integration supports a deeper understanding of the battlespace, improving the Navy's ability to monitor vast oceanic areas and conduct detailed reconnaissance missions. The use of AI helps in analyzing maritime data more effectively, ensuring the Navy remains alert to any potential threats or irregular activities³⁰⁵.
- **Indian Air Force.** The Indian Air Force is significantly enhancing its C4ISR capabilities through the deployment of small satellites³⁰⁶. These satellites are instrumental in providing high-resolution imagery, real-time data, and broader surveillance coverage, crucial for maintaining situational awareness and strategic edge over large geographic areas. Furthermore, collaborative efforts between the US and IAF are underway to explore and

³⁰³) Kumar Gandharv, "Top Three AI Initiatives for Indian Defence Forces in 2022," Broadcast, INDIAai, May 24, 2022, <https://Indiaai.gov.in/article/top-three-ai-initiatives-for-indian-defence-forces-in-2022>.

³⁰⁴) Ibid.

³⁰⁵) Oishee Majumdar, "Indian Navy Looks to Bolster AI, ML Capabilities," News, Janes.com, (2022.04.22). <https://www.janes.com/defence-news/news-detail/indian-navy-looks-to-bolster-ai-ml-capabilities>.

³⁰⁶) Kartik Bommakanti, "Strengthening the C4ISR Capabilities of India's Armed Forces: The Role of Small Satellites," OCCASIONAL PAPERS, ORF, (2020.06.15). <https://www.orfonline.org/research/strengthening-the-c4isr-capabilities-of-indias-armed-forces-the-role-of-small-satellites-67842/>.

expand the use of artificial intelligence in military operations. These discussions aim to strengthen military ties and technological exchanges between the two nations, focusing on leveraging AI to improve operational efficiency, decision-making processes, and overall mission success in various military contexts³⁰⁷).

Advanced Autonomous Systems in Combat Operations

The Indian military is actively developing and deploying advanced autonomous systems driven by artificial intelligence that enhance its capabilities across multiple domains of warfare.

- **Autonomous Fast Intercept Boat:** The Indian Navy is making strides in maritime security with the ongoing sea trials of its indigenously developed Autonomous Fast Interceptor Boats (A-FIBs)³⁰⁸. These unmanned vessels mark a significant advancement in India's coastal defense capabilities. A-FIBs are designed for high speed and maneuverability, making them ideal for patrolling vast swathes of India's coastline. Their autonomous operation allows them to function without a crew on-board, reducing risks and expanding operational reach. The A-FIB project highlights was jointly developed by the Navy's Weapons and Electronics Systems Engineering Establishment (WESEE) and Bharat Electronics Limited. Their autonomous capabilities will free up crewed vessels for more complex missions, while their speed and agility will provide a robust deterrent against maritime threats.
- **Autonomous Underwater Vehicles (AUVs):** In Mar 2024, the Indian Navy issued a Request for Information (RFI) for an advanced autonomous

³⁰⁷ Colin Demarest, "US and India Launch Talks about Military AI," C4ISRNet, (2022.04.18). <https://www.c4isrnet.com/artificial-intelligence/2022/04/15/us-and-india-launch-talks-about-military-ai/>.

³⁰⁸ IDRW, "Indian Navy Tests Indigenously Developed Autonomous Fast Interceptor Boats," Indian Defence Research Wing, (2024.05.05). <https://idrw.org/indian-navy-tests-indigenously-developed-autonomous-fast-interceptor-boats/>.

underwater vehicle (AUV) that can be launched from a submarine. This initiative, known as the Underwater-Launched Autonomous Underwater Vessel (ULAUV) project, aims to enhance the Navy's capabilities in intelligence, surveillance, and reconnaissance (JSR), as well as mine-countermeasures (MCM) deception operations. The deployment of AUVs marks a significant enhancement in India's underwater capabilities. These vehicles are equipped with sophisticated AI that enables them to perform complex tasks such as seabed mapping, mine detection, and surveillance of underwater assets. AUVs operate independently of surface conditions, providing critical intelligence and operational support in environments that are challenging for human divers³⁰⁹).

- **Unmanned Ground Vehicles (UGVs):** The Indian Army's Design Bureau has been pivotal in fostering collaborations with private firms to develop a range of UGVs³¹⁰), which are crucial for diverse ground-based military operations. One such initiative was 'UGV Experiment-2021', an event that showcased advancements in autonomous ground technology:

- ▲ **Enhanced Collaborative Autonomous Rover System (ECARS):** Developed by the Kalyani Group, the ECARS exemplifies cutting-edge engineering in UGV technology. This multi-terrain vehicle is equipped with an array of sensors for positioning, mapping, path planning, and obstacle detection, ensuring robust operation across varied terrains.

- ▲ **Innovation by Start-ups:** Reflecting the dynamic growth in Indian defense innovation, start-ups are also making significant contributions:

- **Torus Robotics:** Based in Tamil Nadu, this start-up is known for its work on robotics and indigenous disruptive power-train technologies.

³⁰⁹ IDRW, "Indian Navy Seeks Advanced Autonomous Underwater Vehicle," Indian Defence Research Wing, (2024.07.13). <https://idr.org/indian-navy-seeks-advanced-autonomous-underwater-vehicle/>.

³¹⁰ Atul Chandra, "Indian Army Accelerates Efforts to Develop Unmanned Ground Vehicles," *FORCE* (blog), <https://forceindia.net/cover-story/unmanned-rovers/>. accessed 2024.09.13.

Recognized by Start-up India, Torus Robotics is actively developing AI-based UGVs that promise to redefine ground operations.

- **Combat Robotics:** Another innovator from Chennai, Combat Robotics, is developing the Arista UGV, termed the world's first chassis-less UGV. This platform features an integrated motor drive and a modular design, enhancing its portability and ease of deployment in various military contexts.

These developments highlight the Indian defense sector's commitment to integrating sophisticated AI technologies in UGVs, enhancing operational capabilities, and supporting the modernization of ground forces.

3) India's Structural and Organizational Changes for Future AI Warfare

As the future of warfare increasingly becomes defined by artificial intelligence (AI) and autonomous systems (AS), it is essential for military organizations to undergo structural and organizational changes. India's defense strategy is evolving with a focus on integrating cutting-edge AI technologies across all branches of the armed forces, ensuring that the country can meet the demands of modern warfare. This transformation involves a combination of strategic policy adjustments, structural reforms, and capacity-building efforts aimed at fostering innovation, streamlining decision-making processes, and enhancing joint operational capabilities.

Strategic Evolution of India's Defense Infrastructure for AI Integration

Centralized Leadership and Institutional Frameworks

India's commitment to AI in defense is reflected in the establishment of centralized bodies like the **Defence Artificial Intelligence Council (DAIC)**. The DAIC plays a pivotal role in coordinating AI-related initiatives across the

tri-services—Army, Navy, and Air Force ensuring that AI integration is aligned with the broader national defense objectives. Its responsibilities include the development of AI policy frameworks, overseeing research and development, and facilitating collaboration between the military, academia, and private sector.

In addition, Directorates of AI are being set up within individual services, enabling dedicated focus on AI research, operational implementation, and data management. These directorates ensure that AI technologies are being deployed in a manner that enhances force readiness and operational effectiveness while maintaining oversight of ethical and legal considerations surrounding AI deployment in military contexts.

AI-Enhanced Command and Control Structures

AI integration is leading to a transformation of command and control structures within the Indian military. The traditional hierarchical model of decision-making is being augmented with AI-enabled Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems. These systems utilize machine learning algorithms to process vast amounts of sensor data in real-time, providing commanders with accurate, actionable intelligence. This allows for quicker decision-making, enhances battlefield situational awareness, and improves coordination between different military branches.

The restructuring of India's Integrated Defence Staff (IDS) to include AI-focused divisions further demonstrates a shift towards network-centric warfare. By streamlining information flows and providing integrated operational oversight, these divisions ensure that AI-powered platforms can operate seamlessly across multiple domains—land, sea, air, space, and cyberspace.

Cross-Domain AI Integration for Future Combat

AI in the Indian military is not confined to any one domain; rather, it spans across land, naval, and air operations, reflecting a cross-domain integration strategy. The Indian Army's use of swarm drones, AI-powered logistics management, and autonomous ground vehicles (UGVs) for mine detection and surveillance illustrates the growing reliance on AI for operational efficiency.

The Indian Navy's Autonomous Fast Interceptor Boats (A-FIBs)³¹¹ and AI-enabled maritime surveillance³¹² systems reflect the transformative impact of AI on naval operations, while the Indian Air Force's C4ISR upgrades demonstrate the importance of AI in air combat and surveillance. The creation of joint AI task forces across these domains ensures that India's armed forces can respond cohesively to future threats, leveraging AI to coordinate strategies across the board.

AI-Driven Cybersecurity and Information Warfare

As warfare becomes increasingly digitized, AI plays an essential role in cybersecurity and information warfare. AI is being integrated into India's cyber defense systems to enhance capabilities in identifying vulnerabilities, detecting intrusions, and responding to cyber-attacks with remarkable speed and precision. These AI-powered systems can continuously monitor and analyze large-scale networks, quickly identifying anomalies and neutralizing threats before they cause significant harm. The Defence Cyber Agency³¹³, established to lead cyber operations, utilizes AI to strengthen India's cyber resilience by supporting real-time threat detection and response measures, ensuring a robust

³¹¹ ET Online. "Indian Navy to Unveil New Autonomous Boat Swarms and AUVs at Swavlamban Seminar," *The Economic Times*, (2023.10.03). <https://economictimes.indiatimes.com/news/defence/indian-navy-to-unveil-new-autonomous-boat-swarms-and-auvs-at-swavlamban-seminar/articleshow/10412047.cms?from=mdr>.

³¹² IMR Reporter, "Indian Navy Leading in AI Technologies," *Indian Military Review* (blog), (2022.01.15). <https://imrmedia.in/indian-navy-leading-in-ai-technologies/>.

³¹³ PIB, "CYBER WARFARE," Press Information Bureau Government of India Ministry of Defence, <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1742322>. Accessed 2024.10.17.

defense against evolving cyber threats. This integration is critical as it enhances India's ability to manage and mitigate risks in the increasingly complex domain of cybersecurity³¹⁴).

In addition to defending against cyber threats, AI-based information warfare systems are being developed to counter disinformation campaigns and influence operations. These systems analyze social media patterns, detect fake news, and identify malicious content, helping India protect its digital sovereignty in both peace and war³¹⁵).

In conclusion, India's strategic transformation for AI-enabled warfare reflects the country's commitment to staying ahead of evolving military challenges. Key changes have been implemented to integrate AI across all defense sectors. The establishment of pivotal bodies like the Defence Cyber Agency (DCA), the Defence Artificial Intelligence Council (DAIC), and AI Centres of Excellence demonstrates the structural shift toward AI-powered military operations. These institutions oversee critical areas such as cyber defense, intelligence analysis, and decision-making, with initiatives like AI-driven maritime surveillance and autonomous systems. Additionally, the formation of AI-centric Directorates within the Army, Navy, and Air Force ensures a focused and coordinated effort across the tri-services, with each branch tailoring AI adoption to its specific operational needs.

India's approach includes fostering partnerships with the private sector, international collaborations (like the Indo-US Defense AI Partnership), and integrating AI across command, control, and operational structures. Furthermore, an integrating agency, such as the DAIC, ensures that AI initiatives are unified across all branches, promoting cohesion and efficiency in AI development and deployment. Ethical AI governance is also prioritized, ensuring responsible use of

³¹⁴ Majumdar, (2022.04.22). Op. Cited.

³¹⁵ Ministry of Electronics and Information Technology Digital India Dialogues, (2023) "Proposed Digital India Act, 2023," Ministry of Electronics and Information Technology §, https://www.meity.gov.in/writer/eaddata/files/DIA_Presentation%2009.03.2023%20Final.pdf.

technologies like lethal autonomous weapons and information warfare systems.

These structural changes position India to effectively leverage AI for modern warfare, ensuring rapid decision-making, enhanced security, and cross-domain military integration that spans land, sea, air, and cyberspace. This transformation will be crucial as India continues to defend against both conventional and unconventional threats in an increasingly digital and interconnected world.

4) The Governance for India's AI Military Technology Innovation

As artificial intelligence (AI) increasingly shapes the future of military technology, India has undertaken several structural and governance reforms to integrate AI into its defense strategy. These reforms ensure that AI adoption aligns with the nation's security objectives while also addressing ethical, operational, and technological challenges.

Leveraging India's Strength in AI for Defense Innovation

India's strengths in AI provide a solid foundation for advancing its defense capabilities, with strategic initiatives in place to harness these advantages effectively.

- (a) **Skilled AI Workforce:** India's large talent pool of engineers, data scientists, and AI specialists is a significant asset. The country is home to a wealth of expertise in AI technologies, with many professionals applying their skills to defense applications. The Indian Navy, DRDO, and private research centers are working with startups like NewSpace Research & Technologies to develop AI-driven solutions such as swarm drones and AI-powered surveillance platforms. India's talent pool is further leveraged through government initiatives like the iDEX programme, which supports entrepreneurs and startups in contributing innovative solutions to defense. These efforts help develop an agile, tech-driven workforce ready to tackle

modern military challenges.

- (b) **Government Push for AI:** The Indian government's active role in promoting AI growth reflects a strong commitment to harnessing AI for defense. Projects like the US-India AI Initiative and the Applied AI Research Centre focus on fostering AI talent, while the National Research Foundation (Anusandhan) aims to bridge gaps between academia, industry, and R&D. These policies ensure India's defense sector remains at the cutting edge of AI development, with a focus on indigenous solutions. iDEX and DRDO are prime examples of how government-backed innovation is transforming the defense landscape by encouraging the private sector to collaborate on advanced AI technologies.
- (c) **Growing AI Ecosystem:** India's rapidly expanding AI ecosystem, driven by a vibrant startup culture and research institutions, is being integrated into the defense sector. The government has rolled out initiatives like iDEX to fast-track AI-driven military technologies through public-private partnerships. This integration allows military forces to leverage advancements in AI, ranging from logistics management systems to predictive maintenance and fault detection tools for complex systems like aircraft and naval vessels. Collaboration with industry giants like Microsoft, Dassault Aviation, and BEL ensures the defense sector benefits from the best AI technologies available.
- (d) **Strategic Partnerships:** Strategic partnerships have been pivotal in strengthening India's AI capabilities for defense. Collaborations with Thales and HAL to integrate AI in avionics and partnerships with Dassault Aviation to develop AI applications in the Rafale fighters are key examples. Furthermore, under the Indo-U.S. Defense Technology and Trade Initiative (DTTI), a roadmap is being developed to co-create autonomous drones. These partnerships and collaborations in sectors like cloud computing with Microsoft are helping India gain access to the most advanced AI technologies and integrate them into its defense apparatus.

- (e) **Indigenous Development (आत्मनिर्भरभारत):** India's focus on self-reliance is a driving force behind its AI innovation for defense. DRDO and private firms like Tata Advanced Systems and Mahindra Defence are developing AI-powered systems like autonomous drones and missile guidance technologies. The Indian Navy is also working on AI-based underwater autonomous vehicles and swarm boats for maritime defense. This emphasis on indigenous development reduces reliance on foreign technologies and ensures that solutions are customized for India's specific defense needs.
- (f) **Experience in Software Services:** As a global leader in software services, India's extensive experience in this sector provides a unique advantage in AI development. Companies like Infosys, Wipro, and TCS have been at the forefront of software innovation, and their expertise is being channeled into defense AI systems. By applying the principles of quality, scalability, and reliability from the software services sector, India is developing robust AI systems tailored to military applications, ensuring they are both scalable and secure.

India is leveraging these strengths to build a strong AI-enabled defense system that is adaptable to future military needs, ensuring it can remain competitive in the rapidly evolving landscape of AI-driven warfare. Through strategic investment, government initiatives, and public-private collaborations, India is well-positioned to harness its strengths and become a global leader in AI for defense.

Addressing Infrastructure Challenges

India's defense AI systems face several infrastructure-related challenges that need strategic governance and investment to ensure AI's effective integration into military operations.

- (a) **Outdated Hardware and Software:** One of the primary barriers is the reliance on legacy systems within the defense sector, which are not compatible with

modern AI algorithms. Many of these systems require significant upgrades or replacements to support AI-based defense capabilities. Additionally, India is highly dependent on foreign software and operating systems, which poses security risks. In response, India is focusing on indigenous development to reduce reliance on foreign technologies, with institutions like DRDO and private firms driving the development of homegrown solutions.

- (b) **Connectivity in Remote Areas:** Poor connectivity in remote regions where the military operates limits the deployment of real-time AI systems for operations such as surveillance and data analysis. India is investing in satellite-based communication systems and expanding its network infrastructure in challenging terrains to address this. The Indian government is also pushing to deploy 5G technologies to facilitate faster, more reliable connections in remote areas critical for military operations.
- (c) **Data Management:** AI systems require vast amounts of data for both training and operational tasks. India is building high-performance computing (HPC) facilities and data centers designed to handle large-scale data processing. In addition, the National Centre for Transformational AI focuses on secure and efficient data handling for AI applications, especially for defense purposes.
- (d) **Energy Demands:** The energy requirements of AI systems are significant; it is a challenge, particularly in remote areas where access to reliable energy sources is limited. To address this, India is exploring renewable energy solutions like solar-powered grids to support AI operations in difficult terrains. Mobile power units are also being tested to ensure that military AI systems can run uninterrupted even in isolated locations.
- (e) **Interoperability Between Services:** AI solutions often lack interoperability between the Army, Navy, and Air Force, which limits cross-domain coordination. The establishment of AI-centric Directorates within each branch, along with efforts led by the Defence Artificial Intelligence Council

(DAIC), aims to ensure seamless integration and operational efficiency across the services.

- (f) **Funding Constraints:** Although the government has allocated 100 crore annually for AI in defense, this funding is inadequate given the scale of AI investments needed to keep pace with global powers. To overcome this, India is increasingly relying on public-private partnerships and international collaborations to attract more funding and expedite AI development in the defense sector. Furthermore, proposals to increase long-term defense budgets for AI projects are under consideration.
- (g) **Regulatory Framework:** The absence of a clear regulatory framework specifically addressing AI in military applications creates uncertainty, particularly regarding the ethical and legal implications of autonomous systems, like drones. India's Ministry of Defence is working with international bodies such as the UN Group of Governmental Experts (UN GGE) to establish global norms, while domestically, the Defence Artificial Intelligence Council (DAIC) is formulating guidelines to ensure AI's ethical deployment in warfare, with clear responsibilities defined for developers and operators.
- (h) **Cost-Conscious Procurement Practices:** India's focus on selecting the lowest bidder in defense contracts (L1 system) often results in compromises on quality, hindering innovation. Efforts are underway to revise procurement policies to encourage innovation, allowing for higher investments in advanced AI technologies. The Make in India initiative is also geared towards enhancing domestic production and reducing costs by promoting indigenous AI development.
- (i) **Limited Private Sector Involvement:** While the public sector, especially DRDO, has been leading AI initiatives, the pace of innovation can be slow due to bureaucratic constraints. The involvement of private companies, which are often more agile and innovative, is limited. The government is now creating incentives for the private sector to participate more actively in defense AI development, through tax breaks, joint ventures, and easier

access to defense contracts.

- (j) **DRDO's Slow Pace of R&D:** The DRDO is often criticized for delays in the research and development of new technologies. In response, India is pushing for a more agile operational model within DRDO, with increased collaboration with academic institutions and private players to fast-track AI projects. Public-private partnerships are also being expanded to leverage private sector speed and expertise in R&D.

By addressing these infrastructural challenges, India is laying a foundation for integrating AI into its defense framework. Strategic investments in indigenous technology, regulatory frameworks, and public-private collaborations are key to overcoming these barriers and ensuring India's military is well-prepared for future AI-enabled warfare.

Accelerating AI R&D through Public-Private Collaboration

India's defense ecosystem has opened its doors to public-private partnerships in AI research and development. Private sector companies like NewSpace Research & Technologies are playing a crucial role in developing AI-driven technologies for the military, such as swarm drones and AI-enabled surveillance platforms. Such collaboration helps bring fresh innovation, flexibility, and risk-taking abilities often absent in traditional military research and development.

Furthermore, India has initiated joint research programs with international partners, such as the Indo-US Defense AI Partnership³¹⁶⁾ and the Indo-Taiwan Joint Research Centre on AI and ML³¹⁷⁾. These collaborations allow for the exchange of expertise and resources, helping India fast-track the development and deployment of AI solutions in military contexts.

³¹⁶⁾ IUSSTF, "Indo-U.S. Science and Technology Forum (IUSSTF) - Iusstf," <https://iusstf.org/usiai>. accessed 2024.10.16.

³¹⁷⁾ Kelvin Chen. "Taiwan, India Ink MOU on Science Research," *Taiwan News*, (2023.12.08). <https://taiwannews.com.tw/en/news/5055468>.

Leveraging Opportunities for AI Integration in India's Defense Sector

India has several key opportunities that can significantly advance its AI capabilities in the defense sector. Tapping into these opportunities will position the country as a leader in AI-driven military technologies globally.

- (a) **Strategic Alliances:** India's partnerships with technologically advanced nations like the United States, Israel, and France offer a great opportunity to access cutting-edge AI technology. India can fast-track its AI capabilities for defense applications by engaging in joint research and development and resource-sharing. Partnerships like the Indo-U.S. Defense Technology and Trade Initiative (DTTI) provide platforms for the co-development of technologies, such as autonomous drones. These strategic alliances not only enhance technological advancement but also strengthen diplomatic and military cooperation, helping India stay ahead in AI innovation.
- (b) **Defense Exports:** India's growing AI ecosystem presents an opportunity to become a global supplier of AI-driven defense solutions. By developing a robust policy framework for defense exports, India could generate significant revenue from exporting indigenous AI-based technologies to friendly nations. Such exports would bolster the country's economy and contribute to further research and development, fostering innovation. The move to establish 'Brand India' in the global market will also enhance the country's strategic influence and position it as a leader in advanced AI military technology.
- (c) **Strengthening Alliances and Collaborations:** To fully leverage the potential of these opportunities, India must strengthen its existing alliances and seek out new collaborations with global partners. Platforms like the Quad Alliance (India, the U.S., Japan, and Australia) and India-Japan-U.S. Trilateral Dialogue offer avenues for joint AI research and development, fostering technological growth. These collaborations will not only help India access advanced technologies but also establish it as a key player in the AI-driven defense landscape, enabling the exchange of expertise and resources on a

global scale.

By leveraging these strategic opportunities, India can enhance its AI capabilities, drive global partnerships, and secure a significant role in the international defense technology market. These efforts will also contribute to developing a more robust and future-ready defense infrastructure.

In conclusion, India is making significant strides in integrating AI into its military framework through strategic investments, policy reforms, and collaboration with global partners. Leveraging its skilled workforce, robust AI ecosystem, and strong government push for technological innovation, India is well positioned to address its infrastructure challenges and tap into the potential of AI for defense. By mitigating threats such as geopolitical tensions, reliance on foreign technologies, and data security risks while capitalizing on opportunities for international partnerships and indigenous development, India is poised to become a key player in AI-driven military advancements. This forward-looking approach ensures that India remains competitive in the rapidly evolving landscape of AI-enabled warfare, safeguarding national security and enhancing its global defense capabilities.

5) The Educational Innovation for Future AI Warfare: India's Talent Ecosystem

India's journey towards establishing itself as a leader in AI-driven military innovation requires a robust and adaptable talent ecosystem capable of meeting the demands of future warfare. To this end, several educational innovations have emerged, ensuring that India's workforce is well-prepared to develop, implement, and operate AI technologies in defense contexts.

Investment in Talent and AI Education for Defense

Recognizing that the future of warfare depends on human-AI collaboration, India is investing heavily in creating a skilled AI workforce capable of developing,

operating, and maintaining advanced AI systems. The Centres of Excellence for AI³¹⁸⁾ established by the Ministry of Defence (MoD) are tasked with fostering a new generation of AI researchers, engineers, and military officers who are well-versed in AI and autonomous technologies.

Military academies and defense research institutes are revising their curricula to include AI and data science as core subjects. These institutions are collaborating with leading academic organizations, both domestic and international, to ensure that the armed forces have access to cutting-edge AI knowledge. Additionally, India's Quantum Lab^{319),320)} and other initiatives, such as the Defense Institute of Advanced Technology (DIAT), are at the forefront of educating military personnel in next-gen technologies like quantum computing, machine learning, and robotics³²¹⁾, all of which are integral to AI warfare

AI Education and Military Training

One of the pillars of India's AI ecosystem is its focus on enhancing education and training in AI at both the institutional and military levels. The Indian government has launched initiatives like the National AI Portal (INDIAai) and National Institute of Electronics & Information Technology (NIELIT)³²²⁾, which offer AI training programs aimed at developing skilled AI professionals across various sectors, including defense. The INDIAai mission, a collaboration between the Ministry of Electronics and Information Technology (MeitY) and NASSCOM,

³¹⁸⁾ Aayog NITI, "National Strategy for Artificial Intelligence - Discussion Paper", (2018.06) <https://indiaai.gov.in/documents/pdf/NationalStrategy-for-AI-Discussion-Paper.pdf>.

³¹⁹⁾ PIB, "Indian Army Establishes Quantum Laboratory at Mhow (MP)," Press Information Bureau, GoI, (20 21.12.29). <https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=1786012>.

³²⁰⁾ Express News Service, "DIAT to Research, Develop Robotics Platforms for Armed Forces," *The Indian Express* (blog), (2021.02.07). <https://indianexpress.com/article/cities/pune/diat-to-research-develop-robotics-platforms-for-armed-forces-7178681/>.

³²¹⁾ DIAT, "School of Defence Technology - DIAT," <https://diat.ac.in/school-of-defence-technology-2/>. accessed, 2024.10.16.

³²²⁾ National Institute of Electronics & Information Technology (NIELIT), "Artificial Intelligence Courses," Text, National Institute of Electronics & Information Technology (NIELIT), (2022.11.28). <https://www.nielit.gov.in/content/artificial-intelligence-courses>.

provides a hub for AI resources, education, and skill development programs³²³). These efforts help build the necessary talent pool to support the nation's AI innovation, particularly in the defense sector³²⁴).

Moreover, public-private partnerships are playing a key role in addressing challenges in AI skilling and implementation. For example, initiatives like the FutureSkills Prime program³²⁵), led by MeitY and NASSCOM, are focusing on improving AI skills for both IT and non-IT fields, ensuring that India remains competitive in the global AI landscape. These initiatives demonstrate India's commitment to building an ecosystem where education, policy, and industry collaborations come together to foster innovation in AI, specifically in defense applications. This emphasis on education and skilling helps position India as a leader in AI-enabled military technologies and ensures a steady supply of skilled professionals to meet future defence challenges

Further, Military academies, such as the Defence Services Staff College (DSSC) and the Indian Military Academy (IMA), are integrating AI into their curricula, ensuring that future military leaders are well-versed in the strategic and operational applications of AI.

Institutions like the Defence Institute of Advanced Technology (DIAT) play a pivotal role in training military personnel in AI, machine learning, and robotics. DIAT's specialized courses focus on areas such as autonomous systems, cyber defense, and AI-driven surveillance systems. These initiatives prepare the armed forces to adapt to the rapid technological shifts expected in future combat scenarios.

India's National Strategy for Artificial Intelligence³²⁶) has made significant

³²³) Pratyusha Tripathy, "Union Minister Rajeev Chandrasekhar Launches Future Skills PRIME," *National Skills Network- NSN* (blog), (2021.11.01). <https://nationalskillsnetwork.in/union-minister-rajeev-chandrasekhar-launches-future-skills-prime-programme/>.

³²⁴) Anjali Raja, "Understanding the Nature and Scope of AI Skilling Programs in India," INDIAai, (2024.07.25). <https://indiaai.gov.in/article/understanding-the-nature-and-scope-of-ai-skilling-programs-in-india>.

³²⁵) Nasscom, "FutureSkills Prime - India's Technology Skilling Hub," Future Skills Prime, (2024) <https://futureskillsprime.in/home>. accessed 2024.10.17.

³²⁶) NITI Aayog, "National Strategy For Artificial Intelligence," INDIAai, (2019.08.21). <https://Indiaai.gov.in/research-reports/national-strategy-for-artificial-intelligence>.

strides in enhancing educational services by offering personalized learning experiences, automating administrative tasks, and providing real-time feedback to both educators and students. A notable example is BYJU's, India's leading online learning platform, which harnesses AI to tailor individual learning paths. The platform dynamically adjusts the complexity of content based on a student's comprehension, allowing for a customized and more effective learning experience. This demonstrates how AI-driven education platforms are elevating the quality and accessibility of learning, creating a skilled talent ecosystem well-suited for future AI challenges, including in the defense sector.

Emerging AI Educational Initiatives

- (a) **Centers of Excellence:** The establishment of these centers is pivotal in fostering AI research and development, contributing to sectors such as defense. With key milestones like the announcement of three new Centers of Excellence in February 2023³²⁷⁾, and the creation of a central project management unit at IIT Jammu, these initiatives align with India's strategic vision of 'Make AI in India and Make AI Work for India.' Further support comes from established institutions like the International National Centre for Transformational AI, which plays a crucial role in AI innovation.
- (b) **AI-focused Education:** Initiatives such as the *Responsible AI for Youth* ³²⁸⁾ program are designed to nurture AI talent from an early stage, equipping future generations with the skills necessary for AI in defense applications. The National Research Foundation's *Anusandhan* initiative³²⁹⁾ further bridges academia, research, and industry, ensuring a steady development of expertise in AI.

³²⁷⁾ Bhuvana Kamath, "Union Minister Dharmendra Pradhan Launches Three AI Centres of Excellence," Your Story, (2024.10.15). <https://yourstory.com/2024/10/union-minister-dharmendra-pradhan-launches-3-ai-centres-of-excellence>.

³²⁸⁾ YUVAi, "YUVAi - Youth for Unnati & Vikas with AI," Responsible AI for Youth, , <https://responsibleaifooryouth.negd.in/home>. accessed 2024.10.17.

³²⁹⁾ NRF, "Anusandhan National Research Foundation,," <https://www.psa.gov.in/nrf>. accessed 2024.10.17.

(c) **Defense-oriented AI Research:** India's commitment to integrating AI into its military capabilities is evident with the creation of specialized research centers, such as the National Institute for Robotics and Artificial Intelligence³³⁰), as well as dedicated AI laboratories within the Indian Navy and Air Force. These institutions are tasked with ensuring AI technologies align seamlessly with the defense strategy.

Collaborative Ecosystem between Academia, Defense, and Industry

India's educational framework for AI warfare is also characterized by deep collaborations between academic institutions, the defense sector, and private industry. Centers of excellence, such as the Indian Institutes of Technology (IITs), Indian Institutes of Information Technology (IIITs), and universities, are working closely with defense organizations like DRDO and private defense contractors to build cutting-edge AI applications for military use.

Initiatives like iDEX (Innovations for Defense Excellence) enable students, researchers, and startups to collaborate on defense challenges, fostering an innovation-driven culture. These partnerships help bridge the gap between theoretical AI research and its practical, real-world applications in defense.

Upskilling and Reskilling Existing Personnel

As AI technologies continue to evolve, the upskilling and reskilling of existing personnel are essential. Various Indian military institutions have incorporated advanced AI training modules for officers, engineers, and soldiers.

Over the last few years, Indian Naval personnel have been involved in AI-focused courses, including predictive maintenance, data analytics, decision support systems, and autonomous maritime systems. This training is conducted in collaboration with prominent institutions like the Indian Institutes of Technology

³³⁰) "National Institute of Robotics & Artificial Intelligence | NIRA," National Institute of Robotics & Artificial Intelligence | NIRA, <https://nira.ac.in/>. accessed 2024.10.17.

(IITs) and involves hands-on projects in AI applications relevant to naval operations³³¹). Moreover, the Indian Navy has formed an AI core group to drive these efforts, ensuring that personnel at all levels—officers, engineers, and sailors—receive continuous education in AI and machine learning.

AI training in the Indian Army is part of a broader initiative to modernize and digitize the forces. For example, AI is utilized in artillery systems to calculate factors like wind speed, temperature, and air density for more precise targeting, as well as in logistics to predict potential disruptions in supply chains. AI technologies are expected to significantly reduce time and improve decision-making in battlefield environments by factoring in multiple real-time variables for a more accurate operational picture. AI in Army operations is expanding through collaborations with academic institutions, where specialized programs in AI are helping personnel learn and apply these technologies for enhanced operational efficiency and strategic planning³³²).

The Indian Air Force (IAF) has taken notable steps to incorporate AI technologies into its operations, with a significant focus on upskilling personnel. AI is being integrated across several domains, including predictive maintenance of aircraft, autonomous systems, and real-time threat analysis. One prominent initiative is the establishment of the Centre of Excellence for Artificial Intelligence (CoEAI) at Air Force Station Rajokri. This center is part of the IAF's broader digital transformation efforts under UDAAN (Unit for Digitization, Automation, Artificial Intelligence, and Application Networking). It focuses on developing AI capabilities in areas like supply logistics, intelligence gathering, decision support systems, and mission planning, all of which are integral to modern air operations.

Moreover, IAF personnel, including engineers and pilots, are being trained in

³³¹) Pritam Bordoloi, "Indian Navy's Quest to Become an AI-Enabled Force," AIM, (2022.07.25). <https://analyticsindiamag.com/ai-origins-evolution/indian-navys-quest-to-become-an-ai-enabled-force/>.

³³²) Pritam Bordoloi, "How Does the Indian Army Want to Use AI?," AIM, (2022.08.04). <http://analyticsindiamag.com/ai-breakthroughs/how-does-the-indian-army-want-to-use-ai/>.

AI-based systems, including predictive maintenance for aircraft and UAV operations. Predictive maintenance allows crews to preemptively identify potential failures in aircraft systems, enhancing operational efficiency and safety. AI-powered training simulations are also used to prepare pilots and ground crews for real-world scenarios, enhancing decision-making capabilities in complex operational environments. These training programs are often conducted in collaboration with academic institutions and public sector undertakings to ensure that personnel are adept at using cutting-edge AI technologies in their roles.

In conclusion, India's talent ecosystem for AI warfare is supported by a growing synergy between educational institutions, the defense sector, and private industries. This multifaceted approach ensures that the country's military is equipped with the knowledge, skills, and tools required to leverage AI in future combat scenarios. Through continuous investment in education, training, and public-private partnerships, India is developing a dynamic workforce that will play a critical role in shaping the future of AI-driven warfare.

6) The Discourse and Strategy for the "Human in the Loop" in India

As India continues to integrate AI into its defense strategy, the “human in the loop” approach remains a central tenet. This approach ensures that while AI systems provide support, critical decisions—especially those involving the use of lethal force—are made by human operators. The balance between AI-driven automation and human oversight is essential to maintaining ethical standards, ensuring accountability, and mitigating risks associated with fully autonomous operations.

Human Oversight and Ethical Concerns

India's commitment to maintaining human oversight over AI-driven systems reflects broader international concerns regarding the ethical implications of fully

autonomous weapons. The Indian Ministry of Defence and the Defence Artificial Intelligence Council (DAIC) have formulated guidelines to ensure that autonomous systems, including lethal autonomous weapons systems (LAWS), operate with a human in control³³³). This focus on human oversight aligns with India's participation in international forums like the UN Group of Governmental Experts (UN GGE), which promotes discussions on maintaining human control over AI in warfare.

India's stance on LAWS has been a balancing act the need to develop emerging technologies with ethical and legal concerns. India has repeatedly stressed the importance of a governance framework that avoids widening the technology gap, while also cautioning against over-regulation that could stifle innovation. Ambassador D.B. Venkatesh Varma's 2014 statement at the UN GGE highlighted the need for regulation that would neither restrict technological advancements nor make the cost of warfare so low that it could encourage the use of lethal force to settle disputes³³⁴).

Ethical AI and Governance in Military Applications

As India moves forward with the integration of AI into its defense strategy, ethical considerations are being prioritized. The Defence Artificial Intelligence Council (DAIC), alongside the Ministry of Defence, is developing AI governance frameworks that ensure the responsible and ethical use of AI in military applications. This includes the development of AI safety standards, protocols for the use of lethal autonomous weapons systems (LAWS), and guidelines on maintaining human oversight in AI-enabled decision-making processes.

India's focus on AI ethics also extends to its international stance, where the

³³³) Richa Bhatia, "If The Future Of Warfare Is With Automated Weapons - Where Does India Stand In The Race?," AIM, (2018.03.27). <https://analyticsindiamag.com/ai-origins-evolution/if-the-future-of-warfare-is-with-automated-weapons-where-does-india-stand-in-the-race/>.

³³⁴) Kashyap Raibagi, "In Conversation With Trisha Ray, Associate Fellow At The Observer Researcher Foundation," AIM, (2021.01.15). <https://analyticsindiamag.com/intellectual-ai-discussions/in-conversation-with-trisha-ray-associate-fellow-at-the-observer-researcher-foundation/>.

country has been advocating for global norms and regulations on the use of AI in warfare. This diplomatic engagement highlights India's commitment to the responsible use of AI, particularly in areas such as autonomous weapons, cyber warfare, and data privacy.

Operational Strategy and Application

India's operational strategy follows a "human in the loop" model for key military AI applications, ensuring that final decisions in battlefield scenarios rest with human operators. For instance, AI systems provide real-time data processing, target identification, and threat analysis, but decisions on engagement remain with human commanders.

A relevant example of this approach is the MQ-9B Sea Guardian drones, including the MQ-9 Reapers, which India has acquired. These drones are capable of being configured for fully autonomous operations, where they could independently identify, track, and engage targets. However, India has so far refrained from employing these drones autonomously, opting instead for human oversight in all operational decisions. This cautious approach ensures that ethical standards and strategic control are upheld, even as technology advances towards full automation.

Challenges and Opportunities

The "human in the loop" approach, while essential for ethical reasons, presents challenges, particularly in balancing the speed of AI systems with human decision-making processes. AI can process vast amounts of data much faster than humans, and the need for human intervention can introduce delays in critical situations. To mitigate this, the Indian military is focused on training personnel in the operation of AI systems, ensuring they can make rapid, informed decisions when necessary.

By retaining a human in the loop, India ensures accountability and adherence

to international law while leveraging AI for enhanced operational efficiency. This strategy reflects India's commitment to maintaining ethical oversight as AI-driven systems play an increasingly significant role in modern warfare.

7) Conclusion: India's Roadmap to AI-Driven Warfare

The strategic integration of Artificial Intelligence (AI) into India's defense ecosystem is not only inevitable but essential to ensuring the nation's security in the face of evolving global threats. It is evident that India's AI military innovation is progressing on multiple fronts, leveraging national strengths while addressing infrastructural, operational, and ethical challenges.

India's journey toward AI-driven warfare is grounded in a comprehensive approach that incorporates global perspectives, ethical considerations, indigenous innovation, and human oversight. India's perception of AI aligns with global trends, where rapid advances in AI are reshaping modern warfare, exemplified by the ongoing conflicts in Gaza and Ukraine. These conflicts underscore the urgent need for countries like India to embrace AI to stay competitive and prepared for future challenges.

India's comprehensive national AI strategy underlines the importance of investing in AI research, fostering public-private partnerships, and building a skilled workforce. India's National Strategy for Artificial Intelligence enables the country to capitalize on opportunities across sectors while emphasizing the development of indigenous solutions tailored to defense needs.

AI is transforming the Indian military's operational capabilities, spanning land, air, and naval domains. Integrating AI-powered autonomous systems, enhanced C4ISR structures, and cutting-edge decision-making tools marks a significant shift towards network-centric warfare. As India's defense infrastructure evolves, it is important to create centralized bodies like the Defence Artificial Intelligence Council (DAIC) and dedicated AI directorates to ensure a cohesive,

forward-looking AI strategy for military modernization.

While India is embracing AI-driven innovation, the critical role of human oversight and governance in this transition is a crucial consideration. Ethical concerns, especially regarding Lethal Autonomous Weapons Systems (LAWS), remain at the forefront of India's AI discourse. By maintaining a "human in the loop" in key military AI applications, India strikes a balance between leveraging technological advancements and adhering to international law and moral principles.

Furthermore, India's talent ecosystem is essential to achieving success in AI-driven defense. By integrating AI into education and military training, the country ensures that its future workforce is prepared for AI-enabled warfare. The collaboration between academia, defense institutions, and private industry ensures that India remains agile, innovative, and competitive in the global AI race.

India's commitment to developing an AI-enabled military ecosystem through the lens of governance, international collaboration, and talent development. This multifaceted approach ensures that India's AI-driven warfare strategy is technologically sound and strategically robust, resilient, and adaptable to future conflicts.

In conclusion, India's roadmap for AI-driven warfare rests on the pillars of innovation, collaboration, ethics, and human oversight. The nation's ability to develop and deploy cutting-edge AI technologies while ensuring that ethical standards and international regulations are upheld places India at the forefront of global AI military innovation. As AI continues to reshape the landscape of warfare, India's preparedness for future conflicts will depend on the successful execution of the strategies outlined in this chapter—ensuring security, resilience, and operational excellence in the era of AI-enabled defense.

5

The United Kingdom's AI Military Innovation

NATIONAL ASSEMBLY FUTURES INSTITUTE

Rod Thornton

1) The Perception of AI and the Future of Warfare

It is clear that the armed forces of the United Kingdom (UK) wish to be a leading world player in the development of Artificial Intelligence (AI) for use as a capability enabler or enhancer across a broad range of military systems. The UK Ministry of Defence (MoD) does see AI as being a major factor in future warfare. This is made clear in a series of recent official documents. The subject of AI and its role in future defense thinking was first raised in a high-profile manner in the UK government's March 2021 document, *Integrated Review of Security and Defence. Global Britain in a Competitive Age*.³³⁵⁾ This document pointed to several issues relating to new technologies and to the character of future conflict in what is referred to as a 'competitive age'. AI, however, was referred to only once in this document's 114 pages. It was described as a 'critical area' where the UK needed to establish a 'leading edge':

We [the UK] will be recognized as a Science and Tech Superpower, remaining at least third in the world in relevant performance measures for scientific research and innovation, and having established a leading edge in critical areas such as artificial intelligence (Global Britain in a Competitive Age, p. 9).

Thus, the UK government seems to be quite ambitious in its aspiration to be a

³³⁵⁾ HM Government, *Global Britain in a Competitive Age: The Integrated Review of Security, Defence, Development and Foreign Policy*. (2021.03). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/975077/Global_Britain_in_a_Competitive_Age-the_Integrated_Review_of_Security_Defence_Development_and_Foreign_Policy.pdf

significant player when it comes to the use of AI in future warfare. The general narrative, however, that falls out of this and subsequent UK government documents related to AI (see below) is that development of AI is needed, not so much because it represents the ‘future of warfare’, but rather because the UK cannot afford *to fall behind* its ‘competitors’ – Russia and China. These two states are perceived to be heavily engaged in AI development as a force multiplier. This view has been described as the ‘if we do not do it, then others will’ approach³³⁶. In a follow-on document of 2022, *Defence Artificial Intelligence Strategy*³³⁷, the then UK Defence Secretary, Ben Wallace, appeared to sum up this mentality:

AI has enormous potential to enhance capability, but it is all too often spoken about as a potential threat. AI-enabled systems do indeed pose a threat to our security, in the hands of our adversaries, and it is imperative that we do not cede them a vital advantage. (Defence Artificial Intelligence Strategy p. 3)

The dynamics behind the UK AI strategy seem clear. There is an ‘AI arms race’ and the UK cannot afford to be a victim of this race³³⁸. Overall, then, UK AI development may be said to be focused on not ceding this ‘vital advantage’. So, rather than the UK looking to create AI-enabled technologies that are seen to fit some vision of the ‘future of warfare’, there is actually more of a threat-based demand push.

What does need to be pointed out in terms engaging in this ‘arms race’ is the ethical issue. There is considerable public debate within the UK about the ethics of the use of AI within weapons systems. This debate attracts a high degree of government involvement and thus (at least rhetorical) oversight of AI

³³⁶ Nadibaidze, Anna. ‘The UK Defence AI strategy: Situating Global Britain in the “AI Race”’, *Autonorms*. (2022.07.04). <https://www.autonorms.eu/the-uk-defence-ai-strategy-situating-global-britain-in-the-ai-race/>

³³⁷ UK Ministry of Defense. *Defence Artificial Intelligence Strategy*. (2022.06). https://assets.publishing.service.gov.uk/media/62a7543ee90e070396c9f7d2/Defence_Artificial_Intelligence_Strategy.pdf

³³⁸ Kamphuis, Yori and Stephan Leijnen, ‘Here’s what you need to know about the new AI “arms race”’, *World Economic Forum*. (2021.02.22.). <https://www.weforum.org/agenda/2021/02/heres-what-you-need-to-know-about-the-new-ai-arms-race/>

development by the military. This is particularly true as it pertains to the creation of fully autonomous weapons systems (AWS) – ‘killer robots’. The UK military itself appears to have little to say on this AWS matter. The UK government also appears reluctant to openly discuss the issue. The official government line is that the military, ‘does not possess fully autonomous weapons and has no intention of developing them.’³³⁹⁾ This was a reiteration of the phrasing that first appeared in a MoD document in 2017 (and in referring to drone aircraft):

*The UK does not possess armed autonomous aircraft systems and it has no intention to develop them. The UK Government's policy is clear that the operation of UK weapons will always be under human control as an absolute guarantee of human oversight, authority and accountability. Whilst weapon systems may operate in automatic modes there is always a person involved in setting appropriate parameters. (Unmanned Aircraft Systems p. 7)*³⁴⁰⁾

It is, however, known (through a Freedom of Information release) that the MoD is pursuing over 200 projects linked to the use of AWS. Some of these, in the eyes of certain observers, can actually be seen as ‘building blocks’ for the development of fully AWS systems.³⁴¹⁾ Hence, there is doubt in some quarters that the MoD and government are being entirely truthful in their denials about AWS development. It has also been pointed out that the UK has not supported moves at the United Nations to ban AWS.³⁴²⁾ Indeed, the UK government is arguing that any international treaty which would outlaw AWS ‘represents a threat to UK Defence interests’.³⁴³⁾

³³⁹⁾ UK Parliament, *Autonomous weapons: Question for Ministry of Defence*, UIN HL5479, tabled on 18 January 2022. <https://questions-statements.parliament.uk/written-questions/detail/2022-01-18/HL5479>

³⁴⁰⁾ Cole, Chris, ‘New MoD document on use of drones, same old spin’, *Drone Wars*. (2017.09.13.). <https://dronewars.net/2017/09/13/new-mod-document-on-use-of-drones-same-old-spin/>

³⁴¹⁾ Burt, Paul and Chris Cole. ‘MoD AI projects list shows UK is developing technology that allows autonomous drones to kill’, *Drone Wars*. (2023.07.29.). <https://dronewars.net/2023/07/29/mod-ai-projects-list/>

³⁴²⁾ Norton-Taylor, Richard, ‘AI Weapons and “killer robots” – the MOD’s new plans to spend the public’s money’, *Declassified UK*. (2023.09.23). <https://www.declassifieduk.org/ai-weapons-and-killer-robots-the-mods-new-plans-to-spend-the-publics-money/>

³⁴³⁾ UK Ministry of Defence, *The Government Response to the Report by the House of Lords AI in Weapon Systems Committee: “Proceed with Caution: Artificial Intelligence in Weapon System”*, (Session 2023–24

It is clear, though, that the UK's armed forces do want to adopt AI in as many military systems as possible and as soon as possible. High degrees of autonomy are valued, including (when reading between the lines) as part of weapons systems. The issue of whether or not a human actor should be 'in the loop' when it comes to decision-making regarding the use of any 'autonomous' weapons systems is not really discussed by the military. The word that appears most frequently in UK military documentation is that AI is merely an 'enabler', i.e., it helps systems, processes and weapons work better but AI does not actually have decision-making powers. There will always be a human 'in the loop'.

This issue of the ethics of using AWS is dominating UK thinking about the use of AI in future warfare. When, for instance, the MoD released a Joint Doctrine Note (JDN) in 2017, entitled, *The UK Approach to Unmanned Aircraft Systems*,³⁴⁴ its somewhat *laissez-faire* discussion on the ethical and legal issues surrounding AWS raised concerns. As one source put it, 'The subsequent press coverage [relating to this JDN] so horrified the MoD that they removed the publication from their website only restoring it six months later when things had calmed down. Perhaps that is why the new document is so bland.'³⁴⁵ The 'new document' referred to here is the UK MoD's *Unmanned Aircraft Systems* (2017), which is seen as 'bland' because it appears to seek to skirt around issues concerning AWS development and deployment.

This issue of ethical consideration suffuses this paper and will be returned to frequently. This is because, while UK Defence can have a perception of future warfare that does include AWS, it can never admit this openly and nor can it openly be seen to be developing AI. This constraint will inevitably affect AI development going forward.

HL Paper 16) (2024.02)., p.4 https://assets.publishing.service.gov.uk/media/65cb77caa7ded0000c79e526/Government_response_to_the_House_of_Lords_AI_in_Weapon_Systems_Committee_Report.pdf

³⁴⁴ UK Ministry of Defence, *The UK Approach to Unmanned Aircraft Systems*, JDN 2/11. (2011.03). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/644084/20110505-JDN_2-11_UAS_archived-U.pdf

³⁴⁵ Cole, Chris, 'New MoD document on use of drones, same old spin', *Drone Wars*. (2017.09.13.). <https://dronewars.net/2017/09/13/new-mod-document-on-use-of-drones-same-old-spin/>

In terms of this paper's structure, there will firstly be a section looking at the UK MoD's 'vision' related to AI use. There then follows sections related to this ethical issue in more detail. Further sections then consider the framework within which UK AI development for military purposes is operating. A conclusion seeks to draw together the main take-aways on this development.

Before looking in detail at the approach of the UK military to the issue of AI in general and AWS development in particular, there needs to be some situating in terms of the overall atmosphere within which the UK armed forces have to operate. These armed forces act within a western democracy where civilian oversight of military AI development is quite intense. Thus, it is worthwhile first establishing what the overall oversight framework consists of and where it is applying constraints. The overriding message from such oversight is that the UK military, where AI development is concerned, should 'proceed with caution'.

2) The Vision and Strategies for Future AI Warfare

The UK MoD does have an overall 'vision' in regard to the use of AI. This is laid down in the *Defence Artificial Intelligence Strategy (DAIS)* document of 2022.³⁴⁶⁾ The main aim of this document was to make sure, according to Laurence Lee (the UK MoD's then second permanent secretary), that Defence was 'an AI-ready organization'.³⁴⁷⁾ The *DAIS* stresses that military AI development can never just be the responsibility of the MoD. It will always be a collaborative enterprise involving industry, academia and Allies and Partner states.³⁴⁸⁾

'Our vision', the *DAIS* states, 'is that, in terms of AI, we will be the world's most effective, efficient, trusted and influential defense organization for our size.'³⁴⁹⁾

³⁴⁶⁾ UK Ministry of Defence, *Defence Artificial Intelligence Strategy*. (2022.06). https://assets.publishing.service.gov.uk/media/62a7543ee90e070396c9f7d2/Defence_Artificial_Intelligence_Strategy.pdf

³⁴⁷⁾ Wodecki, Ben. 'UK Defense official: The necessity of AI in modern warfare', *AI Business*. (2023.01.25). <https://aibusiness.com/ml/uk-defense-official-on-ai-and-modern-warfare>

³⁴⁸⁾ 'Allies' are fellow NATO states while 'Partners' are those states close in thinking to the UK, such as those in the Five Eyes community outside of NATO – Australia and New Zealand.

This statement can be noted for the word ‘trusted’ – perhaps to give the impression that UK MoD would always be using AWS in a way that conforms to accepted ethical and internationally held norms. There is also the phrase, ‘for our size’. UK MoD wants to be able ‘to punch above its weight’ in terms of the development of military capabilities enhanced by AI. The document points to specific strengths in AI that the UK possesses: ‘The UK is a global superpower in AI’. It says that, ‘UK universities ranked third in the world for most highly cited AI research publications.’³⁴⁹⁾ There is little mention, however, of AWS. They come across as peripheral to the development by the UK military of AI systems more generally. One such mention, though, is with: ‘We particularly seek to deliver and operate world-class AI-enabled systems and platforms, including AI-enabled weapon systems.’³⁵⁰⁾ This word ‘enabled’ may be seen as key; there is nothing about AI supplying actual ‘autonomy’.

This *DAIS* document stresses that the UK is involved in, basically, this AI ‘arms race’.³⁵²⁾ For the UK to fall behind in this ‘race’, notes the *DAIS*, carries strategic risks. The general message is that because the UK’s ‘adversaries’ are developing AI-enabled systems then, as the then UK Defence Secretary, Ben Wallace expressed it, ‘it is imperative that we do not cede them a vital advantage’.³⁵³⁾ In such language, the idea of *having* to develop AWS can be seen to be couched. In terms of looking to the future, this document states that, ‘We face a strategic imperative: adapt and excel in our exploitation of technologies like Artificial Intelligence (AI), or increasingly fall behind our allies and competitors. The challenges are far-reaching and fundamental, and we must be ambitious’.³⁵⁴⁾ The UK military’s situation, as evident from *DAIS*, may be paraphrased by saying,

³⁴⁹⁾ UK Ministry of Defence. *Defence Artificial Intelligence Strategy*, (2022.06). https://assets.publishing.service.gov.uk/media/62a7543ee90e070396c9f7d2/Defence_Artificial_Intelligence_Strategy.pdf, p.2

³⁵⁰⁾ Ibid. p.5

³⁵¹⁾ Ibid. p.13

³⁵²⁾ Kamphuis, Yori and Stephan Leijnen. ‘Here’s what you need to know about the new AI “arms race”’, *World Economic Forum*. (2021.02.22.). <https://www.weforum.org/agenda/2021/02/heres-what-you-need-to-know-about-the-new-ai-arms-race/>

³⁵³⁾ UK Ministry of Defence, (2022.06). Op.cited. . p.1

³⁵⁴⁾ Ibid. p.9

'if our adversaries are doing it then it will be irresponsible of us not to do the same.'

'Proceed with caution'

One body that has been conducting oversight of the UK military's AI development is the House of Lords (HoL). This is the UK parliament's (unelected) second chamber.³⁵⁵ It may be viewed as a body that, being non-partisan, acts as something of a national 'conscience'. It can act, too, as a brake on what the lower chamber of elected Members of Parliament (MPs) in the House of Commons would like to see enacted, i.e., 'the government'. The HoL can, and does, act as a restraint on the introduction of certain government policies. In terms of the potential use by the UK military of, in particular, AWS, the HoL had set up a committee made up of Peers (i.e., members of the HoL) called the 'AI in Weapons Systems Committee'. In December 2023, this committee produced a report which looked at the development, by the British armed forces, of AWS. This report was entitled, *Proceed with Caution: Artificial Intelligence in Weapons Systems*.³⁵⁶ The title here indicates the concerns of the Peers. One of its main findings was that 'the government', when it came to the military's use of AWS, 'must ensure that human control is consistently embedded at all stages of a system's lifecycle, from design to deployment.' In essence, this HoL committee was not content with the approach being adopted by the MoD. The report stated that the MoD's claim to be 'ambitious, safe, responsible'³⁵⁷ in the way that it was applying AI 'had not lived up to reality'.³⁵⁸

The government is always obliged to react to any report by the HoL. In its

³⁵⁵ The House of Lords consists of roughly 782 members, about a third of whom have no political affiliation, including 25 bishops.

³⁵⁶ House of Lords. *Proceed with Caution: Artificial Intelligence in Weapons Systems*, (HL Paper 16), (2023.12). <https://lordslibrary.parliament.uk/ai-in-weapon-systems-committee-report-proceed-with-caution/#:~:text=A%20House%20of%20Lords%20special,artificial%20intelligence%20in%20weapon%20systems>.

³⁵⁷ UK Ministry of Defence, *Ambitious Safe and Responsible: Our approach to the delivery of AI-enabled capability in Defence*, (2022.06). https://assets.publishing.service.gov.uk/media/62a9b1d1e90e07039e31b8cb/20220614-Ambitious_Safe_and_Responsible.pdf

³⁵⁸ House of Lords. (2023.12) Op. cited. p. 3

‘response’, the government (that of the Conservative Party, which was in power, 2010-2024) picked up on this phrase, ‘proceed with caution’. It stated, in the conclusion of its response, that, “Proceed with caution”, the overall message of this [HoL] report, mirrors the MoD’s approach to AI adoption’. (*The Government Response*) Thus, the government was saying that there was nothing to be concerned about: the military would apply its own ‘caution’ because it, like the government, ‘had no intention of developing’ AWS. However, as will be highlighted in this chapter, there appears to be a government understanding that a degree of license needs to be given to the MoD so that it can develop those AWS that it feels may be needed given the ‘arms race’ and the consequences of losing this race.

Actually, some external observers have been critical of the Lords because their report seemed actually to be ‘aligned with the government’s own agenda.’³⁵⁹⁾ But there are definitely ways, though, in which the Lords are certainly not aligned with the government’s agenda. The Lords recommended that the government should introduce an actual definition for an AWS. The government, however, does not want to provide a definition because once a definition comes into play then grey areas are reduced: a system is either an AWS or it is not and can then be banned. If no one knows what an AWS actually is then how can they be declared illegal? The vagueness allows governments to continue to develop them. On this issue, the government asserts that, ‘there is a strong tendency in the ongoing debate about autonomous weapons to assert that any official AWS definition should serve as the starting point for a new legal instrument prohibiting certain types of systems.’³⁶⁰⁾ The government wishes to avoid any ‘prohibition’ because, as it states, its priority ‘is to maximize our military capability in the face of

³⁵⁹⁾ Burt, Peter, ‘Proceed in harmony: The Government replies to the Lords on AI in weapon systems’, *Drone Wars*. (2024.02.28) <https://dronewars.net/2024/02/28/proceed-in-harmony-the-government-replies-to-the-lords-on-ai-in-weapon-systems/>

³⁶⁰⁾ UK Ministry of Defense. *The Government Response to the Report by the House of Lords AI in Weapon Systems Committee: “Proceed with Caution: Artificial Intelligence in Weapon System”*, (Session 2023-24 HL Paper 16). (2024.02). https://assets.publishing.service.gov.uk/media/65cb77caa7ded0000c79e526/Government_response_to_the_House_of_Lords_AI_in_Weapon_Systems_Committee_Report.pdf , p.20

growing threats.' In other words, the 'threat' is acting to give license to the military to develop AWS. As the government further points out, any international treaty that hampers the development of AWS, 'represents a threat to UK Defence interests'.³⁶¹⁾ One of the general government arguments is that because certain other countries will 'misuse advanced AI technologies' then UK Defence cannot limit itself.³⁶²⁾ As a seeming sop to the Lords on this AWS issue, the government states that, 'the irresponsible and unethical behaviors and outcomes about which the [Lords'] Committee is rightly concerned [in regard to AWS use] are already prohibited under existing legal mechanisms.'³⁶³⁾ But this statement is vague at best. In regard to AWS, just what are 'irresponsible and unethical behaviors' and can UK Defence also be allowed to engage in them *if necessary*?

The Lords had made a request that the UK government become a world leader in terms of the 'responsible development and governance of AI.' But this is not taken up by the government. It responded by saying that it was part of a series of international initiatives with what it calls 'like-minded' states. In essence, these are states (such as the US, those in NATO and the Five Eyes community (US, UK, Canada, Australia and New Zealand) that hold the same views about defining AWS as does the UK – that is, they do not want to define it. The UK government is not going to stand out from the crowd in terms of pushing for restrictions on AWS. It cannot be the 'world leader' the Lords want it to be.

3) Ethical issues raised in the DAIS

In this *Defence Artificial Intelligence Strategy* (DAIS) document, there are allusions to the ethical issues that AI development is bound to raise within the military organization of any democratic state. Then Defence Secretary Wallace noted this by saying that 'the use of AI...raises profound issues' (without

³⁶¹⁾ Ibid. p.4

³⁶²⁾ Ibid. p.5

³⁶³⁾ Ibid. p.7

specifically referring to AWS). But, he went on, ‘we must be ambitious in our pursuit of strategic and operational advantage through AI, while upholding the standards, values and norms of the society we serve.’ This word ‘ambitious’ is interesting. It appears to imply, at the very least, some stretching of the ‘standards, values and norms’. This word also appears in the title of the aforementioned government document that seeks to allay any fears of the UK adopting AWS: *Ambitious Safe and Responsible: Our approach to the delivery of AI-enabled capability in Defence*.³⁶⁴

By way of caveat, Wallace, in the *DAIS*, does point out that however ‘ambitious’ UK Defence might be, UK AWS development will not just be a matter of the MoD deciding what the norms might be. These will be overseen by other, civilian, bodies. It is stated in the *DAIS* that, ‘Expertise on issues like AI ethics and safety is provided by organizations like Cambridge University’s Centre for the Study of Existential Risk and Leverhulme Centre for the Future of Intelligence, and Oxford University’s Centre for the Governance of AI and Centre for Long-Term Resilience.’³⁶⁵ Moreover, Wallace affirms that:

The UK’s position as a global AI leader is strengthened by our respected legal system, well-developed regulatory approaches and influential government bodies including the Office for Artificial Intelligence, the Centre for Data Ethics and Innovation (CDEI), the independent AI Council and the Regulatory Horizons Council. (Defence Artificial Intelligence Strategy p. 41)

The *DAIS* goes on:

We are clear that we seek to maximize our operational capability through the use of AI, but also that there must be no ‘race to the bottom’ – no pursuit of capability without regard for responsibilities and safeguards...The UK has an important role to play in avoiding any such downward spiral and has long been

³⁶⁴ UK Ministry of Defence, *Ambitious Safe and Responsible: Our approach to the delivery of AI-enabled capability in Defense*. (2022.06).

³⁶⁵ *Ibid.*

at the forefront of shaping the open international order. International Humanitarian Law [IHL] provides a robust, principle-based framework for the regulation of weapons development and use, focusing on effects rather than the nature of any particular technology. It imposes positive obligations that take account of core principles – distinction, necessity, humanity and proportionality – and is the most appropriate way of regulating new means and methods of warfare. (Defence Artificial Intelligence Strategy p.52)

Such language is, again, somewhat loose. It fails to assure that the UK would strictly adhere to IHL and to the (already vague) *jus ad bellum/jus in bello* 'core principles' of the IHL (distinction, necessity, humanity and proportionality). Rather, they would merely be 'taken into account'. And how does a 'positive obligation' manifest itself? An 'obligation' does not equate to an 'adherence'.

Within this *DAIS* document there is no sense that the UK is going to go out on a limb in terms of advocating restrictions on the use of AI in weapons systems. As the *DAIS* goes on, 'Our approach will underpin our efforts to forge a global understanding on the responsible uses of military AI, aligned with UK values.' There is no sense provided by UK Defence that it will apply its own 'norms' and impose any restrictions on itself. All that UK Defence appears to be saying is that it would adhere to IHL if other states do. It is stated that, 'It is right that we continue to place importance on the UN Convention on Certain Conventional Weapons (CCW), which discusses 'Lethal Autonomous Weapons Systems' (LAWS).' But, again, 'to place importance on' is not the same as following the stipulations of this particular convention.

Within the *Ambitious Safe and Responsible* document there is a mirroring of the vagueness.

We will focus on outcomes, exploring ambitious options rather than filtering out ideas or concepts when they are still on the drawing board. We do not rule out incorporating AI within weapon systems. (p. 9)

So, UK Defence does ‘not rule out incorporating AI within weapons systems’. But this is not saying much. And what about actual ASW? Are they ‘ruled out’?

In practice, however, some concepts and capabilities may prove impossible to deliver in a safe and responsible manner – and we are very clear that there must be context-appropriate human involvement in weapons which identify, select and attack targets. This could mean some form of real-time human supervision, or control exercised through the setting of a system’s operational parameters. (p. 3)

What does ‘context-appropriate’ mean? And does all this equate to a human being ‘in the loop’? And when would ‘a system’s operational parameters’ be set? This could happen in the factory long before the system gets anywhere near a battlefield.

There is thus what might be seen as considerable UK Defence ‘wriggle room’ when it comes to AWS. UK Defence is not going to tie itself down to strict limitations on AI development or utilization. In essence, there is an argument to be made that it cannot. Just as with the development of nuclear weapons in the past, there is a view that it would be irresponsible, in terms of AWS and national security, not to develop weapons that can have a major effect on future battlefields and beyond.

But having said all this, UK Defence does need to be extremely wary of a large body of opinion within the country that totally rejects the idea of the UK having ‘killer robots’. UK Defence might, indeed, have a ‘vision of future warfare’ that does involve such AWS but it can never admit that they are being developed. ‘We have no intention’ of developing ASW *has* to remain the mantra.

4) The British Army’s approach to the use of AI

The UK military as a whole laid out its approach to the use of AI as a capability enabler in the above document, *Defence Artificial Intelligence Strategy*. At a

lower level, the British Army also produced a document (in 2023) that established its own view on the matter.³⁶⁶ Interestingly, this document does not mention the word 'weapon' once (strange for an 'army'!) or make any mention of what might be seen as an AWS. What is clear, though, is that the Army wants to rapidly develop and upscale its own AI capabilities. A number of reasons are given for this.

Competitive advantage

It is seen that the adoption of AI within the British Army will increase the operational tempo and agility of the Army. This will allow, in particular, for 'better-informed and distributed machine-speed decision-support in response to threats.'³⁶⁷ This will enable the Army to not only better control the pace of its operations but also to create faster decision-making cycles than those of adversaries. Success in modern warfare can, in many ways, be reduced to the speed and the tightness of OODA (Observe-Orientate-Decide-Act) loops. But AI can be used to enhance technologies all across the C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance) spectrum that feed into OODA loops.

As a corollary, AI-enabled systems can also be used to 'degrade, disrupt, dislocate, and undermine the adversary's confidence in their own information and intelligence' ³⁶⁸). In essence, what is being discussed here in this sense is principally the use of AI to enable/enhance electromagnetic warfare (EW) assets and cyber warfare effects. Thus, overall, if AI can be used by the Army to make better decisions of its own and to undermine the ability of the adversary to make their own decisions, then a 'competitive advantage' is naturally gained. But there is nothing in this document about AI being used within weapons systems to gain any 'advantage'.

³⁶⁶ UK Ministry of Defence, *Defence Artificial Intelligence Strategy*. (2022.06).

³⁶⁷ *Ibid.* p.5

³⁶⁸ *Ibid.* p.7

Operating efficiency

The British Army looks upon AI as being able to improve flexibility, productivity and training regimes. By implementing what is called ‘intelligent automation’, AI can reduce the ‘cognitive burden’ on individuals and thereby enhance decision-making in, specifically here, the combat service support field. This is seen to lead to improved outcomes in relation to repetitive and complex analytical tasks, ultimately driving operating efficiency and effectiveness. AI, for instance, is seen as being able to ‘revolutionize military engineering capabilities’ and enhance logistics provision.³⁶⁹⁾

Human-centric AI

From this document, *British Army’s Approach to Artificial Intelligence*, it appears that the Army only appears to require AI’s assistance in the areas of decision-making. The adoption of AI is to be focused on the ‘enhancement and support of human decision-making.’³⁷⁰⁾ (To repeat. there is no discussion of AI to ‘enhance’ weapons systems.) What seems to be clear in such a statement is that, rather than AI replacing humans, its use will merely complement human wisdom and judgement, providing decision-makers with the capacity to process and exploit vast amounts of data quickly and accurately. Importantly, this tenet of AI merely enhancing and supporting decision-making is said to be ‘bound by the ethical principle of human-centricity’, as stated in the MoD’s *Ambitious, Safe and Responsible* AI policy document. This Army publication quotes from this earlier document, saying that ‘Human responsibility and accountability cannot be removed – irrespective of the level of AI or autonomy in a system.’³⁷¹⁾ So this is *seemingly* a backing-up of the ‘we have no intention of developing AWS line’.

³⁶⁹⁾ HM Government Press Release, ‘AI set to revolutionise military engineering capabilities’, UK Ministry of Defence. (2023.10.31). <https://www.gov.uk/government/news/ai-set-to-revolutionise-military-engineering-capabilities#:~:text=An%20artificially%20intelligent%20tool%20will,equipment%20before%20they%20become%20problematic>

³⁷⁰⁾ Ibid. p.8

³⁷¹⁾ UK Ministry of Defence, (2022.06). Op cited.

Responding to threats

But also within this Army document there is the general message which, as before, can be paraphrased as, 'if we don't do it, somebody else will.' The threat from adversaries who are making substantial improvements in their own AI capabilities is mentioned. Thus, the Army's message is that it needs to rapidly develop and upscale its own AI capabilities to maintain technological advantage over adversaries and to counter their own use of AI. But, again, there is no mention of weapon systems in this respect.

The question of 'talent'

As with many of the official UK documents devoted to the military's development of AI, the question of finding, encouraging, nurturing and supporting individuals who work in this and related fields is discussed in this Army document. The problem for the Army is that the individuals who are experts in developing AI can work in the private sector for much greater financial rewards. Thus, the idea of 'collaboration' with private industry and academia is a constant refrain in *British Army's Approach to Artificial Intelligence*, as it is in other documents. There is also the question raised of developing a new 'culture' within the Army itself so that the use of AI comes to be accepted more readily.

Ethical considerations

The Army in this document is said to be 'committed to developing and deploying AI-enabled systems responsibly.' The word 'responsibly' again. This would be 'in accordance with applicable UK and international law and clear ethical principles.' There is no sense, however, and as elsewhere, what these 'clear ethical principles' might be. The Army also repeats that the UK will be a leader in 'shaping international standards for the ethical use of AI in defense.'³⁷²

³⁷² UK Ministry of Defence, (2023). Op cited , p.8

Overall stance of the British Army

The sense from *British Army's Approach to Artificial Intelligence* is that the rapid development and scaling (lots of it!) of AI capabilities are crucial for the Army to gain a 'competitive advantage' over adversaries. Making substantial use of AI would, above all (according to this document), enhance human decision-making and improve operating efficiency. And the use of AI would of course, be 'responsible'. What is perhaps remarkable, though, is that the use of AI in 'weapons' does not merit a mention in the whole of *British Army's Approach to Artificial Intelligence*.

5) Framework for development of AI in UK Defence

There is considerable disaggregation of authority in terms of the development of AI within UK Defence. That is, there is no one overarching body with responsibility for taking it forward. As the *Defence Artificial Intelligence Strategy* document expresses it, 'There is no single overall owner for AI in Defence. Every business unit and Function [sic] has an important role to play if we are to achieve our goals.'³⁷³) A certain division of labor is, though, evident:

- MoD Head Office (otherwise known as 'Main Building' on Whitehall in central London). This sets AI policy and strategy, defines capability targets, directs strategic programs and ensures overall coherence.
- There are what are known as Business Units and Functional Leads. These concentrate on forms of AI most relevant to them. They will, to a degree, be guided by Head Office.
- There is also what is known as Strategic Command (based at Northwood, west of London). This is a body tasked with marrying up strategic and

³⁷³) UK Ministry of Defence, (2022.06). *Defence Artificial Intelligence Strategy* https://assets.publishing.service.gov.uk/media/62a7543ee90e070396c9f7d2/Defence_Artificial_Intelligence_Strategy.pdf , p.4

operational issues and thus in creating integration across the warfighting domains (Land, Air, Maritime, Cyber and Space) in terms of AI requirements/demands.

Overall strategic coherence is then said to be in the hands, jointly, of the Defence AI and Autonomy Unit (DAU) and the Defence AI Centre (DAIC). The DAU sets strategic policy frameworks governing development, adoption and use of AI. The DAIC provides a focal point for AI R&D and technical issues.³⁷⁴⁾

It can thus be seen that, with AI development, there is no clear top-down structure that can act to provide true 'governance'. This may be seen as a fault. Especially so when considering – and trying to implement – all of the MoD's 'objectives' that are set out in the *Defence Artificial Intelligence Strategy* document. These are:

Objective 1: 'Transform Defence into an "AI ready" organization'

This would involve:

- Upskilling leaders and the workforce
- Recruiting key talent
- Addressing policy challenges
- Modernizing digital, data and technology enablers

What is notable here are the changes required beyond just introducing new technologies. There has to be the basis prepared for their development. Personnel issues are obviously a factor. People who understand AI and know how to apply it need to be recruited. But there is a lack of them across the whole UK civilian workforce. They will be in demand by civilian firms. This is understood to be a weakness the UK and the UK armed forces have to deal with. The

³⁷⁴⁾ Ibid. p.5

government itself has recognized that, at source, the UK's education system is not providing the human material that can go on to play a part in the development of AI. This educational system does not focus on mathematical and hard sciences in the way that many other countries do (including 'competitor' states, especially Russia).³⁷⁵⁾

In terms of harnessing the human potential that can assist in AI development, the 'readiness' challenge is clear: 'AI development and delivery teams require a range of specialists, including data scientists, AI developers, machine learning engineers and AI analysts.' It is noted that, 'An AI career in Defence must be recognized as an attractive, aspirational choice for this highly skilled talent.'³⁷⁶⁾ In pursuit of better human materiel, it is stated that UK Defence will:

- establish a Head of AI Profession responsible for the AI Skills Framework, developing our recruitment and development retention offer, setting standards for delivery team skills.
- create AI career development and progression pathways with options for deep specialists as well as skilled generalists.
- develop new mechanisms to identify and incubate AI talent within Defence, potentially including aptitude testing, flexible entry paths to the new AI profession and incentive schemes to encourage uptake of advanced technical courses.
- explore options for Unified Career Management of military AI professionals, similar to the model that has been established for Cyber professionals (see below).
- strengthen existing academic partnerships and explore options to tap into government supported interventions across top talent, PhDs and

³⁷⁵⁾ Hodgen, Jeremy and David Pepper, 'Is the UK an outlier? An international comparison of upper secondary mathematics education', *Nuffield Foundation*. (2010). https://www.nuffieldfoundation.org/wp-content/uploads/2019/12/Is-the-UK-an-Outlier_Nuffield-Foundation_v_FINAL.pdf

³⁷⁶⁾ UK Ministry of Defence, (2022.06). *Defence Artificial Intelligence Strategy*, p.25

Masters levels. This includes Turing Fellowships, Centers for Doctoral Training, Postgraduate Industrial-Funded Masters and AI Conversion Courses. We will examine placement schemes for AI Masters students to gain practical experience in Defence, and work with national skills programs to increase the volume of UK talent in critical areas

- use more specialist reservists, tailoring recruitment exercises to attract data-literate individuals to ensure we make effective use of the UK's wider AI talent pool – an essential component of the Whole Force.³⁷⁷⁾

There are several problems with all these aspirations to provide the human material that might assist in AI development in the UK armed forces – and beyond the failings of the UK's educational system. One is that the traditional promotion structure within the UK armed services relies on gaining experience across a broad range of subject areas and in different locales/operational zones. Generalists tend to gain promotion to the highest ranks, not specialists. This mindset has to change if the likes of AI (and other technologies) are to be truly a major part of the armed forces' thinking going forward. An AI specialist (or cyber, or EW or whatever) cannot be sent off to command a ship or a battalion for two years to gain the 'necessary' experience for promotion. As specialists, they need to stay *in situ* gaining skills and experiences in order to be better at their specialism. Promotion pathways have to recognize this. Hence the idea, expressed above, of having the 'Unified Career Management of military AI professionals.' This will, though, be an issue for UK Defence going forward. The idea of privileging 'leaders' over 'specialists' has to change. The final point above about using Reservists is something that is increasingly coming to be an issue for the UK armed forces. Specialists in AI, cyber or any other technological realm, can earn far more than they could do in the military. Thus, the military has to attract people who can split their time between their well-paid civilian jobs and occasional work with the military.

³⁷⁷⁾ Ibid.

Going back to the 'Objectives' laid down in the DAIS:

Objective 2: 'Adopt and exploit AI at pace and scale for Defence advantage'

This would involve:

- Organizing for success
- Exploiting near and longer-term opportunities
- Systematic experimentation
- Collaborating internationally

The mantra of 'at pace and scale' is one frequently seen in UK documents referring to AI development in the military. The uptake of the use of AI-enabled systems has to happen quickly and it has to happen almost *en masse*.

The last point is key. A reiterating that developing AI is something that is best achieved in collaboration with Allies (i.e., NATO) and Partners. There needs to be burden-sharing.

Objective 3: 'Strengthen the UK's defense and security AI ecosystem'

This would involve:

- Building confidence and clarifying requirements
- Addressing commercial barriers
- Incentivizing engagement and co-creation
- Supporting business growth

This idea of a UK 'AI ecosystem' is one used in several government documents relating to AI development. In essence, the idea in creating this ecosystem comes from the understanding that developing AI systems of sufficient capability cannot be done by the military alone. There needs to be input from UK civilian

organizations – industry, academia, etc. Defence, in essence, needs to 'piggy-back' on profit-driven enterprises that develop technologies that the military can make use of itself (dual-use). Indeed, the military could take some technologies and develop them further so that they have specific military uses. (For 'ecosystem', see also below.)

Objective 4: 'Shape global AI developments to promote security, stability and democratic values'

Here is the ethical issue again. But note how this objective is couched. There is no sense that the UK would be in any sense a leader in terms of setting an example in terms of upholding 'democratic values' when it comes to AI development. All that UK Defence can promise to do is to 'shape global AI developments.'³⁷⁸⁾

6) Structural and organizational changes

Given this series of objectives, the government and UK Defence understand that a series of changes are required. Creating the 'AI ready' organization that Defence needs has to involve significant changes. The *DAIS* calls for, 'changes to our culture, skills and policies, training leaders [and] upskilling the workforce.' How is this all to be done? Structures and frameworks are needed.

Perhaps the most important demand here is the necessity to 'upskill' UK Defence's own workforce so that they are able to make full use of AI.

Upskilling the workforce

All this discussion of development, ecosystems and objectives means nothing unless there is the human material to make it all work. To this end, as the *DAIS* puts it:

³⁷⁸⁾ Ibid. p.1

We will generate an informed community of AI users across our workforce, enshrining an understanding of AI as a fundamental component of professional development at all levels of the organization, supported by appropriate training and awareness.

This ‘community’, moreover, has to be about more than just scientists and engineers who develop the AI technologies. It must also include those have to work with the AI tools and systems on a daily basis. Degrees of competence and confidence need to be inculcated. And, again, as the *DAIS* also notes, they must be able to ‘work responsibly’ with AI.

Thus, as the *DAIS*, puts it, ‘we will’:

- explore options to establish and manage a distinctive ‘AI-enabled military operator’ skill-set or trade, adapting existing skill-sets where AI becomes a significant factor;
- institute clear and auditable processes for the licensing and routine re-certification of military AI operators, akin to licenses to operate vehicles or machinery, where appropriate;
- integrate AI and Human-Machine Teaming throughout our training and exercise programs, using real, virtual and simulated techniques, and establish clear systems to capture and learn AI-related lessons from our operational deployments.³⁷⁹⁾

AI leadership at all levels

In line with this desire to create a more ‘savvy’ pool of people who would be developing of working with AI systems within the military, those in positions of responsibility also need to be educated in how best to employ AI: ‘Leaders at all levels must be equipped to appreciate the benefits AI can provide, the risks they

³⁷⁹⁾ Ibid. p.19

need to look out for, and any ethical and societal implications that might arise (with technical knowledge varying by roles).'³⁸⁰) To this end, the *DAIS* has mandated that a series of steps be taken. Training courses will be set up, including those that give 'all senior leaders across Defence [a] foundational and strategic understanding of AI and the implications for their organization.'³⁸¹) Support also needs to be provided that allows personnel at all leadership levels the license to 'implement risk' so that the opportunities AI presents are exploited to their maximum extent. Inculcating this acceptance of AI is seen as crucial if AI development and deployment is truly to continue 'at pace'. As such, the *DAIS*, 'task[s] all Defence organisations and Functions to review policies and processes to ensure leaders are empowered to seize AI opportunities at pace'.

The ecosystem

The idea of creating an AI development 'ecosystem' was discussed earlier: the drawing together of both civilian and military skill-sets to create synergies. But this really needs an actual structure in order to bring it fully into effect. This structure has to draw together all of the relevant parties. Forums thus need to be provided, as *DAIS* expresses it, so that 'communities of interest [are brought together] to share understanding of issues, opportunities and best practice'.³⁸²)

But in drawing together the various parties, there has been no real talk of any sort of actual civil-military 'fusion' where the development of AI for the military is concerned. The language used in the likes of the *DAIS* does, though, stress the high degrees of cooperation necessary between defense, academia and industry – the main players in this 'UK defense and security AI ecosystem.' It is said that, 'We will champion and support our national AI ecosystem as a strategic asset in its own right, forging a more dynamic and integrated partnership.'³⁸³) (*Defence*

³⁸⁰) Ibid.

³⁸¹) Ibid.

³⁸²) Ibid.

³⁸³) Ibid. , p. 5

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A key element of the ecosystem will be the new Defence and National Security AI Network. This, according to *DAIS*, would ‘promote talent exchange and co-creation’ and ‘encourage civil sector investment in defense-relevant AI R&D.’ Crucial here would be the ability to ‘simplify access to Defence data and assets.’³⁸⁴⁾ The sharing of data would have to be a major factor within the ecosystem. Efforts need to be made to ensure that small and medium-sized enterprises would be part of the ecosystem so that their input and perhaps more agile capabilities could be made use of. Military personnel would be seconded to relevant industries in order to be ‘upskilled’ and, in turn, civilian experts ‘seconded’ to the military. The remit of the latter would be ‘to conduct high-risk innovation and drive cultural change’.³⁸⁵⁾

All of these efforts to create the necessary ecosystem would be assisted by the ‘establish[ing of] an Engagement and Interchange Function, delivered by the Defence AI Centre [see below], to encourage seamless interchange between Defence, academia and the tech sector.’ To assist, moreover, in providing substance to the ecosystem, Defence would share its own AI-related intellectual property in order to maximize their exploitation and commercialization by other parties. The whole ecosystem concept is seen as being very much being a two-way street: Defence would gain benefits and so would the other parties. This is seen to be essential in the wider goal of, ‘supporting [a] transition to an AI-enabled economy, capturing the benefits of innovation in the UK.’³⁸⁶⁾

Policy, process and legislation

All of the above cannot, of course, be enacted in a vacuum. There needs, as UK MoD has understood for some years, to be a policy, process and legislation framework in place. Before the *DAIS* was published, there had been the MOD

³⁸⁴⁾ Ibid.

³⁸⁵⁾ Ibid. p.20

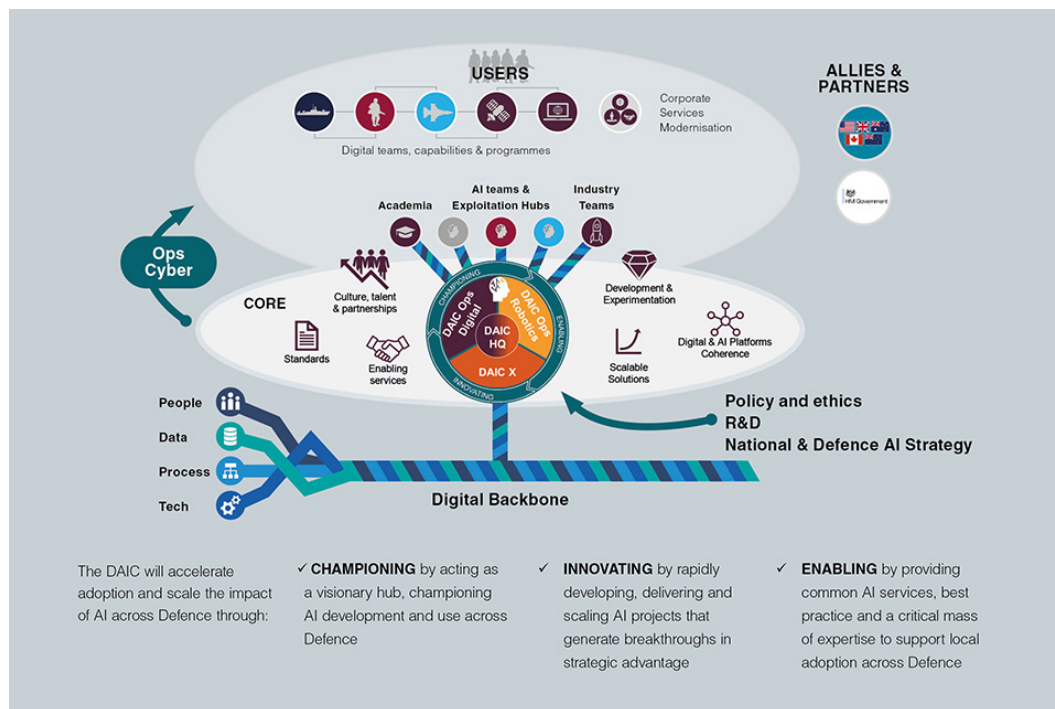
³⁸⁶⁾ Ibid. , p.5

Science and Technology Strategy (2020), which highlighted the importance of 'anticipatory policy making'. This involves resolving policy issues before the point at which any new technology (including those related to AI) is ready to be adopted. The Defence AI and Autonomy Unit (DAU) had already been created in 2018 to help Defence 'adopt these technologies at pace.' (*Defence Artificial Intelligence Strategy* 2.1.6) With *DAIS*, there was a recognition that, 'We must now accelerate efforts to ensure our policies, processes and approaches to legislation enable, rather than constrain us.' (*Defence Artificial Intelligence Strategy* 2.1.6) Issues covered here would be related to the likes of HR policies in relation to staff working with AI; the recruitment of necessary personnel; the use of data, and the use of intellectual property. In essence, the plan is to be proactive on developing policies, processes and legal frameworks so that the eventual adoption of AI systems can happen 'at pace' and is not stymied by red tape. The proactive measures would 'support timely Defence adoption of AI.'³⁸⁷⁾

The Defence AI Centre (DAIC)

At the heart of all of the arrangements designed to bring UK Defence's aspirations to fruition – in terms of the development, adoption and utilization of AI – is the Defence AI Centre (DAIC). The format of this body is provided in diagrammatic form below.

³⁸⁷⁾ Ibid., p.21



[Figure 5-1] Diagram showing the architecture of the Defence AI Centre

(copyright: *Defence Artificial Intelligence Strategy* p.24)

The DAIC was initially set up in April 2022. It is basically designed to bring together expertise from a range of existing UK Defence organizations: Defence Digital, the Defence Science and Technology Laboratory (commonly known as Dstl) and the Defence Equipment and Support's Future Capability Group. It is said that the DAIC is now growing to develop a 'critical mass of expertise' that will 'accelerate the coherent understanding and development of AI capabilities across [Defence].'³⁸⁸⁾

The DAIC is said to have three main functions (seen at the bottom of the above diagram):

1. to act as a visionary hub, championing AI development and use across Defence;

³⁸⁸⁾ Ibid. p.24

2. to enable and coordinate the rapid development, delivery and scaling of AI projects that generate breakthroughs in strategic advantage;
3. to provide access to underpinning pan-Defence digital/data services and sources of expertise as common services to wider Defence.

The DAIC is geared, when it comes to Defence AI development, to acting as the lead agency for the provision of modern digital capacities, common services and tools and data sources that engineers and data scientists need to produce 'prototypes and to test, assure and then deploy their software and algorithms quickly and at scale'. The DAIC is designed to help, guide and cohere technology development and to establish the appropriate development environment.

What is called the 'Digital Backbone' can also be seen near the bottom of the above diagram. This 'backbone' consists of People, Data, Process, and Tech. These are the various strands that need to be woven together in order that they become more than the sum of their parts in terms of serving AI development. Coming off the 'backbone' is a circle containing four elements that need to be working tightly together. In the center lies the DAIC Headquarters, surrounded by DAIC Ops Digital and Robotics, and DAIC-X (the Defence AI Centre Experimentation hub³⁸⁹). In the wider blue circle surrounding these four inner elements are the goals of the DAIC that are already listed along the bottom: Championing AI in Defence; Enabling its use; Innovating through AI.

Enveloping the circle is a lozenge with 'CORE' on its left extremity. Listed within this lozenge (and, as such, acting to influence the elements within the inner circle) are the 'core responsibilities' of DAIC: to maintain Standards; to Enable services; to create the right Culture; to encourage Talent; to create Partnerships; to encourage Development and Experimentation; to provide Scalable solutions;³⁹⁰ and to generate Digital and AI platforms coherence. The

³⁸⁹ The DAIC-X is designed 'to accelerate the adoption of the next generation of AI and AS technologies for Defence, including through the conduct of rapid AI and AS concept development and experimentation'. (Crown Contract Award Service)

³⁹⁰ That is, to take a 'good idea' in terms of a new AI-enabled system and to convert it into something that can be used 'at scale' (i.e., in a way that matters) in an operating environment.

four arrows leading up from the circle show the engagements (in a second lozenge) that the DAIC needs to have. These are with academia, industry and AI teams and exploitation hubs.³⁹¹⁾ These are in the ‘users community’. Further ‘users’ are registered at the top of the lozenge. These users are the five domains of warfare (Land, Maritime, Air, Cyber and Space). Also included (at the top right) in these engagement channels is the UK’s Allies (i.e., NATO) and Partners. Included here is HM Government – i.e., other government departments.

It will be noted the inputs from the bottom right with the blue arrow. These are the factors that the DAIC must ever be mindful of. It can never operate in a vacuum: Policy, Strategy, Ethics and R&D (new research and development) will all be having their say. At the very bottom are the means by which ‘The DAIC will accelerate adoption and scale the impact of AI across Defence.’ These are through:

- CHAMPIONING by acting as a visionary hub, championing AI development and use across Defence
- INNOVATING by rapidly developing, delivering and scaling AI projects that generate breakthroughs in strategic advantage
- ENABLING by providing common AI services, best practice and a critical mass of expertise to support local adoption across Defence

7) Conclusion

In terms of the UK military’s development and adoption of AI, perhaps the final word should be left to James Cartlidge, the UK Minister responsible (until June 2024) for Defence Procurement. In a Defence Committee hearing in Parliament in March 2024, he was quoted as saying, ‘Are we yet at the stage where we can say, in every aspect of the MoD we’re at the highest level of AI preparedness? No.’

³⁹¹⁾ ‘Hubs’ is here referring to points of contact that the DAIC would have in organizations beyond Defence.

This was inferred as him saying that the UK military was 'not AI-ready'. Cartlidge was not asked about AWS. For him, AI as a military tool was all about, 'the ability to Hoover up data to analyze it at a far greater scale, far more quickly'. It was all about information advantage and not weapons systems advantage.³⁹²⁾

There is a clear understanding within UK Defence that 'future warfare' will inevitably involve considerable use of AI. There is also a clear understanding that the UK's 'competitors' have the same idea. As such, UK Defence is inevitably a party to an AI arms race. If the UK does not develop AI-enabled systems of sufficient quality, in a timely fashion (at pace) and in sufficient quantities (at scale), then it risks being left vulnerable to states who do manage to do this – Russia and China, for instance. But UK Defence understands that it cannot go it alone in terms of AI development. It needs help from commercial enterprises and universities within the UK and from Allies and Partners abroad. There is thus a considerable need for collaboration and burden sharing in terms of AI development.

The elephant in the room in regard to all AI development by UK Defence is the ethics of the issue of AWS. The advice from the House of Lords was that UK Defence should 'proceed with caution' in terms of AWS development. But the unspoken, between-the-lines message from a raft of government and Defence documents relating to such development is that while the UK might be 'proceeding with caution' it really has to 'proceed' with AWS. There is an AI arms race. The UK cannot allow itself to be put in a situation where adversary states are able to deploy AWS and effectively use them across a broad spectrum of military activities while the UK cannot. If this happens then, if nothing else, a degree of blackmail might ensue from such adversary powers akin to the nuclear blackmail of times past. UK Defence might, rhetorically, 'have no intention of developing AWS' but it seems it may have to.

³⁹²⁾ Martin, Tim, 'United Kingdom military is not AI-ready, procurement minister says', *Breaking Defense*. (2024.03.20). <https://breakingdefense.com/2024/03/united-kingdom-military-is-not-ai-ready-procurement-minister-says/>

6

Israel's AI Military Innovation

NATIONAL ASSEMBLY FUTURES INSTITUTE

Shlomo Shpiro

The development of Artificial Intelligence (AI) has a wide impact on defense and security all over the world. This research report concentrates on developments in Israel, with special focus on the impact of the Gaza War on Israel's use, perceptions and strategies over the use of AI in defense and security.

This report was written in the period of May-September 2024 using non-confidential sources only. Background interviews were not sourced.

1) The Israeli Perception on the Future Warfare related to the Emerging Technology (AI tech)

Throughout its history, Israel had to rely on military technological superiority for its regional defense. As a small country surrounded by enemies, it could never hope to achieve a quantitative edge over its numerically superior enemy forces. In addition, the cost of a large standing army was beyond the economic possibilities of Israel. As a result of these limitations, Israel's national security policy developed in the 1950s and 1960s on the basis of maintaining a technological military superiority over the opposing enemies, augmented by a large military reserve force capable of being mobilized at short notice. Therefore, the three basic pillars of Israel's national security were:

- a relatively small standing army, mainly based on conscripts and a professional officer corps
- a large reserve army, based on former soldiers who are trained about one

month a year until the age of 50 and are constantly available for emergency mobilization

- cutting-edge advanced military technologies, both defensive and offensive, custom developed to address specific threats to Israel's security

Over the past decade, perceptions over the use of AI in defense and military technologies developed incrementally in parallel to advancements in the capabilities of AI and its robustness. The widest advancements in the use of AI in the Israeli Defense Forces (IDF) were in the field of intelligence, but AI also became an inherent part of tactical and strategic missile defense systems, battlefield command and control systems, and in confidential applications in the field of counterterrorism. Perceptions on the future utility of AI in national defense were high, in the hopes that AI would not present only an incremental improvement in capabilities but would revolutionize certain fields, principally in intelligence, so as to make some more traditional activities obsolete, and achieve not only improvements in capabilities but also substantial savings in resources and manpower.

The 7th October 2023 was the Jewish holiday of *Simhat Torah*. IDF forces along the Gaza border were very thin, with many soldiers being released to celebrate the holidays at home with their families. Early that morning, behind a heavy barrage of thousands of rockets fired at Israel's main cities, about 6000 Hamas terrorists crossed the border between Gaza and Israel and attacked dozens of Israeli villages and towns. Border defenses were breached in over 30 places and the small military garrisons in border fortifications were overwhelmed. The Hamas terrorists massacred Israeli civilians, killing over 1200 people. The Israeli military response was slow, and by the time sufficient forces were mobilized and dispatched South much damage had already been done. The military, and the country at large, were shocked at the scale of the attack, the depth of penetration into Israel, and the extreme brutality of the attacks against the civilian population.

The Hamas attack on Israel on 7th October 2023 radically and dramatically altered the situation in the Middle East, and had a profound impact on the use and perceptions of AI in warfare. The intelligence surprise and the scale of carnage of the 7th October attack called into question many of the basic premises of Israel's security doctrine, not only in early warning but also in military contingency planning and reaction. The Hamas surprise attack and the ensuing war also impacted the use and perceptions of AI, both specifically by the military and in general over AI in defense roles.

Analysis of the intelligence failures which led to the 7th October surprise are beyond the scope of this manuscript but will be the subject of much analysis in coming years. As soon as war broke out in Gaza, the IDF was called upon to conduct a large-scale war characterized by two fixed limitations:

- Most of the battle areas were heavily populated urban areas.
- Under most of Gaza, the Hamas constructed an enormously extensive Hamas underground infrastructure, including tunnels, subterranean bases and munition storage areas.

The IDF had therefore to quickly adapt their AI-based systems for fighting a three-dimensional war on a scale never before imagined or planned. It became clear that the future of AI-based emerging military and defense technologies in Israel would very much depend on their performance in the current war. Thus, perceptions in Israel are still in constant change, influenced by the turmoil of war and the shifting threats from Gaza towards a 'second tier' rocket war from Iran, the Houthis in Yemen, etc.

2) The Vision and Strategies for Future warfare (AI warfare)

The Gaza War brought about major changes in the expectations, vision and strategies for future AI-based warfare. The failure of AI-based intelligence to

provide early warning of the Hamas attack discredited the vision of AI intelligence replacing human intelligence, at least on the strategic level. It has become clear that traditional espionage still has an important role to play in the defense against enemies whose level of technological use is relatively low. Israeli intelligence may have won the AI War but failed in its most basic task, that is to provide an early warning of a military attack against Israel. In the absence of intelligence early warning, the IDF had to rely on massive air firepower and quick mobilization of reserves to stop and then push back the Hamas attack across the border. Even the most advanced AI capabilities used by Israel did not prevent the horrific massacre of over a thousand civilians in one day, the worst day in Israel's history.

While the debate is still raging over the extent of AI's fault in the October 2023 intelligence failure, the vision and the strategies for future AI-based warfare have fundamentally changed. AI-based warfare is no longer perceived as a substitute but rather as an augmentation to kinetic based traditional military warfare. In Gaza, the IDF conducts conventional warfare which, in its most fundamental basics, is not much different than that conducted in urban warfare throughout the 20th century. The main difference is on the tactical level, in which AI plays an increased role in assisting the troops on the ground in a variety of ways. AI systems are used to enhance traditional warfare rather than replace it. For example, AI systems are used to quickly analyze vast intelligence collection resources and provide targets for Israeli firepower quickly and accurately. Other systems analyze the movements and location of suspected Hamas terrorists, both above and below the ground.

One area in which AI made a substantial contribution at the outbreak of war is that of managing various aspects of the military mobilization effort. Once the Gaza war broke out, the IDF mobilized over 300,000 reservists within days. This mobilization was channeled in two opposite directions: while many forces were directed to the front in Gaza, many others were sent north to be ready for a potential attack by the Hezbollah in Lebanon. All these added soldiers needed to

be fed, clothed, equipped and housed without any delays. Such a mobilization by far exceeded existing military contingency plans, which foresaw much of the potential concentration of mobilized troops in the north of Israel rather than in the south. AI systems played a major role in assisting and streamlining the vast logistical effort put in place in order to provide all the needs of those mobilized units. Much of this effort was 'learning by doing' and quickly adapting existing resource management systems to the needs of the new war. The ability of AI systems to quickly learn and adopt out-of-the-box solutions greatly enhanced the IDF's ability to effectively address many of the challenges posed by such a rapid and geographically spread mobilization.

There is much debate in conventional wisdom over defensive and offensive characteristics of AI-based warfare. In post-October 2023 Israel, these characteristics became sides of the same coin. The traditional differentiation between defensive and offensive AI was all but eliminated by the battlefield realities and necessities of the current war. For example, if an AI-based system provides you with analysis of the location and movement of a team of Hamas terrorists, the same system can be expected to, and indeed effectively adapted to, direct necessary firepower for the destruction of those terrorists. One result of the war was the convergence of different AI-based systems to provide effective tactical battlefield solutions. This also became a way of bridging traditional differences between different types of military units, such as infantry, armor, artillery etc. each with its own often deeply entrenched ways of conducting its role in warfare. By jointly accessing and using AI-based warfare systems, a more common approach to battlefield management was created. The results are measurable and indeed very visible military results on the ground, which in turn contributes to a higher degree of confidence within the command structure of the utility of AI-based systems in achieving their military aims.

While much of the current military use of AI-based warfare technologies is confidential, two examples or case studies may be briefly provided to illustrate the potential capabilities and achievements in this field: the first is the

identification of targets for air attacks, the second is the massive use of face recognition technology.

According to foreign media reports, the IDF is using an AI-based system code-named '*Lavender*' to analyze information on identifying targets for air attacks. Especially in the early part of the Gaza war, massive Israeli power was used to weaken the military structures of Hamas and inflict damage to its infrastructure.³⁹³) In such a densely populated area as the Gaza strip, the use of AI-based systems is essential to effectively analyze huge amounts of data, much of it constantly changing, obtained from a wide range of sensory, observatory, communication analysis and other types of sources. The results of such effective analysis maximize the battlefield utilization of limited airpower resources, on the one hand, while trying to minimize civilian casualties and collateral damage as possible, on the other.

The use of AI-based face recognition technologies enables the use of huge amounts of data, from existing and live sources, to identify individuals. The need to identify individuals, at varying distances and light situations, became very important because Hamas kidnapped over 200 Israeli civilians to Gaza. It was unclear where these hostages were being kept, and whether hostages were transferred from Gaza City to other areas of the Gaza Strip as the fighting progressed. IDF observation teams tried to identify Israeli hostages, often at great distances, within the masses of Palestinians moving to safe areas. In a parallel way, advanced face recognition technologies were used to identify terrorists hiding within the civilian population, to track the movements of key terrorists and commanders and to interface with other systems tasked with applying firepower to eliminate immediate terrorist threats.³⁹⁴) For example, on 13 June 2024, the Israeli air force bombed a hiding place of Hamas leader Mohammed Deif. Deif has been a target of several Israeli assassination attempts in the past

³⁹³) YNET. '*This is the AI system which identified 37.000 targets and why the IDF is using it*', (2024.03.03). <https://www.ynet.co.il/news/article/h1jypvj1c>

³⁹⁴) YNET. '*Intelligence sources: this is how Israel uses face recognition technologies to locate wanted persons in the Gaza Strip*', (2024.03.27). <https://www.ynet.co.il/news/article/hj008byzr>

but he always managed to escape in time. Deif became very adept at hiding within the civilian population. This time the Israeli army took no chances and Deif's hiding place was bombed as soon as information was verified as to his presence there. He was killed together with another leading Hamas terrorist. The timing and precision of such an operation critically depends on a multitude of information sources, digital and human, work which is greatly enhanced by using AI-based systems.

3) Organizational Changes of Defense (Military) for Future Warfare

The IDF is a huge organization, with hundreds of thousands of people and many hundreds of units. Many of these units enjoy a high level of freedom and budgets to develop their own technological solutions. In the early years of AI adoption within the IDF, parallel and even competing solutions emerged, with a level of incompatibility which could have adversely affected operational capabilities of the army as a whole at wartime.

The capabilities and challenges of AI-based defense and military technologies required organizational changes within the IDF as well as a realignment of its interaction with industry in this field. In 2019, the Digital Transformation Directorate was created within the IDF's IT and Cyber Defense Branch. This new directorate was tasked with regulating the digital aspects of IDF activities, including AI. Its main challenge was to bridge between the various AI initiatives and activities of specific military units and create an IDF-wide AI strategy.³⁹⁵⁾ The directorate created IDF-wide AI architecture and standards, bringing existing systems into this unified architecture and ensuring that future systems development would conform with the standards.

A large number of IDF units are involved in adoption and use of AI in the

³⁹⁵⁾ Shay Elmakias, 'Digital provides security just like a fighter plane or missile boat', Makor Rishon, (2023. 01.16). <https://www.makorrishon.co.il/magazine/dyukan/566929/>

defense and military realm. Some of those work closely with industry research and development, while others provide user input, new innovation ideas and practical experience. Most of these units and their activities are confidential and cannot be discussed within the remit of this report.

One strong characteristic of the organizational changes of defense for future warfare regarding AI is close cooperation between industry and military end users. Such close cooperation has three important advantages:

- the development of more efficient and effective AI-based systems suitable for real-world military needs
- narrowing the technology gap between 'hard security' military end-users and industry developers
- cutting through red tape barriers and enhancing the dialogue between developers and end-users throughout the lifetime of an operational system

One such example is the cooperation between Microsoft and the IDF. In 2020, the IDF's Combat Methods and Innovation Division, together with the Tactical Command College (*Maltak*), created a new course for teaching AI skills to combat commanders. The course was concentrated on the principles of AI and how they are applicable to combat and wartime situations. A hackathon was held at the end of the course, focusing on operational challenges proposed by the participants.

Following a successful pilot, this course was converted to a fully online format and offered across the IDF in two parts. The first part was an introduction to AI and was offered to all IDF personnel on their mobile devices. The second part, restricted to officers of the rank of captain and above, focused on more operational (and inevitably confidential) aspects of AI. These online courses became very popular and illustrate the usefulness of industry-military cooperation which goes beyond system developments to the realm of the introduction of new AI technologies to end users.³⁹⁶⁾

4) The Governance for Military Technology Innovation

The governance of AI-based military technology takes place within a defused multilevel environmental innovation. On the one hand, the IDF defines specific needs and requests proposals from the industry to meet these requirements. On the other hand, a multitude of SMEs and even very small companies address and develop very specific capabilities, sometimes quite narrow but very innovative, and try to market it for military adoption. This defused governance is not limited only to AI-based military technologies but is characteristic of the wider high tech defense field as a whole.

Even the Israeli military itself is not always a unitary actor but rather has within it several organizations and subunits which require different or even competing AI-based systems at any given time. The activities of the Digital Transformation Directorate within the IDF's IT and Cyber Defense Branch went a long way towards establishing basic standards and architectures required from AI-based military technologies to be accepted by the military, but the AI military technology field is still a multi-stakeholder environment in Israel. This is even more pronounced currently because of specific requirements of various IDF units which emerged and evolved during the current war. Seeing an opportunity, many small private sector companies strive to market their limited but often very ingenious solutions to specific military problems, though such highly-focused systems do not always dovetail with the wider IDF AI-based military warfare strategy.

An old proverb says that '*Necessity is the mother of innovation*'. One very painful example of this civil-military fusion, which illustrates the form of AI-based military technology governance in Israel, was the urgent need to

³⁹⁶ IDF Information. 'Get to know the new IDF AI course', (2021.08.05). <https://www.idf.il/%D7%9B%D7%AA%D7%91%D7%95%D7%AA-%D7%95%D7%A2%D7%93%D7%9B%D7%95%D7%A0%D7%99%D7%9D/2021/%D7%91%D7%99%D7%A0%D7%94-%D7%9E%D7%9C%D7%90%D7%9B%D7%95%D7%AA%D7%99%D7%AA-%D7%91%D7%9B%D7%A3-%D7%94%D7%99%D7%93-%D7%9C%D7%9B%D7%9C%D7%9C-%D7%97%D7%99%D7%99%D7%9C%D7%99-%D7%95%D7%9E%D7%A4%D7%A7%D7%93%D7%99-%D7%A6%D7%94%D7%9C-%D7%A7%D7%95%D7%A8%D7%A1/>

identify many hundreds of bodies of the civilian casualties murdered on 7th October 2023. Many of these civilians were mutilated, burnt or blown up, many bodies were in a state which defied conventional identification technologies. There was great urgency to identify those victims for two reasons: the first was strong pressure by families of missing persons who did not know whether their loved ones were kidnapped to Gaza or were killed. The second was the Jewish tradition in which burial is carried out as soon as possible after death. While most military bodies could be identified with the help of conventional dog tags or teeth x-rays (which are provided by every soldier upon enlistment), many civilians murdered did not have any identification documents on them, some were pulled out of bed early in the morning, and the private belongings of many were looted by the Hamas terrorists.

Immediately after the Hamas massacre, many private sector AI-based companies offered their assistance in the difficult work of identifying the bodies.³⁹⁷ In the case of many bodies, facial features were destroyed and so was the ability to take fingerprints. AI played a major role in the search for missing persons and the identification of bodies. Some bodies were destroyed to such an extent that only archaeological means of identification could be used. As the crisis over the fate of over 200 Israelis kidnapped by Hamas terrorists to Gaza evolved, the task of identification of bodies also meant providing more specific information on who was killed and who was kidnapped. It took a mammoth effort over many months by the police and civilian organizations, but eventually all civilian bodies of those murdered by Hamas could be identified and brought to a proper burial.³⁹⁸ This effort also caused deep psychological scars to many of its participants, who were constantly exposed to horrific graphic and video images of the Hamas massacres as well as to the mutilated and damaged bodies of the victims.

³⁹⁷ Yeshuda Confortes, 'AI at war: High-tech again comes to the rescue', Anashim Umachshevim (People and Computers), (2023.10.13). <https://www.pc.co.il/featured/397084/>

³⁹⁸ Adir Yanko, 'A month to the massacre: 1194 bodies of civilians and soldiers identified so far', YNEY, (2023.11.08). <https://www.ynet.co.il/news/article/skt110vtxp>

5) The Educational Innovation for Future Warfare: Talent Eco system

The ecosystem which forms the base for security AI development in Israel is based on talent pools in three overlapping circles:

- the military intelligence
- the universities
- high-tech industries in general, and cyber high-tech in particular

The Israeli military intelligence, commonly known as *AMAN* (Intelligence Branch), is a large and complex system of various units and subunits dealing with different aspects intelligence collection and analysis. This work is mostly technology-based, although it has an element of human intelligence collection as well. The largest of these units is 'Unit 8200', which is the central SIGINT unit responsible for the interception and analysis of communication. Although Unit 8200 is a central element of military intelligence, it is by far not the only one – the military intelligence ecosystem encompasses numerous units, each with its own technological specializations, systems and fields of responsibility.

Much of the work at the military intelligence is conducted by national service soldiers, augmented by a large officer corps and professional long-term military staff. Israeli citizens, both men and women, serve a compulsory three-year national service in the military. This means that every year a large number of young people who completed their national service at the military intelligence are released into civilian life. Many of these are people who were at the very leading edge of AI technologies, both in development and in the practical application of those systems. After their discharge from the military, many of these young people develop a thriving career in the civilian AI economy and such workers are highly sought after by potential employers.

Israeli universities were very quick to pick up the trend of AI as a field of research and studies. Although universities in Israel are independent entities,

higher education policy is being centrally planned and coordinated by the Higher Education Council (*Malag*), a government appointed body responsible for much of the funding of higher education and the planning of new study programs and degrees. In August 2021, the Israeli government adopted a resolution on advancing AI innovation and encouraging high-tech private sector activities in this field.³⁹⁹ Universities were encouraged not only to open and expand AI study programs but also to increase the use of AI in existing programs, both as a base for advanced research and for teaching. Thus, the universities in Israel became early on a part of the talent ecosystem in expanding the use of AI for defense and military technologies.

The third component of the AI talent pool are the high-tech industries. Israel has often been defined as the 'high-tech nation', with the highest rate of high-tech start-ups per capita. These are being encouraged by a very strong venture capital base, augmented by governmental incentives and an atmosphere which favors investments in the high-tech sector. Israel's high-tech sector is characterized by a high degree of career mobility and serves as a talent pool for the AI sector. High salaries and competitive working environments provide strong incentives for the mobility of talented personnel within the high-tech and AI sectors.

The three talent pools described above – military intelligence, universities and the high-tech sector – provide a sufficient level of manpower for Israel in expanding the AI sector and especially for private sector companies developing security and military AI applications and technologies.

6) The discourse and strategy for the “human in the loop”

Two elements limit public discourse in Israel over the use of AI and military roles: the debate over the use of big data analysis by Israel's General Security

³⁹⁹ Israeli Government Decision No. 212 of 1.8.2021, augmented later by Israeli Government Decision No. 173 of 24.2.2023.

Service (*Shabak*) during the corona pandemic; and the brutality of the Hamas attack against Israel on 7 October 2023.

During the years of the corona pandemic, the Israeli government permitted the internal security service, known as the Shabak, to collect and process big data on the entire population, mainly movement data, for the purpose of contact tracing of people infected with the coronavirus. This breach of privacy and individual rights was extensively debated, both politically and legally, but this practice was eventually accepted and tolerated as the lesser evil in preventing the spread of the coronavirus.⁴⁰⁰

The brutality of the Hamas against Israeli towns and villages, on 7 October 2023, went beyond anything experienced or imagined in the context of the Arab-Israeli conflict. Over 1200 people were murdered, mostly civilians, many of whom were raped, tortured or burnt. Over 200 others were kidnapped, many of whom were subsequently killed in cold blood. This brutality was a deep national and individual shock for the Israeli public. It resulted in wider public acceptance of military measures in Gaza which went beyond previous wars in this region.

The acceptance of widespread big data use by the intelligence services during the corona pandemic, on the one hand, and the horrible brutality of the Hamas attack, on the other hand, limited critical public discourse over the use of AI in military roles, and it was general accepted as an expedient necessity and as an essential part of maintaining military superiority over Israel's enemies.

At the same time, discourse over the ethical aspects and strategy of AI use in military roles took place over the past few years within Israel's military establishment. Much of this debate centered around the issue of 'the human in the loop' and the level of autonomy to be given to AI-based weapons and systems. In general, it could be said that over the years there was an incremental trend of awarding AI-based systems an increasingly higher level of autonomy but without

⁴⁰⁰ Shpiro, S. Israeli Intelligence and the Coronavirus Crisis. *International Journal of Intelligence and CounterIntelligence*, (2020). 34(1), 1-16. <https://doi.org/10.1080/08850607.2020.1805711>

giving up a clear decision-making role of the human in the loop.

One example of this debate over autonomous AI decision-making is the development of the 'See-Shoot System' (Heb. *Roa Yora*). This system was developed for reinforcing border defenses along the Gaza Strip. It consisted of a series of concrete towers mounted with electronic detection systems and large caliber machine guns. These unmanned towers were connected to regional control centers, in which observation cameras, border sensors and other elements were integrated into a border incursion prevention system, manned 24/7 by IDF observers. The purpose of the 'See-Shoot' system was to provide automated firepower on the border line itself without having to risk soldiers in positions exposed to Hamas fire. This system was first deployed in 2010 at great cost and was continually improved technologically to mesh with a wide variety of border sensors and observation systems.⁴⁰¹⁾

While technically capable of a very high degree of autonomy, the actual firing of the 'See-Shoot' guns was only permitted through a structured layer of human intervention, involving at least two persons in identifying the target, such as terrorists crossing the border, and authorizing to open fire on them. The human-machine interface of the 'See-Shoot' system took less than two minutes, so as not to miss the often very limited window of opportunity of preventing armed terrorists from crossing the border. Role of the 'human in the loop' in this system was designed to minimize mistakes which could have resulted in innocent victims. It may also have limited the effectiveness of the system as an element of deterrence. Be that as it may, in the time of its greatest test, the 'See-Shoot' system failed miserably. As waves of terrorists crossed the Gaza border, on the morning of 7 October 2023, the Hamas used small drones to attack the 'See-Shoot' towers and destroy their capabilities.⁴⁰²⁾ In parallel, communication systems between the towers and the control centers were destroyed. The control

⁴⁰¹⁾ Anshil Peper, 'They see and shoot: Hitting terrorists from a chair at a command center', Haaretz, (2010. 07.02). <https://www.haaretz.co.il/misc/2010-07-02/ty-article/0000017f-e628-da9b-a1ff-ee6fcc1a0000>

⁴⁰²⁾ Maariv, 'Washington Post Investigation: This is how Hamas neutralized the technological systems on the fence', (2023.11.17). <https://www.maariv.co.il/news/military/Article-1053028>

centers themselves were attacked by large numbers of terrorists, some were overrun and the soldiers manning them were killed or kidnapped.⁴⁰³⁾

One element which increased public legitimacy for AI-based military solutions was the use of AI in military and national mobilization. AI-based solutions were used at the outbreak of war to make national mobilization more efficient and streamlined. This included the management and allocation of national emergency resources, securing critical infrastructures, and even enhancing the distribution of injured people to various hospitals. The perceived success of AI in rapidly providing solutions to complex problems on the national level, especially at a time of emergency, went a long way towards the acceptance and public legitimacy of AI military use.

In the current need to enhance military operations and use every possible form of defense to protect Israel's civilian population from rocket and terrorist attacks, the debate over how much autonomy to give AI-based systems is still open. Technology today could enable such systems to have a very high degree of autonomy. However, overall Israeli societal responsibility, even at times of war, still necessitates a clear presence of the 'human in the loop'. This societal necessity is not expected to change in coming years.

7) Conclusions

Israel is often described as a high-tech nation, characterized by a very wide high-tech private sector and strong government incentives to technology start-ups and large corporations alike. The Israeli military industries are amongst the most advanced in the world, and are world leaders in certain fields, including drones and anti-missile defenses. The Israeli military also works closely with these defense industries in the development of leading-edge technological solutions to maintaining Israel's qualitative military advantage over its numerous

⁴⁰³⁾ At the main observation control center, in Nachal Oz, 54 IDF soldiers were killed and 10 kidnapped.

enemies, both across its borders and at a greater distance. Israel is amongst the earliest countries to adopt AI-based military technologies on a wide scale, and the military use of AI has gained wide acceptance and legitimacy.

Since October 2023, Israel finds itself in a war on five fronts: in the south with the Hamas in the Gaza Strip; in the north with Hezbollah in Lebanon; in the northeast with rebels in Syria and Iraq, as well as attacks by the Houthis in Yemen and by Iran, both at a distance of around 2000km from Israel's borders. The outbreak of war, the civilian carnage caused by the Hamas attack, and the intelligence failure to provide early warning from this attack illustrated the limits of AI in military technologies.⁴⁰⁴ It has proven to be an excellent tactical tool, but not a strategic game changer.

This research report examines various aspects of military use of AI in Israel and the dilemmas surrounding these capabilities and developments. It is not a story of linear, incremental success. Israeli military is now in the midst of a transitory period, adapting and enhancing AI technologies to augment existing conventional military capabilities rather than replace them. Over-reliance on AI-based intelligence analysis was undoubtedly one of the reasons for the intelligence failure of 7th October. There was disappointment and disillusionment about the overall contribution of AI to the nation's military capabilities when it was needed most. However, during the war, AI-based systems proved their value on countless occasions, but without replacing troops on the ground. Technology-centered hopes of AI replacing major conventional military capabilities were dashed against the harsh realities of the Middle East conflict. One therefore could say that AI now takes its right place within Israel's national defense strategy as augmenting conventional kinetic capabilities but not replacing them.

⁴⁰⁴ Nevo Trabelsi, 'Technology instead of the Head of AMAN: Could this have prevented the Hamas massacre?', Globes, (2024.01.06). <https://www.globes.co.il/news/article.aspx?did=1001466779>

7

NATO's AI Military Innovation

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NATO (North Atlantic Treaty Organization) is a military alliance established in 1949 by Western countries to counter Soviet expansion during the Cold War. It operates on the principle of collective defense, meaning an attack on one member is considered an attack on all. In 2024, NATO marked its 75th anniversary of upholding collective defense. Since its establishment, the transatlantic alliance has grown from 12 founding members to 32 member countries. Finland and Sweden became the most recent members in response to Russia's aggression against Ukraine.⁴⁰⁵⁾ Prior to 2022, while various experts held differing visions and concepts regarding NATO's policies, some even expressing doubts about the alliance's stable future, the Russian invasion of Ukraine has fundamentally altered the security landscape.⁴⁰⁶⁾ The Kremlin's aggressive actions have injected NATO with a much-needed sense of urgency, simultaneously driving accelerated military reforms within member states: boosting defense spending and enhancing the production capabilities of defense sectors.⁴⁰⁷⁾ The Alliance condemned the Russian actions, and many member states strongly engaged in supporting Ukraine militarily.⁴⁰⁸⁾

⁴⁰⁵⁾ Tony Lawrence, Tomas Jermalavičius, Jan Hyllander, *The Newest Allies: Finland and Sweden in NATO*, International Centre for Defence and Security, (2024.03). https://icds.ee/wp-content/uploads/dlm_uploads/2024/03/ICDS_Report_The_Newest_Allies_Lawrence_Jermalavicius_Hyllander_March_2024.pdf (accessed: 3.07.2024).

⁴⁰⁶⁾ Matthias Dembinski and Caroline Fehl (eds.) *Three Visions for NATO. Mapping National Debates on the Future of the Atlantic Alliance*, (Friedrich-Ebert-Stiftung: Berlin, 2021)

⁴⁰⁷⁾ Raimonds Rublovskis, "Impact of Ukraine War on NATO Development. NATO Vision 2030" *Doctrina. Studia Społeczno-Polityczne*, (2023) no 20, DOI: 10.34739/doc.2023.20.04, pp. 77-96.

⁴⁰⁸⁾ Rick Larsen, *Russia's War and Allied Support for Ukraine*, Preliminary Draft Report, 049 DSCTC 24 E, (2024.04.25) <https://www.nato-pa.int/download-file?filename=/sites/default/files/2024-05/049%20DSCTC%2024%20E%20-%20RUSSO-UKRAINIAN%20WAR%20-%20LARSEN%20REPORT.pdf> (Accessed 3.07.2024).

However, the war in Ukraine is not the only factor influencing the Alliance's current policy, as it must also deal with other security challenges.⁴⁰⁹⁾ In this context, the situation in the Middle East and the war in Gaza, as well as China's increasingly assertive policy in the Indo-Pacific region and on the world stage, as well as its partnership with Russia play a pivotal role in designing the NATO's strategic approach.⁴¹⁰⁾ The authorities in Beijing are investing heavily in the development of new technologies, especially in the AI domain, where Chinese investments are three times larger than those of the US.⁴¹¹⁾ Already in 2019, 10 NATO member states (34%) were using Chinese AI-enabled surveillance technologies.⁴¹²⁾ Beijing's AI strategy aims to boost its economy by \$150 billion through AI advancements by the year 2030⁴¹³⁾, and to achieve world's technological supremacy by 2049.⁴¹⁴⁾ Therefore, the unprecedented challenges posed by the situations in Israel and Ukraine together with rising Chinese military and technological capabilities have precipitated a fundamental political and military shift within NATO, unparalleled since the end of the Cold War.⁴¹⁵⁾ Currently one of Alliance's main goals and a driven force behind its policy regarding the modern warfare is to maintain the technological edge over its competitors and avoid situation where China or Russia got a strategic leverage in the technological rivalry.⁴¹⁶⁾

⁴⁰⁹⁾ Tim Sweijts, Frans Osinga, "VIII. Maintaining NATO's Technological Edge", *Whitehall Papers*, (2019) 95:1, pp. 104-118, DOI: 10.1080/02681307.2019.1731216.

⁴¹⁰⁾ Ben Wodecki, "NATO at risk of losing AI innovation race to Russia, China", (2022.05.04). <https://aibusiness.com/verticals/nato-at-risk-of-losing-ai-innovation-race-to-russia-china> (Accessed 15.07.2024).

⁴¹¹⁾ Sunny Cheung, *AI Frontlines: China's PLA evolution vs. NATO's counterplay*, (2023.11.24). <https://www.freiheit.org/taiwan/ai-frontlines-chinas-pla-evolution-vs-natos-counterplay> (Accessed 4.07.2024).

⁴¹²⁾ Simona R. Soare, *Digital Divide? Transatlantic defence cooperation on Artificial Intelligence*, UE Institute For Security Studies, (2020.04) Brief 3, p. 6.

⁴¹³⁾ Ryan Atkinson, 'Artificial Intelligence in Modern Warfare Strategic Innovation and Emerging Risks', *Military Review*, (2024.09-10) 105.

⁴¹⁴⁾ Federico Berger, "The Alliance in the loop: NATO and Artificial Intelligence", NATO Defense College Foundation Paper, (2021). <https://www.natofoundation.org/wp-content/uploads/2021/12/NDCF-Paper-Berger-NATO-and-Artificial-Intelligence-151121.pdf> (Accessed 4.07.2024).

⁴¹⁵⁾ Jordan McDonald, "Overseas Conflicts Spur NATO Tech Transitions", (2023.12.23). <https://govciomedia.com/overseas-conflicts-spur-nato-tech-transitions/> (Accessed 15.07.2024).

⁴¹⁶⁾ Edward Hunter Christie, "Artificial Intelligence at NATO: dynamic adoption, responsible use", (2020.11.24). <https://www.nato.int/docu/review/articles/2020/11/24/artificial-intelligence-at-nato-dynamic-adoption-responsible-use/index.html> (Accessed 15.07.2024).

1) NATO's Perception of AI and Future Warfare: Lessons Learned from Recent Conflicts

Since the beginning of the full-scale Russian invasion of Ukraine, the Alliance has been closely monitoring the course of hostilities, drawing a vast number of conclusions regarding the tactical, operational, and strategic levels of modern warfare. These conclusions encompass a broad spectrum of dimensions ranging from strategic communication, ISR, and cybersecurity to the use of Unmanned Aerial Vehicles, and role played by private companies.⁴¹⁷⁾ The conflict in Ukraine has demonstrated that despite many opinions suggesting a new paradigm of warfare and the growing importance of the cyber domain, effective military operations cannot be conducted without an adequate number of personnel, equipment, and logistical support. The war in Ukraine has shown that the way it is fought is still largely traditional, with most operations relying on the massive use of tanks, armored fighting vehicles, artillery, and combat aircraft. The most important lessons learned were published by NATO in a *Curriculum Guide* in December 2023.⁴¹⁸⁾

Despite numerous indications of the growing role of AI, its utilization in military operations in Ukraine remains marginal. Despite the *Guide's* limited discussion of AI in Ukraine, NATO recognizes its transformative potential for warfare and defense strategies. Moreover, the war has underscored the critical role of technologies identified by NATO as Emerging and Disruptive (EDTs). These include established areas like cyber defense and drone warfare, as well as AI and space-based systems. These technologies are proving to be valuable tools for

⁴¹⁷⁾ Alessandro Marrone, *The War against Ukraine and Its Lessons for NATO Militaries: Food for Thought*, IAI Commentaries, (2023.02.05). <https://www.iai.it/sites/default/files/iaicom2305.pdf> (3.07.2024); John R. Deni, (Accessed 2023.03.20).: *What NATO can do now to apply lessons from Russia's war in Ukraine*, <https://www.atlanticcouncil.org/blogs/new-atlanticist/what-nato-can-do-now-to-apply-lessons-from-russias-war-in-ukraine/> (Accessed 3.07.2024); Franklin D. Kramer, Ann M. Dailey, and Joslyn A. Brodfuehrer, *NATO multidomain operations: Near- and medium-term priority initiatives*, (2024.02.21). pp. 8-10, <https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/nato-multidomain-operations/> (Accessed 15.07.2024).

⁴¹⁸⁾ NATO, *Russian War Against Ukraine. Lessons Learned. Curriculum Guide*, (NATO: Brussels, 2023.12). December 2023.

Ukraine in its ongoing defense efforts, but are also used and developed by countries like China and Russia.⁴¹⁹⁾

In turn, the Hamas attack on Israel in 2023 demonstrated not only how crucial it is to have advanced information regarding security threats but also how the collected data should be analyzed, evaluated, validated, and handled at the command level and by political decision-makers. While Israel is one of the leading countries in the development of modern technologies and a regional power in the Middle East, its intelligence apparatus was unable to effectively prevent the Hamas attack. The Israeli intelligence failure of early warning provides a very important lesson for NATO, especially in the context of the relationship between modern technologies (i.e., detection sensors, SIGINT) and their practical and effective use in an increasingly digital world. Firstly, it shows that while machines are currently able to pool vast amounts of data using various systems, in the end, there are still people who make decisions, and they could draw the wrong conclusions. Secondly, having access to cutting-edge technologies should go hand in hand with constantly enhancing human potential because, in the near future at least, machines will not replace humans in the decision-making process. Finally, AI might be very useful in analyzing collected data, especially in the field of predictive analytics.⁴²⁰⁾ More importantly, analyzing the conflicts in Ukraine and Gaza through the lens of military innovation reveals that the application of AI is the most striking development. It is revolutionizing security policies and will soon or later fundamentally reshape the way wars are fought.⁴²¹⁾

⁴¹⁹⁾ Ulrike Franke, "Technological change in the war in Ukraine – what lessons for NATO allies?", *Bulletin of the Eastern Europe Studies Centre (EESC)*, (2024.02.21) <https://www.eesc.lt/en/publication/technological-change-in-the-war-in-ukraine-what-lessons-for-nato-allies/> (Accessed 3.07.2024).

⁴²⁰⁾ Sonia Lucarelli, Alessandro Marrone; Francesco Niccolò Moro (eds), "NATO Decision-Making in the Age of Big Data and Artificial Intelligence", (NATO: Brussels 2021); Richard Blunt et al, "Using Data Analytics and Machine Learning to Assess NATO's Information Environment", <https://www.sto.nato.int/publications/STO%20Meeting%20Proceedings/STO-MP-IST-160/MP-IST-160-S2-2.pdf> (Accessed 4.07.2024).

⁴²¹⁾ Callum Fraser, "AI's baptism by fire in Ukraine and Gaza offers wider lessons", (2024.04.22) <https://www.iss.org/online-analysis/military-balance/2024/04/analysis-ais-baptism-by-fire-in-ukraine-and-gaza-offer-wider-lessons/> (Accessed 15.07.2024).

NATO's Science and Technology Organization (STO) defines the AI as the "ability of machines to perform tasks that normally require human intelligence – for example, recognizing patterns, learning from experience, drawing conclusions, making predictions, or taking action – whether digitally or as the smart software behind autonomous physical systems".⁴²²⁾ According to NATO, AI is changing the global defense and security environment offering an unprecedented opportunity to strengthen the Alliance's technological edge but at the same time escalating the speed of the new threats. NATO believes that the AI technology will likely affect the full spectrum of activities undertaken by the Alliance in support of its three core tasks: collective defense, crisis management, and cooperative security.⁴²³⁾

The Alliance recognizes that AI is rapidly transforming our world and already impacting modern warfare, with its influence set to become pervasive and lasting.⁴²⁴⁾ Given the rapid pace of technological advancement, a passive stance is untenable for NATO and the alliance is forced to assume an active role in shaping the technological landscape.⁴²⁵⁾ Early applications of AI in defense have primarily focused on surveillance, reconnaissance, and offensive capabilities. Nation-states, private military companies, and even non-state actors like terrorist groups are now leveraging AI-powered systems for these purposes.⁴²⁶⁾ Off-the-shelf drones equipped with rudimentary AI for targeting and navigation are a prime example of this growing trend.⁴²⁷⁾ Modern warfare is witnessing a

⁴²²⁾ NATO. Science & Technology Trends 2020-2040. Exploring the S&T Edge, (NATO: Brussels, 2020.03) p. 14, https://www.nato.int/nato_static_fl2014/assets/pdf/2020/4/pdf/190422-ST_Tech_Trends_Report_2020-2040.pdf (4.07.2024).

⁴²³⁾ NATO. 'Summary of the NATO Artificial Intelligence Strategy', (2021.10.22). https://www.nato.int/cps/en/natohq/official_texts_187617.htm (4.07.2024).

⁴²⁴⁾ Radosław Bielawski, "Development of Security Technologies by NATO: Current Status and Development Prospects", *Safety & Defense*, (2022) 8(1), pp. 23-29, DOI: <https://doi.org/10.37105/sd.170>.

⁴²⁵⁾ Andrea Gilli, "NATO-Mation": Strategies for Leading in the Age of Artificial Intelligence, *NDC Research Paper No. 15*, (2020.12.) .

⁴²⁶⁾ Clarisa Nelu., *Exploitation of Generative AI by Terrorist Groups*, ICCT Analysis, (2024.06.10) <https://www.icct.nl/publication/exploitation-generative-ai-terrorist-groups> (accessed 3.07.2024).

⁴²⁷⁾ Jacques Hartmann, Eva Jueptner, Santiago Matalonga, James Riordan, Samuel White, "Artificial Intelligence, Autonomous Drones and Legal Uncertainties" *European Journal of Risk Regulation* (2023) 14(1), pp. 31-48. doi:10.1017/err.2022.15.

surge in the digitalization of kinetic forces. This translates to equipping soldiers and combat units with advanced technologies that augment their capabilities. The AI and machine learning (ML) are at the forefront of this transformation.⁴²⁸⁾ NATO also recognized the possibilities and threats related to exploitation of AI as a tool to wage and prevent hybrid attacks⁴²⁹⁾ and as a mean to spread and counter the disinformation campaigns.⁴³⁰⁾

Taking into account the rapid spread of new technologies NATO took several steps to properly address the rising challenges related to AI development for future warfare. In October 2021 NATO adopted its first “*Artificial Intelligence strategy*”.⁴³¹⁾ The document was revised in July 2024. While the strategy remains classified, the alliance released its summary which outlines main objectives and stressed its agenda. NATO has updated its 2021 AI strategy to address the rapidly evolving technological landscape, particularly focusing on generative AI and its potential misuse for disinformation. Recognizing the increasing sophistication of AI-generated content, NATO aims to bolster its defenses against adversarial AI applications, including deepfakes and other forms of manipulated information that could undermine the alliance’s unity and decision-making processes. The revised strategy also emphasizes responsible AI development and integration

⁴²⁸⁾ Sam Medhat, “Innovation and Digital Technologies: Underpinning NATO’s Warfare Development Agenda”, *Science in Parliament*, (2023) Vol 79(3), Autumn, <https://www.scienceinparliament.org.uk/wp-content/uploads/2024/05/Innovation-and-Digital-Technologies-Underpinning-NATOs-Warfare-Development-Agenda.pdf>, (accessed 4.07.2024), p. 2.

⁴²⁹⁾ Ralph Thiele, “Artificial Intelligence – A key enabler of hybrid warfare”, *Hybrid CoE Working Paper*, (20 20.03.06) https://www.hybridcoe.fi/wp-content/uploads/2020/07/WP-6_2020_rgb-1.pdf (accessed 4.07.2024).

⁴³⁰⁾ Tetiana Haiduchyk, Artur Shevtsov, Dr Gundars Bergmanis-Korāts, *AI in Precision Persuasion. Unveiling Tactics and Riskson Social Media*, (Riga: NATO STRATCOM COE, 2024.08) <https://stratcomcoe.org/pdfjs/?file=/publications/download/AI-In-Precision-Persuasion-DIGITAL.pdf?zoom=page-fit> (accessed 1 6.10.2024); Alfonsas Juršėnas et al, *The Role of AI in the Battle Against Disinformation*, (Riga: NATO STRATCOM COE, 2022.02) <https://stratcomcoe.org/publications/the-role-of-ai-in-the-battle-against-disinformation/238> (accessed 5.07.2024).; Shawn Benson, “Fighting Fire with Fire: Opportunities for NATO’s Use of AI to Defend Against AI-Assisted Disinformation”, *Georgetown Security Studies Review*, (202 4.03.26) <https://georgetownsecuritystudiesreview.org/2024/03/26/fighting-fire-with-fire-u-s-and-uk-leadership-can-lead-natos-use-of-ai-to-defend-against-ai-disinformation/> (accessed 5.07.2024).

⁴³¹⁾ NATO. ‘Summary of the NATO Artificial Intelligence Strategy’, (2021.10.22), https://www.nato.int/cps/en/natohq/official_texts_187617.htm (accessed 4.07.2024).

within NATO, incorporating measures for testing, evaluation, and workforce adaptation to harness AI's potential while mitigating associated risks. The revised strategy set the four main goals of the NATO's policy towards the AI:

- To provide a foundation for NATO and Allies to lead by example and encourage the development and use of AI in a responsible manner for Allied defense and security purposes;
- To accelerate and mainstream AI adoption in capability development and delivery, enhancing interoperability as a key element within the Alliance, including through the delivery of AI Use Cases;
- To Protect and monitor our AI technologies, manage related risks, and protect our ability to innovate, addressing security policy considerations such as the operationalization of our PRUs;
- To Identify and safeguard against the threats from adversarial use of AI.⁴³²⁾

Moreover, in 2021 NATO Defense Ministers endorsed “Foster and Protect: NATO’s Coherent Implementation Strategy on Emerging and Disruptive Technologies” which became a cornerstone of how the Alliance is addressing the EDT threats. The strategy prioritizes “fostering a coherent approach to the development and adoption of dual-use technologies” with the main goal of strengthen the technological edge, and “creating a forum for Allies to help protect themselves from the use of EDTs by hostile actors”. According to NATO, these are the keys to ensuring that the Alliance retains its “strategic and effective dominance”.⁴³³⁾ In June 2022, at the Summit in Madrid, heads of member states adopted the NATO Strategic Concept which underscored that Russia and China, as “strategic competitors”, invest in technologies that could limit access to space, cripple space capabilities, and threaten the infrastructure. NATO recognized also

⁴³²⁾ NATO. ‘Summary of NATO’s revised Artificial Intelligence (AI) strategy’, (2024.07.10.). https://www.nato.int/cps/en/natohq/official_texts_227237.htm (accessed 15.07.2024).

⁴³³⁾ NATO, ‘Emerging and disruptive technologies’, (2024.05.30). https://www.nato.int/cps/en/natohq/topics_184303.htm, (4.07.2024).

the dual nature of EDTs. These innovations are “altering the character of conflict, acquiring greater strategic importance and becoming key arenas of global competition”, and ultimately influencing victory on the battlefield.⁴³⁴⁾

To navigate the evolving security landscape, and to effectively evaluate the future trends in changing dimensions of warfare, NATO is focusing its innovation efforts on nine key technology areas: AI, autonomous systems, quantum technologies, biotechnology and human enhancement technologies, space, hypersonic systems, novel materials and manufacturing, energy and propulsion and next-generation communications networks. NATO is crafting tailored roadmaps for each of these nine critical technology areas. These plans will pave the way for the Alliance to champion responsible innovation, expedite adoption of modern capabilities, enhance decision-making, guide transatlantic innovation for defense and security and ensure alignment with Allied values, norms, and international law.⁴³⁵⁾

Beyond artificial intelligence, NATO has placed a central focus on quantum technologies which hold the potential to revolutionize innovation and become game-changers for security, including modern warfare. Recognizing this potential, NATO released a summary of its quantum strategy in January 2024.⁴³⁶⁾ This strategy goes beyond defense, guiding cooperation with industry to develop a transatlantic quantum technologies ecosystem.⁴³⁷⁾

⁴³⁴⁾ NATO. ‘NATO 2022 Strategic Concept’, (2022). https://www.nato.int/nato_static_fl2014/assets/pdf/2022/6/pdf/290622-strategic-concept.pdf (accessed 4.07.2024), p. 5.

⁴³⁵⁾ NATO, (2024.05.30). Emerging and disruptive technologies. Op cited.

⁴³⁶⁾ NATO. “NATO releases first ever quantum strategy”. (2024.01.17.). https://www.nato.int/cps/en/natohq/news_221601.htm (accessed 5.07.2024).

⁴³⁷⁾ NATO. Summary of NATO’s Quantum Technologies Strategy, (2024.01.16). https://www.nato.int/cps/en/natohq/official_texts_221777.htm accessed 5.07.2024).

2) NATO's vision and strategies for Future AI warfare

As the modern world becomes increasingly digitized and advanced technologies emerge, many nations and researchers are pondering the future of warfare.⁴³⁸⁾ NATO, recognized as the most effective alliance in history, also invests heavily in studies to anticipate the evolving nature of warfare. These studies have resulted in the publication of various reports. What most of these analyses have in common is the emphasis placed on the future, multi-domain use of AI, the application of which in armed conflicts will be practically unlimited. In a 2016 publication by NATO's Allied Command Transformation (ACT), titled '*Visions of Warfare 2036*', a unique approach was taken. This document employed storytelling to explore a future shaped by the unpredictable consequences of rapid scientific and technological advancements, including human enhancement, advanced weaponry, robotics, artificial intelligence and atypical soldiers.⁴³⁹⁾

Many of the scenarios presented in the report have a real chance of being implemented in practice, and probably much faster than the authors anticipated. Therefore, the ACT completed in 2023 its most in-depth exploration of future trends with the release of the *Strategic Foresight Analysis 2023* (SFA23). This report establishes a foundation for future research initiatives, including NATO's Future Operating Environment project.⁴⁴⁰⁾ Through analyzing potential challenges and opportunities identified in SFA23, the ACT works to ensure NATO's military capabilities adapt to the evolving security landscape by 2043. It achieves this by evaluating the key factors and potential disruptive events that are molding the future security landscape.

The report emphasizes the need to integrate green energy sources and EDTs for

⁴³⁸⁾ See for example: Artur Gruszczak, Sebastian Kaempf (eds) *Routledge Handbook of the Future of Warfare*, (Routledge, 2023) <https://doi.org/10.4324/9781003299011>; Marina Miron, Rod Thornton, "The use of cyber tools by the Russian military: Lessons from the war against Ukraine and a warning for NATO?," *ACIG*, (2024). vol. 3, no. 1, DOI: 10.60097/ACIG/190142; James Johnson, (2021). *Artificial intelligence and the future of warfare. The USA, China, and strategic stability*, Manchester: Manchester University Press.

⁴³⁹⁾ Trina Marie Phillips, August Cole (eds.), *Visions of Warfare 2036*, (Norfolk VA: NATO ACT. (2016).

⁴⁴⁰⁾ NATO. The Future Operating Environment Workshop Concludes in London, (2023.12.04). <https://www.act.nato.int/article/foe-concludes-in-london/> (accessed 5.07.2024).

a sustainable and future-proof fighting force. However, the EDTs will likely introduce novel ethical, moral, conceptual, and governance challenges. Additionally, they could increase the chances of strategic surprise and unintended escalation. The analysis also highlights that military capabilities will become more intelligent and interconnected, with a growing reliance on the commercial sector.⁴⁴¹⁾

According to NATO's vision, the rise of AI in weaponry promises a significant advantage for countries that integrate it first. While countermeasures may eventually emerge, they might struggle to keep pace with the rapid advancements in AI. These EDTs will fundamentally alter how wars escalate, who can afford them, and the overall distribution of military power. This includes the potential for non-state actors to gain access to such technologies. Leading militaries with advanced AI will possess a new generation of highly sophisticated weapons. These weapons will be more accurate, interconnected, faster, have a longer range, and be more destructive than anything currently deployed. AI can be used to control unmanned vehicles across land, sea, and air, enabling 'fire-and-forget' missile systems and automating various tasks within the military. Additionally, AI could be used to orchestrate swarms of intelligent drones, launch devastating cyberattacks, or even trigger high-altitude nuclear blasts causing widespread electronic disruption. Beyond AI, another critical EDT – additive manufacturing (3D printing) – holds the potential to revolutionize military logistics.⁴⁴²⁾ This technology, when combined with advancements in AI, machine learning, big data, and robotics, could lead to on-demand manufacturing systems that respond in real-time to unforeseen challenges. This could significantly shorten supply chains, promote regionalization of production, and improve overall military efficiency. State and private space agencies could particularly benefit from 3D-printed components for complex and expensive satellites. While quantum sensors promise unparalleled military advantages like pinpointing missile

⁴⁴¹⁾ *Allied Command Transformation Strategic Foresight Analysis 2023*, (Norfolk VA: NATO ACT 2023), p. 10.

⁴⁴²⁾ Samu Rautio, Mika Broms M. 'Security scenarios: 3D printed firearms', *Security and Defence Quarterly*, (2024). 48(4). doi: 10.35467/sdq/181047.

launches or mapping enemy territory, their high cost might widen the gap between wealthy and less wealthy nations. Additionally, quantum computing's potential to break encryption could disrupt global financial systems and classified information.⁴⁴³⁾

NATO emphasizes that the future holds both promise and peril with the emergence of EDTs. While these technologies will offer significant benefits, a lack of regulations will create vulnerabilities leading to increased economic and societal challenges. The rapid pace of EDT development will outpace existing regulations and governance frameworks, increasing complexity, confusion, and challenges in anticipating, understanding, attributing, and responding to threats. State and non-state actors are likely to explore dual-use applications of EDTs. The research budgets of most authoritarian states will remain hidden, making it difficult to predict the full extent of their technology development portfolio. It is highly likely, however, that state actors will continue to prioritize EDT development and exploitation of dual-use technologies, with the private sector enabling them to conceal intent and capacities, remaining undetected until deployment. Strategic competitors will likely prioritize achieving first-mover advantage and securing critical technologies, which may lead to a decoupling in scientific research collaboration and an increased volume of intelligence operations. Early adoption of EDTs is expected to confer prime advantages, particularly in areas of command and control (C2) and military decision making, while also creating new risks and vulnerabilities.⁴⁴⁴⁾

While designing the vision of future warfare, NATO pays significant attention to the outcome of the AI as a tool enhancing military capabilities.⁴⁴⁵⁾ This enhancement will primarily come from integrating AI into various related technologies, including virtual and augmented reality, quantum computing,

⁴⁴³⁾ *Allied Command Transformation Strategic Foresight Analysis 2023*, (Norfolk VA: NATO ACT 2023), p. 38.

⁴⁴⁴⁾ *Ibid*, p. 38.

⁴⁴⁵⁾ Maggie Gray, Amy Ertan, *Artificial Intelligence and Autonomy in the Military: An Overview of NATO Member States' Strategies and Deployment*, (NATO CCDCOE, Tallin, 2021). https://ccdcoe.org/uploads/2021/12/Strategies_and_Deployment_A4.pdf (accessed 4.07.2024).

autonomy, modeling and simulation, space, materials research, manufacturing and logistics, and big data analytics. AI is expected to revolutionize nuclear, aerospace, cyber, materials, and biotechnologies. According to some analysts, the strategic impact of AI could be comparable to the advent of nuclear weapons.⁴⁴⁶⁾ In this context, AI will change the battle spaces introducing more connectivity between physical domain, information technology and cognitive space.⁴⁴⁷⁾

3) Structural and Organizational Changes of Military for Future AI Warfare

NATO's Command Structure is overseen by the Military Committee, the highest military authority within NATO. Composed of the Chiefs of Defense from all 32 member states, the Military Committee directs the two strategic commands: Allied Command Operations (ACO) and Allied Command Transformation (ACT). The latter plays a crucial role in modern warfare by leading the Alliance's military adaptation. It ensures NATO's forces are ready and interoperable for future challenges, coordinates national efforts, and provides a secure transition to crisis or conflict. ACT's leadership, headed by the Supreme Allied Commander Transformation, is responsible for the Alliance's transformation and development to meet modern warfare demands.⁴⁴⁸⁾ While the emergence, research, and adaptation of AI for military purposes had not yet triggered broader discussions about the need for structural changes within the NATO commands, the Russian invasion of Ukraine and the accession of two new members sparked comments about the urgency of a new military structure.⁴⁴⁹⁾

⁴⁴⁶⁾ NATO. Science & Technology Trends 2020-2040. Exploring the S&T Edge, (NATO: Brussels, 2020.03), p. 14, https://www.nato.int/nato_static_fl2014/assets/pdf/2020/4/pdf/190422-ST_Tech_Trends_Report_2020-2040.pdf (accessed 4.07.2024), pp. 54-55.

⁴⁴⁷⁾ Can Kasapoğlu, Barış Kırdemir, Artificial Intelligence and the Future of Conflict [in] Tomáš Valášek (ed) New Perspectives on Shared Security: NATO's Next 70 Years, (Carnegie Endowment for International Peace, Brussels, 2019). p. 35.

⁴⁴⁸⁾ Allied Command Transformation, https://www.nato.int/cps/en/natohq/topics_52092.htm (accessed 16.10.2024).

⁴⁴⁹⁾ Richard D. Hooker, Jr., 'A new NATO command structure,' (2024.06.05). <https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/a-new-nato-command-structure/> (accessed 15.10.2024).

In the near future, NATO may consider restructuring its internal organization, particularly as it anticipates the significant transformation of militaries by artificial intelligence. AI has the potential to enhance decision-making, increase operational efficiency, and develop autonomous systems for various tasks. This could lead to faster and more precise responses to threats, but also raises ethical concerns regarding the use of autonomous weapons and the potential for AI-driven cyberattacks. How future warfare might unfold, and particularly how AI will be used to enhance and strengthen military capabilities, was the central question for the 6,000 scientists, engineers, and analysts from NATO's collaborative network who contributed to a report titled '*Science & Technology Trends: 2020-2040*,' compiled by the NATO Science and Technology Organization. This analysis forecasts that AI will revolutionize numerous sectors within the next two decades. According to NATO's STO the AI's impact is expected to unfold:

- **Leveraging the Data Deluge:** AI will capitalize on the exponential growth of digitalization, particularly the vast availability of large datasets. Publicly accessible data will fuel the development and training of increasingly sophisticated AI systems.
- **Cyber-Physical Revolution:** AI's integration with cyber-physical systems is expected to become widespread, leading to significant advancements in automation and interconnectedness.
- **Unforeseen Applications:** As investment in and adoption of AI techniques accelerate, entirely new applications are likely to emerge, potentially revolutionizing various fields.
- **Decision-Making Revolution:** AI's ability to analyze vast amounts of data and optimize outcomes has the potential to transform decision-making processes in areas like power systems management and resource allocation.
- **Computational Evolution:** AI is expected to drive advancements in

computing power, including edge computing, ubiquitous sensors, efficient database design, and the development of new tools and algorithms. This synergy between AI and computing will further accelerate AI's own development.

- **Advanced Data Analysis and Vision:** Continued development of advanced tools for large data pooling and computer vision will empower AI to extract deeper insights from complex data sets.⁴⁵⁰⁾

Within the military domain, NATO believes that the following areas will be significantly impacted by developments over the next two decades:

- **C4ISR:** Future warfighters will use AI-powered systems for dull, dirty, dangerous, or difficult tasks. This could involve virtual assistants, decision support for war games, and AI-suggested courses of action. AI can revolutionize intelligence analysis by aiding data fusion and target identification. Analysts can leverage AI for information gathering across various sources, leading to better threat assessments and decision-making. AI integration can improve military intelligence in various areas.⁴⁵¹⁾ This includes faster warning systems, knowledge management tools, and support for analyzing human behavior and targeting decisions. Additionally, AI could enable powerful embedded processing for real-time battlefield assessments.⁴⁵²⁾
- **Weapons and Effects:** "AI is seen to be of potential use in cross-cueing, trajectory planning, collision avoidance, swarming, weapon selection, battle damage assessment and effects coordination".⁴⁵³⁾

⁴⁵⁰⁾ NATO. Science & Technology Trends 2020-2040. Exploring the S&T Edge, (NATO: Brussels, 2020.03), p. 14, https://www.nato.int/nato_static_fl2014/assets/pdf/2020/4/pdf/190422-ST_Tech_Trends_Report_2020-2040.pdf (accessed 4.07.2024), pp. 50-51.

⁴⁵¹⁾ Brandi Vincent, "AI will 'revolutionize' the way NATO looks at geospatial intelligence, leader says", (20 24.05.07). <https://defensescoop.com/2024/05/07/nato-geoai-revolutionize-geoint-scott-bray/> (accessed 15.07.2024).

⁴⁵²⁾ NATO. 'Science & Technology Trends 2020-2040. Exploring the S&T Edge', (2020.03). p. 55.

- **UxV:** Future autonomous systems will leverage AI for advanced tasks like trajectory planning, obstacle avoidance, and mission adaptation. This includes enabling multi-drone control by a single operator, dynamic navigation for data collection, and even fully autonomous tasks like urban bomb disposal in hazardous environments.
- **Capability Planning:** “AI will support the development of analytical solutions to assist in long term planning within NATO, including supporting complex decision-making that cuts across traditional internal boundaries; assisting assessments of complex factors and effects chains for decision-makers.”⁴⁵⁴⁾
- **CBRN:** NATO seeks a comprehensive AI-powered system for rapid detection and analysis of CBRN threats during various missions. This system would free up human operators, optimize sensor placement, and improve situational awareness for better decision-making and hazard management.
- **Medical:** AI can revolutionize battlefield medicine by aiding with evidence-based treatment, automated decision support, and diagnostics for medics treating casualties in complex situations.⁴⁵⁵⁾
- **Enterprise Management:** NATO seeks to optimize resource management and decision-making through AI-powered analytics for finance (cost analysis, economic impact) and enterprise processes (planning, risk management, readiness).⁴⁵⁶⁾
- **Logistics:** “AI systems have the potential to minimize equipment downtime, minimize system failures, improve inventory and repairs management etc.”⁴⁵⁷⁾

⁴⁵³⁾ Ibid., p. 55.

⁴⁵⁴⁾ Ibid., p. 55.

⁴⁵⁵⁾ Ibid., p. 55.

⁴⁵⁶⁾ Ibid., p. 56

⁴⁵⁷⁾ Ibid., p. 56.

- **Cyber & Info-space:** AI-powered systems will be crucial for cyber defense, autonomously analyzing data, making decisions, and managing networks at speeds exceeding human capabilities.
- **Training:** “AI systems (especially when paired with virtual/augmented reality systems) have the potential to improve individual and customized training through real-time adaption to human behavior and the generation of customized training environments or scenarios”.⁴⁵⁸⁾

“*Science & Technology Trends 2020-2040*” identifies also how adversaries could exploit AI to weaken NATO forces, while also outlining vulnerabilities inherent to AI systems themselves:

- **Cyber:** “AI systems are particularly vulnerable to cyber-attacks, whereby small, deliberate changes may lead to erroneous recommendations or sub-optimal actions”.⁴⁵⁹⁾
- **Information:** “Advances in speech processing and synthesis technology are likely to allow the realistic simulation of friendly and enemy personnel over communications links and broadcast media (i.e. deep fakes). Combined with twitter-bots and other social media hacks, ever more effective AI (e.g. generative adversarial networks, GANs) will greatly increase the scale and effectiveness of hybrid attacks, whether by near-peer or asymmetric threats”.⁴⁶⁰⁾
- **Aberrant Behavior:** AI systems can be a double-edged sword for warfare. While their ability to generate unexpected strategies offers an advantage, their unpredictable and potentially inexplicable behavior poses a significant risk. This is especially worrisome when considering unrestricted AI used by adversaries against human-controlled systems.⁴⁶¹⁾

⁴⁵⁸⁾ Ibid., p. 56.

⁴⁵⁹⁾ Ibid., p. 56.

⁴⁶⁰⁾ Ibid, p. 56.

- IEDs: “Increasingly intelligent, learning systems will enable new generations of improvised explosive devices, less susceptible to traditional countermeasures”.⁴⁶²⁾

Overall, NATO’s analysis indicates that AI will revolutionize various sectors within the next two decades, driven by massive data availability, integration with physical systems, and the emergence of novel applications. This technology will significantly impact decision-making, computing power, and data analysis. AI will fundamentally change how militaries operate, improving performance in areas like command and control, weapons systems, unmanned vehicles, and logistics. However, AI also presents challenges, including vulnerabilities to cyberattacks, the potential for misinformation, and the risks associated with unpredictable AI behavior.

3) The Governance for AI Military Technology Innovation: Civil–Military Fusion

Unlike the Cold War era where defense often spearheaded technological advancements, the commercial sector now dominates innovation in fields like AI. This shift necessitates increased reliance of defense organizations on commercial technology companies for cutting-edge solutions. While civilian-focused companies drive innovation, the direct transfer of these technologies to military applications is not guaranteed due to factors such as profit motives, ethical concerns, and the potential need for substantial modifications. Moreover, the absence of commercial viability for certain defense AI applications requires dedicated military research and development, highlighting the potential mismatch between market-driven innovation and defense requirements.⁴⁶³⁾

⁴⁶¹⁾ Ibid., p. 56.

⁴⁶²⁾ Ibid., p. 56.

⁴⁶³⁾ Sophie-Charlotte Fischer, “NATO and Artificial Intelligence: the Role of Public-Private Sector Collaboration” [in] Sonia Lucarelli, Alessandro Marrone, Francesco N. Moronato (eds.) *Decision-Making in the Age of Big Data and Artificial Intelligence*, (Brussels: NATO, 2021) p. 75-76.

NATO recognizes that the traditional linear development ('Waterfall model') is insufficient for complex, rapidly evolving challenges. Instead, agile methodologies, characterized by iterative development, close user collaboration, and rapid adaptation, are increasingly seen as essential. This approach, combined with concepts like DevOps, DevSecOps, and DataOps, is crucial for harnessing the potential of AI and machine learning. However, implementing these agile practices within the complex structure of NATO requires significant organizational change, including flexible resource management, cultural shifts, and overcoming potential conflicts between traditional and agile approaches.⁴⁶⁴ The practical implementation of AI within allied defense organizations presents a complex set of challenges. Edward Christie identifies four key areas requiring careful consideration: iterative development, access to human capital, access to data, and engagement with civilian-oriented technology institutions through supportive innovation mechanisms.⁴⁶⁵

NATO's strength lies in its diverse membership, offering a wide range of capabilities. However, maintaining interoperability among these diverse forces is challenging. This challenge presents an opportunity to foster a collaborative approach to AI development and deployment. By sharing decision-making, operational experiences, and AI-related actions, NATO seeks to create a more efficient and effective AI ecosystem within the alliance.⁴⁶⁶ Nevertheless, the uneven pace of AI development among members remains a hurdle.⁴⁶⁷ This disparity in capabilities hinders equitable task distribution and unified military operations.⁴⁶⁸ While NATO provides institutional support and funding for AI

⁴⁶⁴ Edward Hunter Christie, "The Nato Alliance and the Challenges of Artificial Intelligence Adoption" [in] Sonia Lucarelli, Alessandro Marrone, Francesco N. Moronato (eds.) *Decision-Making in the Age of Big Data and Artificial Intelligence*, (Brussels: NATO, 2021) p. 87.

⁴⁶⁵ Edward Hunter Christie, Amy Ertan, "NATO and Artificial Intelligence" [in] S. N. Romaniuk, M. Manjikian (eds.) *Routledge Companion to Artificial Intelligence and National Security Policy*. Routledge. Forthcoming. <http://dx.doi.org/10.2139/ssrn.4133397>.

⁴⁶⁶ Jacopo Scipione, *AI and the Transatlantic Challenge*, NATO Defense College Foundation, (n.d.) <https://www.natofoundation.org/game-changers-2020-dossier-nato-european-union-and-artificial-intelligence/> (accessed 3.07.2024).

⁴⁶⁷ Edward Hunter Christie, "Defence cooperation in artificial intelligence: Bridging the transatlantic gap for a stronger Europe" *European View*, (2022) 21(1), pp. 13-21. <https://doi.org/10.1177/17816858221089372>.

⁴⁶⁸ Erik Lin-Greenberg, "Allies and Artificial Intelligence: Obstacles to Operations and Decision-Making",

development, concurrent national research efforts contribute to significant fragmentation in AI's military application.⁴⁶⁹⁾

Therefore, NATO's established expertise in defense innovation and technology assessment faces new problems and challenges.⁴⁷⁰⁾ While the alliance historically prioritizes continuous adaptation through innovation, several factors now hinder its ability to transform effectively. These factors may include the rapid commercialization of digital technologies critical for security, ongoing technological competition with major powers, and internal bureaucratic hurdles. Still, NATO's current approach to defense innovation is a significant shift from the past. Backed by changes in internal structures and processes, it embraces risk-taking and experimentation to a much greater degree. This focus goes beyond technical aspects and incorporates ethical considerations into the development of new technologies (i. e. quantum and AI strategies). NATO seeks to leverage this innovation push to create a new framework for alliance adaptation. By capitalizing on the strengths of democratic member states, NATO can foster an innovation environment that surpasses centralized models like China's.⁴⁷¹⁾

Since 2018, NATO has spearheaded several initiatives to help member states understand how EDTs will impact defense strategies. These ongoing projects focus on both internal Alliance efforts and collaboration with the allies. Developed by NATO's ACT and endorsed in 2019, the Emerging and Disruptive Technologies Roadmap identified seven key technologies with significant defense implications, including AI, big data, and hypersonics. The NATO 2030 Process, an ongoing initiative, explores how the Alliance can adapt and future-proof itself in response to growing competition from major powers and rapid technological advancements. To implement the EDTs Roadmap, the NATO Innovation Board was established in 2020 to coordinate innovation policies and efforts across the

Texas National Security Review, (2020) 3(2), pp. 56-76.

⁴⁶⁹⁾ Alex Etl, (n.d.) "The Impact of AI on NATO Member States' Strategic Thinking", *Proceedings of International Scientific Conference "Strategies XXI"*, vol. XVIII, pp. 493-505.

⁴⁷⁰⁾ Lawrence Aronhime, Alexander Cocron, "NATO's Innovation Challenge", (2021.07.19). <https://www.nato.int/docu/review/articles/2021/07/19/natos-innovation-challenge/index.html> (accessed 15.07.2024).

⁴⁷¹⁾ Simona R. Soare, "Innovation as Adaptation: NATO and Emerging Technologies", (2021.06.11). <https://www.gmfus.org/news/innovation-adaptation-nato-and-emerging-technologies> (accessed 5.07.2024).

Alliance. Additionally, the Innovation Unit, situated within the Emerging Security Challenges division, works on developing pipelines and ecosystems to foster innovation among NATO member states. In October 2022, the Alliance adopted a NATO Data Exploitation Framework, established NATO's Data and Artificial Intelligence Review Board (DARB), and adopted NATO's Autonomy Implementation Plan. In July 2023, NATO's Digital Transformation Implementation Strategy was adopted which aims to link digital transformation to capability-development goals and interoperability requirements.⁴⁷²⁾

[Table 7-1] The NATO's New Unit of AI and Technologies

Year	Unit	Goals
2020	NATO Innovation Board	Led by the Deputy Secretary General, a diverse leadership board seeks external ideas, sparks discussion, and promotes best practices to drive innovation across NATO.
2020	NATO Advisory Group on Emerging and Disruptive Technologies	An independent group of 12 experts from the private sector and academia externally advises NATO to improve its innovation, with membership renewed every two years
2022	Data and Artificial Intelligence Review Board (DARB)	DARB promotes the ethical use of AI in NATO by creating practical tools and certifications, helping Allies implement responsible AI practices.
2022	Defence Innovation Accelerator for the North Atlantic (DIANA)	Foster transatlantic cooperation on critical technologies, promote interoperability and harness civilian innovation by engaging with academia and the private sector
2022	NATO Innovation Fund (NIF)	The EUR 1 billion venture capital fund provides strategic investments in start-ups developing dual-use emerging and disruptive technologies in areas that are critical to Allied security.
2024	Transatlantic Quantum Community	The Transatlantic Quantum Community, an informal group of NATO Allies, fosters collaboration on quantum technologies by sharing expertise and coordinating efforts to advance national agendas.
2024	NATO-Ukraine Joint Analysis, Training and Education Centre (JATEC).	JATEC aims to achieve a two-fold mission: enhancing Ukrainian Armed Forces capabilities through training and education, and learning from Russia's military tactics and modus operandi to inform future strategies.

⁴⁷²⁾ Sven Clement, "NATO and Artificial Intelligence: Navigating the Challenges and Opportunities", Preliminary Draft Special Report, (2024.04.09). p. 6, <https://www.nato-pa.int/download-file?filename=/sites/default/files/2024-05/058%20STC%2024%20E%20-%20NATO%20AI%20-%20CLEMENT%20REPORT.pdf> (accessed 15.07.2024).

On the assumption that the development of future warfare strategies and tools will take place in close symbiosis between the military and civilian sectors, NATO has decided to launch the Defence Innovation Accelerator for the North Atlantic (DIANA). This initiative aims to foster transatlantic cooperation on critical technologies, enhance Allied interoperability, and leverage civilian innovation to strengthen collective defense. Launched in 2021 and endorsed by all NATO Allies in 2022, DIANA focuses on emerging technologies like AI, quantum, and biotechnology to address conventional and technology-based threats. Through competitive challenges, grants, accelerator sites, and test centers, DIANA supports innovators in developing dual-use technologies with both commercial and defense applications. The initiative also provides access to mentorship, investment, and market pathways within NATO and its member countries, DIANA provides innovators with access to a vast support network, including experienced mentors and investors. Additionally, it helps connect these innovators with NATO and its member countries to explore potential commercial and military applications for their technologies. DIANA rewards selected innovators with grants that won't take ownership of their companies (non-dilutive grants). These innovators also get access to a network of specialized facilities across NATO. 'Accelerator sites' are hosted by these facilities, offering unique programs designed to help innovators develop technologies that have both commercial and defense applications (dual-use). DIANA also provides 'test centers' - labs or real-world environments - where innovators can test, refine, and validate their creations. To further stimulate innovation, the NATO Innovation Fund (NIF) was established. This €1 billion fund, backed by 24 of 32 NATO countries⁴⁷³⁾, invests in promising startups developing defense and security technologies. Priority is, however, given to companies supported by DIANA.⁴⁷⁴⁾

In 2023, DIANA launched its first three pilot challenges, selecting 44 companies from a pool of over 1,300 applicants to join its accelerator program and address

⁴⁷³⁾ The US, Canada and France did not join the program.

⁴⁷⁴⁾ NATO. "Defence Innovation Accelerator for the North Atlantic (DIANA)", (2024.07.05). https://www.nato.int/cps/en/natohq/topics_216199.htm (accessed 15.07.2024).

specific challenges in energy resilience, undersea sensing and surveillance, and secure information sharing.⁴⁷⁵⁾ Initial investments include European companies specializing in robotics, computer chips, and space materials, as well as venture capital funds focused on deep tech. NATO is also establishing deep tech hubs to foster innovation and strengthen the Alliance's technological sovereignty, addressing challenges in communication, procurement, and the development of cutting-edge technologies like AI and robotics.⁴⁷⁶⁾ Both instruments – DIANA and NIF are meant to bring NATO members and their industries into closer partnership to fund, develop, and field dual-use EDTs, with AI being one of the most crucial technologies.⁴⁷⁷⁾

5) The Educational Innovation for Future AI Warfare: Talent Eco System

NATO recognizes the pivotal role of education in bolstering its AI warfare capabilities. While individual member states spearhead scientific and educational endeavors in AI research, the Alliance has also launched numerous initiatives to enhance public awareness and provide the necessary expertise to streamline the development of diverse AI applications. The Alliance possesses a wealth of resources including world-class institutions, top researchers, innovative startups, and a strong financial ecosystem. These combined assets can address complex challenges in both defense and civilian sectors, such as augmented reality and quantum computing. A dual-use approach is crucial for maximizing the impact of these technologies, driving innovation, and fostering societal benefits. By encouraging collaboration between government, industry, and academia, the

⁴⁷⁵⁾ Emerging and disruptive technologies, 30 May 2024, https://www.nato.int/cps/en/natohq/topics_184303.htm (accessed 19.07.2024).

⁴⁷⁶⁾ Pascale Davies, "NATO begins its €1 billion investment in AI, space, and robotics defence tech", (2024. 06.18) <https://www.euronews.com/next/2024/06/18/nato-begins-its-1-billion-investment-in-ai-space-and-robotics-defence-tech> (accessed 15.07.2024).

⁴⁷⁷⁾ Daniel Fata, "NATO's Evolving Role in Developing AI Policy", Center for Strategic and International Studies, 8 November, 2022, <https://www.csis.org/analysis/natos-evolving-role-developing-ai-policy> (15.07.2024).

Alliance seeks to capitalize on the commercial potential of these technologies while advancing defense capabilities.⁴⁷⁸⁾

In 2022 NATO launched a strategic initiative to better understand AI and its potential impact on warfare. This initiative, called AI Horizon Scanning, brought together over 80 AI experts from NATO member states and partner nations. The goal was to leverage AI technology while maintaining NATO's military and technological edge. Experts discussed practical applications of AI in defense environments, such as training AI with NATO data to address specific challenges. This initiative was part of a broader effort by to develop AI responsibly. The Hague hosted both the NATO workshop and a conference on Responsible AI, emphasizing the importance of ethical considerations alongside technological advancements.⁴⁷⁹⁾

Another important initiative includes the Defence Education Enhancement Programme (DEEP) which supports partners in modernizing and professionalizing the organizational structure of military education institutions and provides tools to establish effective quality assurance systems. By focusing on curriculum and faculty development, and through collaboration and knowledge-sharing among experts, the program aims to bridge identified gaps.⁴⁸⁰⁾ Recently, DEEP has increased its focus on leveraging AI tools in education and training, laying the groundwork for future enhancements to military training and education programs.⁴⁸¹⁾

Moreover, NATO puts an emphasis on extensive education regarding the AI possibilities and threats. In collaboration with external AI specialists, NATO, for

⁴⁷⁸⁾ Rob Murray, "Building a resilient innovation pipeline for the Alliance", 1 September 2020, <https://www.nato.int/docu/review/articles/2020/09/01/building-a-resilient-innovation-pipeline-for-the-alliance/index.html> (accessed 14.07.2024).

⁴⁷⁹⁾ "NATO launches artificial intelligence strategic initiative", 5 December 2022, <https://www.ncia.nato.int/about-us/newsroom/nato-launches-artificial-intelligence-strategic-initiative.html> (accessed 5.07.2024).

⁴⁸⁰⁾ Defence Education Enhancement Programme (DEEP), 10 July 2024, https://www.nato.int/cps/en/nato_hq/topics_139182.htm (accessed 15.07.2024).

⁴⁸¹⁾ "AI Tools for Education" – NATO DEEP eAcademy Initiative Update, 18 November 2023, <https://deepportal.hq.nato.int/eacademy/events/ai-tools-for-education-nato-deep-eacademy-initiative-update/> (accessed 15.07.2024).

example, hosted an intensive two-day Masterclass on Artificial Intelligence (AI) for its senior leadership at the NCI Academy in Portugal. This program aimed to equip leaders with the knowledge and tools to make informed and responsible decisions about integrating AI across the Alliance's defense activities. The Masterclass combined theoretical foundations of AI with practical applications. Participants engaged in workshops and exercises, exploring real-world AI use cases relevant to their roles within NATO. Guest speakers provided additional insights, while discussions focused on key challenges like data requirements, potential security risks, and the ethical considerations surrounding AI adoption. Ultimately, the program aimed to empower NATO leadership to leverage AI responsibly and effectively in support of the Alliance's goals.⁴⁸²⁾

6) Discourse and Strategy for the “Human in the Loop”

Military systems can be categorized based on their level of autonomy. There are three primary categories: Human-in-the-Loop systems, where humans maintain significant control, making critical decisions and overseeing all actions; Human-on-the-Loop systems, where humans can intervene and potentially override system actions but may not have full control over the decision-making process; and Human-Out-of-the-Loop systems, which are highly autonomous and operate independently within predefined parameters with minimal or no human intervention.⁴⁸³⁾ AI systems face significant security vulnerabilities. There is a lack of standardized methods to assess their weaknesses, especially when integrated into larger systems. The development and use of military AI must be subject to strict regulations, including rules of engagement, that comply with

⁴⁸²⁾ “Responsible AI for defence: Providing NATO leaders a strong foundation in AI fundamentals”, <https://www.solita.fi/work/responsible-ai-for-defence-providing-nato-leaders-a-strong-foundation-in-ai-fundamentals/> (accessed 5.07.2024).

⁴⁸³⁾ Nico Luzum, Nicholas Nelson, “NATO Must Embrace AI and Autonomous Weapons”, Center for European Policy Analysis, 19 July 2022, <https://cepa.org/article/nato-must-embrace-ai-and-autonomous-weapons/> (accessed 4.07.2024).

international law and support its application to military AI.⁴⁸⁴⁾ Additionally, adversarial AI poses a serious threat, particularly to systems with limited human oversight. These vulnerabilities could have severe consequences for AI-driven military operations.⁴⁸⁵⁾ Hence, the differing levels of human control in AI-enabled military systems among NATO members could lead to operational difficulties within the alliance.⁴⁸⁶⁾

NATO, however, has consistently underscored the indispensable role of human judgment in decision-making processes augmented by AI, particularly within the demanding and dynamic context of contemporary warfare.⁴⁸⁷⁾ Compared to other countries, especially China and Russia, NATO has taken a leading role by publicly emphasizing the importance of responsible AI use. The revised NATO AI strategy from 2024 emphasizes the need for a growing range of standards, assessment templates, review processes, and other tools and best practices to operationalize the responsible adoption of AI across the Alliance. NATO should also accelerate the responsible adoption of AI capabilities in line with the UN's General Assembly landmark resolution on AI and in accordance with NATO's own principles and guidelines. Although the declassified summary of the revised strategy doesn't explicitly mention the human-in-the-loop concept, the emphasis on responsible AI use underscores the importance of human involvement in developing and employing AI for modern warfare.⁴⁸⁸⁾

⁴⁸⁴⁾ Tobias Vestner, 'Rules of Engagement as a Regulatory Framework for Military Artificial Intelligence', <https://lieber.westpoint.edu/rules-engagement-regulatory-framework-military-artificial-intelligence/> (accessed 15.10.2024).

⁴⁸⁵⁾ Jacopo Bellasio and Erik Silfversten, "The Impact of New and Emerging Technologies on The Cyber Threat Landscape and Their Implications for NATO" [in], A. Ertan, K. Floyd, P. Pernik, T. Stevens (eds.) *Cyber Threats and NATO 2030: Horizon Scanning and Analysis*, (NATO CCDCO: Tallinn, 2020) p. 91.

⁴⁸⁶⁾ James Black et al., *Strategic competition in the age of AI. Emerging risks and opportunities from military use of artificial intelligence*, (Rand Corporation: Santa Monica-Cambridge, 2024) p. 44, https://www.rand.org/pubs/research_reports/RRA3295-1.html (accessed 16.10.2024).

⁴⁸⁷⁾ Michael Boardman, Fiona Butcher, "An Exploration of Maintaining Human Control in AI Enabled Systems and the Challenges of Achieving It", NATO STO. (2019) <https://www.sto.nato.int/publications/STO%20Meeting%20Proceedings/STO-MP-IST-178/MP-IST-178-07.pdf> (accessed 15.07.2024).

⁴⁸⁸⁾ NATO. Summary of NATO's revised Artificial Intelligence (AI) strategy, (2024.07.10.) https://www.nato.int/cps/en/natohq/official_texts_227237.htm (accessed 15.07.2024).

NATO and its member states are committed to responsible AI integration in defense systems, adhering to both NATO's Principles of Responsible Use and international law. These principles, focusing on legality, accountability, transparency, reliability, governance, and bias mitigation, provide a framework for trustworthy and interoperable AI-enabled autonomous systems. Additionally, NATO aligns its approach to Lethal Autonomous Weapon Systems with international humanitarian law and the framework provided by the Convention on Certain Conventional Weapons, ensuring responsible development and use of these emerging technologies.⁴⁸⁹⁾

In February 2023, NATO's Data and Artificial Intelligence Review Board (DARB), comprising legal, engineering, military, and ethical experts, initiated the development of a user-friendly AI certification standard.⁴⁹⁰⁾ NATO's Data and AI Review Board is central to the Alliance's efforts to oversee the responsible development and use of artificial intelligence. It operationalizes the Principles of Responsible AI, agreed upon by NATO Allies, including by establishing a 'Responsible AI' certification standard. The Board also creates practical guidelines, supports AI implementation within NATO, and assists Allies in their responsible AI endeavors. The Board comprises representatives from each NATO member state, drawing expertise from government, academia, industry, and civil society. This diverse composition ensures a multidisciplinary approach to responsible AI. External experts contribute to the Board's work through specialized subgroups focused on AI tools, standards, and knowledge sharing.⁴⁹¹⁾

⁴⁸⁹⁾ NATO. Summary of NATO's Autonomy Implementation Plan, (2022.10.13) https://www.nato.int/cps/en/natohq/official_texts_208376.htm (accessed 15.07.2024).

⁴⁹⁰⁾ Sven Clement, "NATO and Artificial Intelligence: Navigating the Challenges and Opportunities", Preliminary Draft Special Report, (2024.04.09). p. 7, <https://www.nato-pa.int/download-file?filename=/sites/default/files/2024-05/058%20STC%2024%20E%20-%20NATO%20AI%20-%20CLEMENT%20REPORT.pdf> (accessed 15.07.2024).

⁴⁹¹⁾ Digital Transformation, <https://www.act.nato.int/activities/digital-transformation/>, (accessed 15.07.2024).

7) Conclusions

The Russo-Ukrainian War highlighted a key tension: while cyber and hybrid threats remain a growing concern for NATO's security, large-scale conventional warfare with tanks, artillery, and aircraft persists. A significant challenge exposed by the conflict is the ability of the Alliance's defense sectors to produce enough weaponry for a sustained high-intensity conflict. Beyond this, the wars in Ukraine and Gaza showcase a growing trend: hostile actors increasingly leverage new technological tools in warfare. The proliferation of drones and the emergence of AI applications mark the dawn of a new era where EDTs will progressively transform into powerful instruments that reshape the global power landscape.

Despite being the world's strongest military alliance, NATO has meticulously observed this dangerous technological shift but remained largely passive for years in bolstering its own capabilities, even if reports from various NATO bodies predicted the coming technological revolution with the proliferation and military application of AI.⁴⁹²⁾ Several factors contributed to this stance. Internal divisions within the alliance existed regarding research funding, military spending, and security strategies. Additionally, NATO's 32 member states require consensus on key decisions, leading to compromises that balance the often-contradictory expectations and ambitions of individual countries, as evidenced by the development of the AI strategy. Furthermore, some member states conduct independent research on AI in modern warfare, which they are often reluctant to share.

Recent geopolitical shifts have compelled NATO to prioritize the research and development of AI for military advantage. Driven by concerns over Russia's invasion of Ukraine and China's ambitions to integrate AI into its military, NATO is significantly increasing its investments in EDTs. This initiative aims to ensure seamless collaboration among member states, allowing them to leverage these cutting-edge technologies on the battlefield. However, NATO's goals extend

⁴⁹²⁾ Artur Gruszczak, "NATO's Digital Transformation: No Leap forward, Just Strong Pledge", *IDN Brief*, July 2024, 10.

beyond simply catching up with China and containing Russia. It seeks to achieve a strategic advantage in utilizing modern technologies, echoing past successes in containing the Soviet Union through technological advancement.

Since 2020, NATO has launched numerous initiatives to strengthen its own defense capabilities and establish suitable conditions for knowledge production in the utilization and neutralization of EDT, particularly AI. NATO's AI strategy demonstrates that the Alliance not only takes the new technological race seriously but also attaches great moral significance to it, promoting responsible AI research. Moreover, the establishment of DIANA and the NATO Innovation Fund has become a significant step resulting from a shift in the innovation concept, from state-centric to fusion between the military and private enterprises. In this context, NATO also places a strong emphasis on appropriate education and awareness-raising among the command staff regarding the development of modern technologies, which, on the other hand, remains the domain and responsibility of member states. Finally, adequate investment and the development of military-private partnerships present an opportunity for NATO to effectively participate in the global technological competition based on innovation.

PART III

Conclusion

Jungmi Cha

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1. Comprehensive Analysis of Global AI Military Innovation
 2. Five Key Takeaways from the Research
 3. Implications for South Korea's AI Military Innovation

1

Comprehensive Analysis of Global AI Military Innovation

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The integration of technology and defense has always been a defining factor in the evolution of warfare. In the 21st century, Artificial Intelligence (AI) has emerged as a transformative force, reshaping the dynamics of modern military strategies. For nations striving to maintain a competitive edge on the battlefield, a comprehensive AI strategy is no longer optional but essential. By harnessing AI's advanced capabilities, countries can significantly enhance their defense systems through autonomous technologies, intelligent decision-making algorithms, and seamless data integration from diverse sources.

The application of AI in military systems presents unparalleled opportunities for efficiency, precision, and adaptability. For instance, AI-enabled tools such as predictive maintenance systems and real-time battlefield analysis are improving decision-making at every level of command. These advancements not only enable faster response times but also reduce risks to human personnel, paving the way for more autonomous, connected, and networked combat operations.

Through this research, we found that most global military powers recognize the strategic importance of AI superiority in defense and are intensifying their efforts to outpace the AI military capabilities of their competitors. The United States, China, and Russia are leading efforts to develop AI-driven military systems, with countries like India and Israel emerging as key contributors in this domain. At the same time, alliances such as NATO are heavily investing in AI research and development, highlighting the pivotal role of AI technologies in strengthening collective security frameworks.

The growing prevalence of hybrid and asymmetric warfare further underscores the need for AI integration into military doctrines. However, the widespread

integration of AI into defense systems also brings significant ethical, governance, and regulatory challenges. The dual-use nature of AI—serving both civilian and military purposes—complicates oversight and raises concerns about its potential misuse. Addressing these issues will require collaborative efforts among governments, private sector innovators, and academic institutions to foster responsible innovation while establishing robust international norms and governance frameworks.

This study undertakes a comprehensive analysis of AI's transformative role in reshaping military innovation. It examines the strategies of leading military powers, including the United States, China, Russia, India, and the United Kingdom, alongside Israel, recognized for its cutting-edge AI advancements, and NATO, exemplifying collaborative defense initiatives. By comparing these approaches, this research seeks to provide critical insights into how nations and alliances are preparing for the challenges and opportunities of AI-driven warfare. Following contents are the global military powers' strategies and policies for AI military innovation:

United States: The United States' vision for the future of warfare is closely tied to the development and integration of artificial intelligence (AI) technologies. The Department of Defense (DoD) has taken a multifaceted approach, including establishing specialized organizations like the Joint Artificial Intelligence Center (JAIC), reforming acquisition processes, and fostering collaborations with industry and academia. Key initiatives include the creation of task forces across military branches and partnerships with institutions such as the Defense Innovation Unit (DIU) and universities conducting AI research. Programs like the National Defense Education Program (NDEP) and Minerva Research Initiative further align civilian and military efforts. The DoD emphasizes the importance of autonomous systems, AI talent development, and ethical governance, integrating responsible practices into AI education and oversight mechanisms to ensure AI technologies are developed and deployed responsibly.

Russia : Putin emphasized the need to enhance command and communication

systems by integrating AI "at all levels of decision-making." The Russian Ministry of Defense has positioned itself as the central authority for military AI governance. In collaboration with the Russian Academy of Sciences, financial development institutions, leading research centers, and universities, the MoD has developed an extensive innovation system involving over 1,200 entities across 25 regions, supported by 151 cooperation agreements. The Main Directorate of Scientific Research Activities (GUNID MO RF) oversees the organization of these innovative efforts. Additionally, Directorate for the Development of AI has been established. Russia has also strengthened partnerships between the MoD, educational institutions, and the private sector. Russia's focus on technical education, particularly in AI, began as early as 2012. The Foundation for Advanced Research (FPI), often referred to as the Russian equivalent of DARPA, has actively collaborated with higher education institutions to advance military AI research. However, clear public guidelines for the development and deployment of military AI are absent, and ethical and moral concerns are unlikely to constrain Russia's pursuit of military AI innovation.

China : China's preparation for future warfare emphasizes the concept of "AI+," leveraging AI technology to close the gap between its military capabilities and those of the United States. The idea of "winning informationized local wars," highlighted in China's 2019 Defense White Paper, has since evolved to focus on "winning informationized local wars with intelligent characteristics," reflecting the integration of AI into military operations. The Information Support Force is considered a new unit tasked with transforming the People's Liberation Army (PLA) into an AI-centric military force. China's military AI ecosystem is defined by a comprehensive and balanced military-civil fusion system. The establishment of the Central Commission for Integrated Military and Civilian Development in 2017 has played a crucial role in fostering collaboration between state-owned defense corporations and universities. In December 2021, China submitted the "Chinese Position Paper on the Military Application of AI" at the 6th Review Conference of the UN, outlining its stance on regulating military AI. Additionally, China has

actively participated in global multilateral consultations to promote the responsible use of military AI.

India: India's journey toward AI-driven warfare emphasizes indigenous innovation, ethical considerations, and global collaboration. The Defence Artificial Intelligence Council (DAIC) coordinates AI initiatives across the Army, Navy, and Air Force, aligning them with national defense objectives. AI Directorates within the services focus on research, operational implementation, and data management. The government has committed over 100 crore annually to AI-centric projects and fosters partnerships with private industry and international collaborators, including the Indo-US Defence AI Partnership. Educational efforts include the Ministry of Defence's Centres of Excellence for AI, the Defence Institute of Advanced Technology (DIAT), and military academies like the Defence Services Staff College (DSSC) and the Indian Military Academy (IMA), which integrate AI into their curricula. India's strategy combines innovation and governance, with the DAIC and the MoD developing ethical frameworks for responsible AI use in military applications, underscoring its commitment to self-reliance and technological leadership.

UK : The overriding themes of the UK's AI military innovations are "proceed with caution" and "AI-ready." The UK Ministry of Defence (MoD) recognizes AI as a critical factor in future warfare and outlined its vision in the Defence Artificial Intelligence Strategy (DAIS) document of 2022, which emphasizes building an "AI-ready organization." The DAIS involve collaboration with industry, academia, and allied and partner states. The UK MoD is currently engaged in over 200 projects linked to the use of artificial intelligence and autonomous weapon systems (AWS). UK lacks a clear top-down governance structure for military AI. Instead, strategic coherence is jointly overseen by the Defence AI and Autonomy Unit (DAU) and the Defence AI Centre (DAIC). The DAU sets strategic policy frameworks for the development, adoption, and use of AI, while the DAIC serves as a focal point for AI research, development, and technical guidance. The DAIC also facilitates collaboration between defense, academia, and the tech sector to

promote seamless integration of AI innovations. The UK's position as a global leader in AI is bolstered by its respected legal framework, well-developed regulatory approaches, and influential government bodies such as the Office for Artificial Intelligence, the Centre for Data Ethics and Innovation (CDEI), the independent AI Council, and the Regulatory Horizons Council.

Israel: Israel is amongst the earliest countries to adopt AI-based military technologies on a wide scale, and the military use of AI has gained wide acceptance and legitimacy. The Hamas surprise attack and the ensuing war also impacted the use and perceptions of AI, both specifically by the military and in general over AI in defense roles. AI-based warfare is no longer perceived as a substitute but rather as an augmentation to kinetic based traditional military warfare. The Digital Transformation Directorate was created within the IDF's IT and Cyber Defense Branch. Its main challenge was to bridge between the various AI initiatives and activities of specific military units and create an IDF-wide AI strategy. One strong characteristic of the organizational changes of defense for future warfare regarding AI is close cooperation between industry and military end users. IDF's Combat Methods and Innovation Division, together with the Tactical Command College (Maltak), created a new course for teaching AI skills to combat commanders. The eco system for security AI development is based on talent pools in three overlapping circles: the military intelligence, the universities and high-tech industries. Overall Israeli societal responsibility, even at times of war, still necessitates a clear presence of the 'human in the loop'.

NATO : NATO seeks to leverage this AI innovation push to create a new framework for alliance adaptation. In recent years, NATO has taken significant steps to integrate AI and emerging technologies into its defense strategy. NATO adopted its first "Artificial Intelligence strategy" and key initiatives include the establishment of NATO's Data and Artificial Intelligence Review Board (DARB) and the adoption of NATO's Autonomy Implementation Plan. To strengthen civil-military partnerships, NATO launched the Defence Innovation Accelerator for the North Atlantic (DIANA) in 2022. DIANA engages academia and the private

sector to promote interoperability and support the development of dual-use technologies for commercial and defense applications. NATO Innovation Fund (NIF), also launched in 2022, is a EUR 1 billion venture capital fund providing strategic investments in start-ups working on emerging and disruptive technologies. NATO's AI Horizon Scanning initiative, launched in 2022, aims to better understand AI's potential impact on warfare, ensuring that the alliance remains at the forefront of technological advancements. The establishment of DIANA and the NATO Innovation Fund has become a significant step resulting from a shift in the innovation concept, from state-centric to fusion between the military and private enterprises. AI Horizon Scanning Initiative was part of a broader effort by to develop AI responsibly.

2

Five Key Takeaways from the Research

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Acceleration of AI Military Innovation in Recognition of AI's role in Future Warfare

Artificial intelligence (AI) is increasingly recognized as a decisive factor in winning future wars. The development of AI technology, the strategic competition between the United States and China, and the evolving dynamics of warfare observed in Ukraine and Gaza have heightened the necessity for AI-driven military innovation among many nations. Most major defense ministries acknowledge that future warfare will extensively leverage AI, and they aspire to lead AI military innovation to enhance defense capabilities and secure victory in future conflicts.

The rapidly accelerating pace of technological advancement further reinforces the perception that falling behind competitors or adversaries is not an option. This has spurred major military powers to intensify their efforts to strengthen AI-based military capabilities by implementing AI military strategies, military structural reforms, technological innovation, and talent development plans.

The Rise of an AI Arms Race : “If We Don’t Do it, Somebody Else Will”

The cautious approach to the militarization of AI, coupled with ethical concerns and uncertainties, has not deterred major military powers from striving for leadership in AI-driven military innovation. A key driver of this effort is the fear that adversaries or competitors might achieve AI militarization more rapidly, thereby gaining a strategic advantage. The widespread recognition that future warfare will heavily leverage AI underscores the belief that falling behind in AI militarization poses a significant threat to national security. Consequently,

nations are prioritizing AI research and development as a cornerstone of military modernization. Global military powers are accelerating their AI military programs and allocating significant resources to AI military research to remain competitive.

“Military and Civil Dual-Use Innovation Competition” and AI Race

The global states perceive AI as a "game-changer" in both military power and economic growth. With the perception that the AI will be the decisive factor in winning future wars, AI-driven military innovation has become a top priority for global states striving to achieve military modernization. AI is also regarded as a key driver of future economic growth through its integration into various sectors, including science, manufacturing, healthcare, finance, transportation, and smart cities. The dual-use nature of AI technologies forms the foundation for driving global AI military innovation. Global states are thinking that the investment in dual-use technologies allows states to maximize returns, as innovations can benefit both national security and industrial progress. Countries have been competing for geopolitical dominance aim to integrate cutting-edge innovations for military modernization while leveraging them for civilian economic development. With the dual-use development of AI, the AI military technology ecosystems are based on the Military-Civil Fusion and the AI military governance also have been formed within the civil-military cooperative system.

The Expansion of Civil-Military Fusion for AI military innovation

Civilian industries, particularly in tech, often innovate faster than military organizations due to market-driven incentives. Therefore, the civil-military Fusion(CMF) model enables the military to leverage cutting-edge technologies like AI. Based on the comparative research on major countries' AI military innovation, all the states in this research have been adapting civilian technologies to defense needs and collaborating with the private sector for the technological

advancement. Nations with strong CMF ecosystems, such as China and the United States, can rapidly modernize their military capabilities, gaining strategic advantages in AI militarization. The other states such as Russia, UK, India and Israel also have been eager to integrate the private sector with the defense. All the states in this research have tried to build the CMF ecosystem for technological breakthrough and educating the talents. Beyond technical education, ethical considerations and civil-military collaboration are essential to ensure AI integration is both responsible and effective.

The Need for Responsible Innovation : “Human in the loop”

AI is revolutionizing military operations, offering transformative benefits in efficiency, decision-making, and combat effectiveness. However, these innovations come with significant challenges that require careful oversight, regulation, and ethical considerations. AI-driven automation reduces human involvement in combat, raising ethical and legal concerns regarding accountability for autonomous weapons' actions and decisions. There are the rising concerns on the 'Human Out of the Loop', where AI systems operate completely autonomously without human intervention or supervision, could lead to the disaster for the human being.

While nations strive to gain strategic advantage, the ethical, legal, and geopolitical challenges posed by AI militarization underscore the need for global cooperation to ensure stability in the AI-driven security landscape. Based on the comparative research on major countries' AI military innovations, majority of the great powers have been delving into the AI ethics and the discourse on the 'human in the loop'. However, there are different approaches on how much human need to intervene and to regulate the AI militarization. Some have more innovation centric AI military innovation strategies and some have more ethically cautious approaches to deter the negative impact on the AI militarization.

3

Implications for South Korea's AI Military Innovation

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As global competition in AI military innovation intensifies, South Korea faces both opportunities and challenges in maintaining a strategic edge. Given its geopolitical position, technological strengths, and security concerns, the development of AI-driven defense capabilities is critical for South Korea's future security. South Korea also has the *Defense Innovation 4.0* strategy, which is focusing on AI based modernization. With the rise of an AI arms race and AI ethics discussion, South Korea also needs to understand the other countries' strategies and discourses, which will enhance the long-term trend of global AI arms race and its implication for South Korea's AI military innovation.

AI military innovation offers opportunities to expand South Korea's defense industry and position itself as a leader in AI-driven military exports, as well as to enhance the military capabilities in the era of future AI warfare. With facing the diverse security threat from geopolitical crisis, and traditional and non-traditional threat, South Korea needs to harness AI technological capacities to ensure the future national security.

First, South Korea needs a long-term and comprehensive strategy for AI military innovation. Artificial intelligence is changing the world and the warfare. These trends present the risks and opportunities for South Korea's future security. Artificial intelligence (AI) is central to South Korea's defense planning, as demonstrated by the recent launch of the nation's Defense AI Center and its pursuit of technologies such as "on-device AI" to enhance command and control in battlefield situations and offset a shrinking labor force. By pooling the resources of South Korea's civilian technology and defense sectors, Seoul seeks to use AI to deter and defend against threats posed by North Korea and other

potential adversaries.⁴⁹³⁾ With its diverse defense policies related to AI militarization, South Korean military has been striving to achieve the military superiorities. However, the AI military innovation strategy of South Korea needs more long-term and comprehensive visions to position itself as a global military power in AI era.

Second, South Korea needs to strengthen partnerships between the government, defense sector, and private AI companies which can fuel economic growth while meeting national security demands. Amid the global trends of civil-military fusion for AI military innovation, South Korea must strengthen its own CMF mechanism in order to harness its technological edge and the superior advanced manufacturing capacities.

Third, South Korea needs to enhance AI talent development in military domain. South Korea needs to establish specialized AI and defense technology programs in universities to train a new generation of military AI experts. The military sector needs to promote collaboration with global AI military research unit to ensure access to the latest advancements and best practices. The most important tasks for the AI military innovations is to attract and train top AI talent.

Fourth, South Korea needs to strengthen alliances and defense diplomacy to enhance the AI military capabilities and technological superiority. South Korea needs to deepen cooperation with allies and like-minded countries to access cutting-edge AI military technologies and share best practices. South Korea can explore collaborations with the innovative states and other international partners to participate in diverse joint AI defense research projects.

Fifth, cyber security issues and information operations should be included in this AI military innovation. The age of information has also ushered in the age of disinformation. Artificial intelligence (AI), specifically machine learning (ML), is poised to amplify disinformation campaigns—influence operations that involve

⁴⁹³⁾ Indo-Pacific Defense Forum, “South Korea launches defense AI center to enhance technology capabilities,” (2024.07.04). <https://ipdefenseforum.com/2024/07/south-korea-launches-defense-ai-center-to-enhance-technology-capabilities/>

covert efforts to intentionally spread false or misleading information.⁴⁹⁴ Cybersecurity is a critical factor in the era of AI-driven warfare. Ensuring robust cybersecurity measures is essential to safeguarding military AI infrastructure from cyber threats, data manipulation, and adversarial attacks.

Sixth, ethics and global norms on AI should be included in AI military innovation strategies. The global concerns and discussion on the future of AI military innovation are growing. The deployment of AI in military domain raises ethical dilemmas, including accountability and the potential for unintended escalations. South Korea must balance technological development with international norms and its commitment to responsible AI use. South Korea needs to build the Korean model of AI ethics and norms for achieving the development and security. South Korea needs to take an active role in shaping global norms and agreements regarding the responsible use of AI in warfare.

South Korea must leverage its technological strengths, invest in indigenous R&D, and develop strategic partnerships in order to remain competitive in the global AI arms race. By prioritizing ethical AI deployment, talent development, and technological advancement, South Korea can enhance its national security, support economic growth, and establish itself as a leader in AI military innovation.

The role of National Assembly in AI military innovation is crucial, encompassing the development of strategic direction, allocation of funding, oversight, and ethical considerations for the use of AI technologies in defense. In December 2023, the UK House of Lords established the AI in Weapons Systems Committee, which published a report titled 'Proceed with Caution: Artificial Intelligence in Weapons Systems'. This report examined the British armed forces' development of autonomous weapon systems (AWS). Similarly, the U.S. bipartisan House Task Force on Artificial Intelligence released its final 2024 Flash Report on Artificial Intelligence, laying a strong foundation for future Congressional AI policy.

⁴⁹⁴ Katerina Sedova, et al. "AI and the Future of Disinformation Campaigns-Part 1: The RICHDATA Framework," *CEST Policy Brief*, (2021.12). p.1.

South Korea's National assembly needs to have more attentions and discussions on the future of warfare and military modernization in the AI era. National assembly also needs to play a fundamental role in ensuring AI is developed and implemented responsibly to safeguard national security, uphold ethical standards. By fostering innovation while addressing risks, the Korean National Assembly can help shape a future where AI strengthens the nation's defense capabilities without compromising its values or security.

References

References

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Introduction

- Abraham, Yuval. “‘Lavender’: The AI Machine Directing Israel’s Bombing Spree in Gaza”. *+972 Magazine*. (2024.04.03). Retrieved from <https://www.972mag.com/lavender-ai-israeli-army-gaza/>.
- Ball, Mike. “NATO Tactical Datalink Integrated into Naval Combat Management System,” *Defense Advancement*, (2020.11.08). Retrieved from <https://www.defenseadvancement.com/news/nato-tactical-datalink-integrated-into-naval-combat-management-system/>.
- Deepmind. “The Google DeepMind Challenge Match, March 2016”. (n.d.) Retrieved from <https://deepmind.com/alphago-korea>.
- Duran, Nicholas et al.. “2018 Webroot Threat Report,” Threat report, Smarter Cybersecurity Colorado, (2018) *US: Webroot*.
- Dutta, Anisha. “Officials Targeted in New Phishing Bid via Govt IDs” *Hindustan Times*. Retrieved from (2022.01.18). <https://www.hindustantimes.com/india-news/officials-targeted-in-new-phishing-bid-via-govt-ids-101614282608264.html>.
- Fauzi, MA, Bian Yang, and Edlira Martiri. “PassGAN-Based Honeywords System,” *International Conference on Computational Science and Computational Intelligence (CSCI)* (IEEE, 2019).
- Fontes, Robin and Jorrit Kamminga. “Ukraine A Living Lab for AI Warfare”. (2023.03.24). *National Defence*. Retrieved from <https://www.nationaldefensemagazine.org/articles/2023/3/24/ukraine-a-living-lab-for-ai-warfare>.
- Goncharuk, Vitaliy. “Russia’s War in Ukraine: Artificial Intelligence in Defence of Ukraine”. (2024.09.27). *International Centre for Defence and Security*. Re

trieved from <https://icds.ee/en/russias-war-in-ukraine-artificial-intelligence-in-defence-of-ukraine/>

Griffin, Matthew. “Breakthrough AI Hacking Tool Cracks Millions of User Passwords in Minutes,” (2019.01.12). *Futures Blog* (blog). Retrieved from <https://www.311institute.com/breakthrough-ai-hacking-tool-cracks-millions-of-user-passwords-in-minutes/>.

Hao, Karen and Will Douglas Heaven. “The Year Deepfakes Went Mainstream”. *MIT Technology Review*. (2020)

Hendrix, Justin. “AI and National Security: Examining First Principles- a Conversation with Lucy Suchman,” Technology, Power, Policy and People. (2021.04.11). Retrieved from <https://techpolicy.press/ai-and-national-security-examining-first-principles-a-conversation-with-lucy-suchman/>.

Henshall, Will. “The U.S. Military’s Investments Into Artificial Intelligence Are Skyrocketing”. *Time*. (2024.03.29). Retrieved from <https://time.com/6961317/ai-artificial-intelligence-us-military-spending/>

Jensen, Benjamin M., Christopher Whyte, and Scott Cuomo, “Algorithms at War: The Promise, Peril, and Limits of Artificial Intelligence” *International Studies Review*. (2020). 22, no.3: 526-50.

Jones, Grace, Janet Egan, and Eric Rosenbach. “Advancing in Adversity: Ukraine’s Battlefield Technologies and Lessons for the U.S. | Belfer Center for Science and International Affairs,” Belfer Center for Science and International Affairs, Harvard Kennedy School. (2024.07.15). <https://www.belfercenter.org/publication/advancing-adversity-ukraines-battlefield-technologies-and-lessons-us>.

Krepinevich, Andrew F. *The Origins of Victory: How Disruptive Military Innovation Determines the Fates of Great Powers* (New York: Yale University Press, 2023).

Manikanthan, SV et al. “Artificial Intelligence Techniques for Enhancing Smartphone Application Development on Mobile Computing”. (2020).

McGee-Abe, Jason. “One year on: 10 technologies used in the war in Ukraine”. (2023.02.24). Retrieved from <https://techinformed.com/one-year-on-10-tech>

- hnologies-used-in-the-war-in-ukraine/
- O'Hanlon, Michael. *The Art of War in an Age of Peace: US Grand Strategy and Resolute Restraint* (New York: Yale University Press, 2021).
- Owen Bratt, Elizabeth, 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).
- Pascual, Manuel G. "Lavender, Israel's Artificial Intelligence System That Decides Who to Bomb in Gaza," *EL PAÍS English*. (2024.04.17). Retrieved from <https://english.elpais.com/technology/2024-04-17/lavender-israels-artificial-intelligence-system-that-decides-who-to-bomb-in-gaza.html>.
- Scarbro, Graham. "Go Straight at 'Em!': Training and Operating with Mission Command," *Proceedings of US Naval Institute* (2019.05). 145/5, no. 1395. Retrieved from <https://www.usni.org/magazines/proceedings/2019/may/go-straight-em-training-and-operating-mission-command>.
- Schmidt, Eric. E. "Emerging Technologies and Defense: Getting the Fundamentals Right". (2021.02.23). Retrieved from https://www.armed-services.senate.gov/imo/media/doc/Schmidt_02-23-21.pdf.
- West, Darrell M and John R Allen. "How Artificial Intelligence Is Transforming the World". *Washington DC: Center for Technology Innovation, Brookings*. (2018.04.24).
- Wilson, H James and Paul R Daugherty. "Collaborative Intelligence: Humans and AI Are Joining Forces" *Harvard Business Review*. (2018). 96, no.4.

US AI Military Innovation

- Allen, G., & Chan, T. Artificial Intelligence and National Security. *Harvard Kennedy School Belfer Center*. (2017). Retrieved from <https://www.belfercenter.org/publication/artificial-intelligence-and-national-security>.

- Bajak, F. "Pentagon Pushes AI Research Toward Lethal Autonomous Weapons." *CBS News*, 5 May 2024: <https://www.cbsnews.com/sanfrancisco/news/pentagon-pushes-ai-research-toward-lethal-autonomous-weapons/>.
- Beaumont, P. "The Gospel": How Israel Uses AI to Select Bombing Targets." *The Guardian*. December 1, 2023. <https://www.theguardian.com/world/2023/dec/01/the-gospel-how-israel-uses-ai-to-select-bombing-targets>.
- Bendett, S. "The Roles and Implications of AI in the Russian-Ukrainian Conflict." *Russia Matters*, July 20, 2023. <https://www.russiamatters.org/analysis/roles-and-implications-ai-russian-ukrainian-conflict>.
- Black, J., Lucas, R., Kennedy, J., Hughes, M., Fine, H. "Command and Control in the Future - Concept Paper 1: Grappling with Complexity." RAND Corporation. (2024): https://www.rand.org/content/dam/rand/pubs/research_reports/RRR2400/RRR2476-1/RAND_RRA2476-1.pdf.
- Brundage, M., et. al. "The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation." (2018). arXiv:1802.07228: <https://arxiv.org/abs/1802.07228>
- Carter, A. "Running the Pentagon Right." *Foreign Affairs*, (2014). 93(1), 99-110.
- Coombs, R.A. "AI Integration for Scenario Development: Enhancing Wargaming and Training with Artificial Intelligence." *Military Review*. (2024): <https://www.armyupress.army.mil/Journals/Military-Review/Online-Exclusive/2024-OLE/AI-Integration-for-Scenario-Development/>.
- Cummings, M. L., et. al. "Artificial Intelligence and International Affairs: Disruption Anticipated." Chatham House Report (2018).: <https://www.chathamhouse.org/sites/default/files/publications/research/2018-06-14-artificial-intelligence-international-affairs-cummings-roff-cukier-parakilas-bryce.pdf>.
- Defense Innovation Board. "AI Principles: Recommendations on the Ethical Use of Artificial Intelligence by the Department of Defense." (2019). https://media.defense.gov/2019/oct/31/2002204458/-1/-1/0/dib_ai_principles_primary_document.pdf.

- Defense Innovation Unit. "Annual Report" (2020): <https://www.dau.edu/cop/ot/documents/diu-fy20-annual-report>.
- Defense Science Board. "Summer Study on Autonomy." Office of the Under Secretary of Defense for Acquisition, Technology and Logistics. (2016).
- Department of Defense. "Summary of the Department of Defense Artificial Intelligence Strategy: Harnessing AI to Advance Our Security and Prosperity." (2018). <https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF>.
- Department of Defense. "DoD Digital Modernization Strategy." (2019). <https://media.defense.gov/2019/jul/12/2002156622/-1/-1/1/dod-digital-modernization-strategy-2019.pdf>.
- Department of Defense. "Ethical Principles for Artificial Intelligence." (2020). https://www.ai.mil/docs/Ethical_Principles_for_Artificial_Intelligence.pdf.
- Department of Defense. "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway." (2022): <https://media.defense.gov/2022/Jun/22/2003022604/-1/-1/0/Department-of-Defense-Responsible-Artificial-Intelligence-Strategy-and-Implementation-Pathway.PDF>.
- Department of Defense. "Directive 3000.09: Autonomy in Weapon Systems" (2023): <https://www.esd.whs.mil/portals/54/documents/dd/issuances/dodd/300009p.pdf>.
- Duguin, S. and Pavlova, P. "The Use of Artificial Intelligence in Armed Conflicts." *European Parliament*, (2023): [https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/702594/EXPO_BRI\(2023\)702594_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/702594/EXPO_BRI(2023)702594_EN.pdf).
- Etzioni, A. and Etzioni, O. "The Pros and Cons of Autonomous Weapon Systems." *Military Review*, May-June 2017" (2017): <https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/May-June-2017/Pros-and-Cons-of-Autonomous-Weapons-Systems/>.
- Goncharuk , V. "Russia's War in Ukraine: Artificial Intelligence in Defence of Ukraine." *International Centre for Defence and Security* (2024a): <https://icds.ee/en/russias-war-in-ukraine-artificial-intelligence-in-defence-of-ukraine/>.

- Goncharuk, V. "Survival of the Smartest? Defense AI in Ukraine." In: Borchert, H., Schütz, T., Verbovsky, J. (eds) *The Very Long Game*. Contributions to Security and Defence Studies. (Springer, Cham, 2024b). https://doi.org/10.1007/978-3-031-58649-1_17.
- Horowitz, M. C., et. al. "Artificial Intelligence and International Security." Center for a New American Security (2018).: <https://www.cnas.org/publications/reports/artificial-intelligence-and-international-security>.
- Husain, A. "AI is Shaping the Future of War." PRISM (2021) Vol. 9, No. 3.
- Joint Artificial Intelligence Center. "DoD AI Education Strategy" (2020). https://www.ai.mil/docs/2020_DoD_AI_Training_and_Education_Strategy_and_Infographic_10_27_20.pdf.
- Judson, J. "Say Goodbye to JAIC and DDS as Offices Cease to Exist as Independent Bodies June 1." *Breaking Defense*, 31 May 2022: <https://breakingdefense.com/2022/05/say-goodbye-to-jaic-and-dds-as-offices-cease-to-exist-as-independent-bodies-june-1/>.
- Kania, E. "Battlefield Singularity: Artificial Intelligence, Military Revolution, and China's Future Military Power." Center for a New American Security. (2017).
- Kendall, F. *Better Buying Power: Implementation Guidance*. Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. (2016). <https://dod.defense.gov/Portals/1/Documents/pubs/Getting-Acquisition-Right-Jan2017.pdf>.
- Kendall, F. *Getting Defense Acquisition Right. Better Buying Power: Implementation Guidance*. Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. (2017). <https://dod.defense.gov/Portals/1/Documents/pubs/Getting-Acquisition-Right-Jan2017.pdf>.
- Lieberman, J. "Beyond the Headlines: Combat Deployment of Military AI-Based Systems by the IDF." *Lieber Institute West Point* (2024). <https://lieber.westpoint.edu/beyond-headlines-combat-deployment-military-ai-based-systems-idf/>.
- Lin-Greenberg, E. "Integrating emerging technology in multinational military

- operations: The case of artificial intelligence.” *Texas National Security Review*. (2020) <https://tnsr.org/roundtable/policy-roundtable-artificial-intelligence-and-international-security/#essay3>
- McLaughlin, T. “When Algorithms Decide Who Is a Target: IDF's Use of AI in Gaza.” *Tech Policy Press*. (2024). <https://www.techpolicy.press/when-algorithms-decide-who-is-a-target-idfs-use-of-ai-in-gaza/>.
- Mozur, P. and Satariano, A. “A.I. Begins Ushering In an Age of Killer Robots.” *The New York Times*, 2 July 2024: <https://www.nytimes.com/2024/07/02/technology/ukraine-war-ai-weapons.html>.
- Nagl, J. A., et. al. *A Call to Arms: Lessons from Ukraine for the Future War*. National Security Commission on Artificial (Carlisle Barracks, PA, US Army War College Press, 2021) Intelligence.. Final Report. <https://www.nscai.gov/2021-final-report/>
- Pfaff C. A., Christopher J. Lowrance, Bre M. Washburn, and Brett A. Carey. *Trusting AI: Integrating Artificial Intelligence into the Army's Professional Expert Knowledge*. (Carlisle Barracks, PA, US Army War College Press, 2023)
- Project Maven. “Project Maven to Deploy Computer Algorithms to War Zone by Year's End.” Department of Defense. (2017). <https://www.defense.gov/News/News-Stories/Article/Article/1254719/project-maven-to-deploy-computer-algorithms-to-war-zone-by-years-end/>.
- Scharre, P. *Army of None: Autonomous Weapons and the Future of War*. (W. W. Norton & Company, 2018).
- Stern, D. “How Drones and AI Have Reshaped the War in Ukraine.” *The Washington Post*, July 26, 2023. <https://www.washingtonpost.com/world/2023/07/26/drones-ai-ukraine-war-innovation/>.
- Tarraf, D. C., et. al. “The Department of Defense Posture for Artificial Intelligence: Assessment and Recommendations.” RAND Corporation. (2019) https://www.rand.org/pubs/research_reports/RR4229.html.
- U.S. Congress. “National Defense Authorization Act for Fiscal Year 2021”. Public Law 116-283, U.S. (2021) Statutes at Large 134: 3388-3973.

<https://www.congress.gov/bill/116th-congress/house-bill/6395>.

U.S. Congress. “National Defense Authorization Act for Fiscal Year 2023”. Public Law 117-263, (2023) U.S. Statutes at Large 136: 2398-3041. <https://www.congress.gov/bill/117th-congress/house-bill/7900>.

Vergun, D. “Joint Artificial Intelligence Center Has Substantially Grown to Aid the Warfighter.” *U.S. Department of Defense*, November 10, 2020: <https://www.defense.gov/News/News-Stories/Article/Article/2418970/joint-artificial-intelligence-center-has-substantially-grown-to-aid-the-warfighter/>.

Vergun, D. “Pentagon Official Lays Out DOD Vision for AI.” *U.S. Department of Defense*, July 5, 2024: <https://www.defense.gov/News/News-Stories/Article/Article/3682355/pentagon-official-lays-out-dod-vision-for-ai/>.

Wrobel, S. (2024) “Israeli Developer of VR Drone System Used by IDF in Hamas War Raises \$40M.” *The Times of Israel*: <https://www.timesofisrael.com/israeli-developer-of-vr-drone-system-used-by-idf-in-hamas-war-raises-40m/>.

Russia’s AI Military Innovation

Burenok, Vasili M. “Iskusstvennyi Intellekt v Voennom Protivostoyanii Budushchego,” *Voennaya Mysl*, (2021). no.4.

_____. “Problemy Primeneniya Sistem s Iskusstvennym Intellektom v Voennom Dele,” *Izvestiya Rossiiskoi Akademii Raketnykh I Artilleriiskikh Nauk*, (2021).

Litovkin, Dmitri. (2017.08.28). “Armiya-2017: Ot Idei do Tanka,” *Izvestiya*, <https://iz.ru/638219/dmitrii-litovkin/armiia-2017-ot-idei-do-tanka>.

Losev, Aleksandr. “Voennyi Iskusstvennyi Intellekt.” *Arsenal Otechestva*, no. 6(32) (2017). <https://arsenal-otechestva.ru/article/990-voennyj-iskusstvennyj-intellekt>.

Morgan, Forrest E., Benjamin Boudreaux, Andrew J. Lohn, Mark Ashby, Christian Curriden, Kelly Klima, and Derek Grossman. *Military Applications of Artificial Intelligence: Ethical Concerns in an Uncertain World*, (Santa Monica, CA: RAND Corporation, 2020).

- Galinina, Angelina, Dmitry Lyudmitsky and Roman Kretsul. "Oruzhie Razuma: Rossiiskii Put' k Voennomu Iskusstvennomu Intellectu," *Izvestiya*, (2018.11.22.). <https://iz.ru/815370/angelina-galanina-dmitrii-liudmirskii-roman-kretcul/oruzhie-razuma-rossiiskii-put-k-voennomu-iskusstvennomu-intellektu>.
- Khisamov, Taufik. "Gonka Tekhnologii. Kak Iksusstvennyi Intellect Pomogaet Biznesu" *Forbes.ru*, (2017.12.20). <https://www.forbes.ru/tehnologii/354727-gonka-tehnologiy-kak-iskusstvennyy-intellekt-pomogaet-biznesu>.
- Kozyulin, Vadim B. and Albert R. Efimov. "Novyi Bond – Mashina s Litsenziei na Ubiistvo" *Indeks Bezopasnosti*, (2016). no.1(116): 37-60. <https://pircenter.org/wp-content/uploads/2023/01/2016-SI-RUS-Kozyulin-Efimov.pdf>
- The Kremlin. "Presentation of Era Innovation Technopolis". The Kremlin. (2018.02.23.). <http://www.en.kremlin.ru/events/president/news/56923>.
- _____. (2022.07.14). "Law on Era Military Innovation Technopolis". <http://en.kremlin.ru/acts/news/68890>.
- Ministry of Defense. "Konferentsiya "Iskusstvennyi Intellect: Problemy I Puti ikh Resheniya – 2018"". (2018). <https://mil.ru/conferences/is-intellekt.htm>.
- _____. "Konferentsiya".
- _____. "O Teknopolise". (2024.05.27). <https://mil.ru/era/about.htm>.
- Morkhat, Petr M. "K Voprosu o Sootvetstvii Avtonomnykh Intellectual'nykh Sistem Vooruzheniya Printsypam Mezhdunarodnogo Gumanitarnogo Prava". *Vestnik Voennogo Prava*, (2018). no.2: 58-65. <https://millaw.ru/uploads/2018/05/morhat.pdf>.
- Petrella, Stephanie, Chris Miller & Benjamin Cooper. "Russia's Artificial Intelligence Strategy: The Role of State-Owned Firms". *Orbis*, (2020).
- Eduard M. Proydakov, "Sovremennoe Sostoyanie Iskusstvennogo Intellecta," *Naukovedcheskiye Issledovaniya*, (2018). no.2018: 135-142, <https://doi.org/10.31249/scis/2018.00.09>.
- Russian Ministry of Defense. (2017.08.25). "Na Forume Armiya-2017 Obsydyat Perspektivnye Tekhnologii Intellectualizatsii Aviatsionnykh Kompleksov".

- https://function.mil.ru/news_page/country/more.htm?id=12139767@egNews.
- Razikov, V., and Elistratov, V. "Tretya Revolyutsiya." *Armeiskii Sbornik*, no. 1 (2022). <https://army.ric.mil.ru/Stati/item/372265/>.
- Sidorin, A. N., and Bezrodnyi, A. N. "Perspektivy Primeneniya Tekhnologii Iskusstvennogo Intellekta v Radioelektronnoi Bor'be." *Voennaya Mysl*, no. 12 (2021). <https://vm.ric.mil.ru/Stati/item/367144>.
- TASS. "Shoigu Prizval Voennykh I Grazhdanskikh Uchenykh Sovmestno" (2018.03.14).
- _____. "Rostec: Rossiya Uzhe Imeet Narabotki Po Samoobuchayushhemusya Oruzhiyu s Iskusstvennym Intellektom". (2018.06.06). <https://tass.ru/armiya-i-opk/5268765>.
- _____. "Razrabatyvat' Robotov I Bepilotnikov". (2019.02.26). <https://tass.ru/armiya-i-opk/5028777>.
- Vedomosti. "Andrei Belousov: Dvizhushchei Siloy Tekhnologicheskogo Razvitiya Yavlyaetsya Konkurentsya". (2024.04.10). https://www.vedomosti.ru/press_releases/2024/04/10/andrei-belousov-dvizhushchei-siloi-tehnologicheskogo-razvitiya-yavlyaetsya-konkurentsia.
- Zysk, K. Defence innovation and the 4th industrial revolution in Russia. *Journal of Strategic Studies*, (2020). 44(4), 543-571. <https://doi.org/10.1080/01402390.2020.1856090>

China's AI Military Innovation

- Allen, Gregory C. "Understanding China's AI Strategy." Center for a New American Security. (2019.02.06).
- The Aviation Industry Corporation of China. "Military Aviation and Defense-Unmanned Aerial Vehicles." CGTN. (2019.03.16). "China to remain an attractive market for world's high tech sector."
- Cheung, Taiming. "China's Rise as a Global Military Technological Power:

- Geo-Strategic and Geo-Economic Implications.” (2018).
- Global Times. (2019.02.11)“China eyes building next-generation fighter jets by 2035.”
- Laskai, Lorand. “Civil-Military Fusion and the PLA’s Pursuit of Dominance in Emerging Technologies.” The Jamestown Foundation. (2018.04.09).
- Lin, Ying-yu. “China’s AI-driven ‘new quality combat capabilities’ in the Taiwan Strait,” Think China. (2024.06.21).
- Liu, Caiyu. “China’s centennial goal of building a modern military by 2027 in alignment with national strength: experts,” Global Times. (2020.10.31).
- Office of the Central National Security Commission(中央国家安全委员会办公室). The Total National Security Paradigm: A Study Outline〈总体国家安全观学习纲要〉. (2022.04.14)
- Xijiangping. “Secure a Decisive Victory in Building a Moderately Prosperous Society in All Respects and Strive for the Great Success of Socialism with Chinese Characteristic for a New Era.” The Address of the 19th National Congress of the Communist Party of China. (2017.10.18.).
- 刘华清. “坚定不移地沿着建设有中国特色现代化军队的道路前进,” 人民网, (1993.05.20). http://www.china.com.cn/guoqing/2012-09/12/content_26748029.htm
- 王星. “加快推进军队智能化转型发展,” 中国科技网. (2023.08.08). <https://www.stdaily.com/index/kejixinwen/202308/1d5be9dc751a4765aa56188731b738ee.shtml>
- 朱步楼. “坚持以人为本 引导智能向善: 提高人工智能安全治理水平,” 人民日报, (2024.08.25). <http://theory.people.com.cn/BIG5/n1/2024/0805/c40531-40292548.html>
- 周慧. “军事论坛 | 智能化时代军队组织形态变革新趋势,” 中国军网-解放军报,. (2024.06.18.). http://www.81.cn/xxqj_207719/xxjt/ll/16323494.html
- 齐磊, 田峰. “无人智能作战: 改变海战的新引擎,” 学习时报, (2024.04.08). <https://baijiahao.baidu.com/s?id=1795735920398727271&wfr=spider&for=pc>
- 石纯民. “军事智能化时不我待.” 中国军网, (2017.12.11). http://www.81.cn/gfbmap/content/2017-12/11/content_193967.htm
- 曾海清. “智能化时代呼唤训练向“智”转型,” 中国军网 国防部网, (2022.07.21.) http://www.81.cn/jfjbmap/content/2022-07/21/content_320291.htm

刘丽娇, 唐剑. “海上智能化作战怎么打.” 解放军报. (2021.04.29.) http://www.81.cn/bz/2021-04/29/content_10030358.htm

肖天亮主编, 『战略学』, 国防大学出版社, (2020).

吴志忠, 赵礼, 王达. “为充分解放和发展新质战斗力提供人才支撑,” 解放军报, (2024.10.14). https://military.cnr.cn/jq/20241014/t20241014_526938649.shtml

姬建春. “新质战斗力呼唤新型军士队伍,” 光明网24. (2024.07.27.). <https://baijiahao.baidu.com/s?id=1803866788734787681&wfr=spider&for=pc>

人民日报. “沿着中国特色强军之路阔步前进——党中央、中央军委领导推进国防和军队建设70年纪实.” (2019.09.28). <https://baijiahao.baidu.com/s?id=1645920941470993060&wfr=spider&for=pc>

人民日报, “确保如期实现建军一百年奋斗目标,” (2023.06.02). <https://baijiahao.baidu.com/s?id=1767556651813760259&wfr=spider&for=pc>

国务院新闻办公室. “国防白皮书全文” (2015.5.) http://www.81.cn/dblj/2015-05/26/content_6507373.htm

中国新闻网, “习近平：充分解放和发展新质战斗力,” (2024.03.07) <https://baijiahao.baidu.com/s?id=1792873631676470316&wfr=spider&for=pc>

国务院新闻办公室.《新时代的中国国防》白皮书全文》. (2019.07.24.). http://www.mod.gov.cn/regulatory/2019-07/24/content_4846424.htm

解放军报, “从无人装备到智能算法, 解放军报整版关注‘新质战斗力’” (2024.07.11.) <https://news.qq.com/rain/a/20240711A016I500>

解放军报. “国防科技大学智能科学学院着力推进科技创新; 做新时代军事智能化发展的开拓者.” (2017.12.05.). http://navy.81.cn/content/2017-12/05/content_7855748.htm

环球时报, “中国发展空天一体战 是决定未来战争“胜负手” (2014.04.22). <http://mil.news.sina.com.cn/2014-04-22/0857775441.html>

新华社, “经中央军委批准《习近平强军思想学习纲要（2023年版）》印发全军,” (2023.08.01). <https://baijiahao.baidu.com/s?id=1773016661689703996&wfr=spider&for=pc>

中国指挥与控制学会. “关于未来智能化海战的思考.” (2021.04.27). https://www.sohu.com/na/463233448_358040

- 习近平强军思想研究中心, “从学理上把握习近平强军思想的科学体系,” 光明网, (2024.01.04). https://news.gmw.cn/2024-01/14/content_37087338.htm
- 中工网. “以智能化为方向加快军事人员现代化,” (2023.04.23). <https://www.workercn.cn/c/2023-04-03/7790029.shtml>
- 中国军网. “中国首次就规范人工智能军事应用问题提出倡议.” (2021.12.13.). http://www.81.cn/jfjbmap/content/2021-12/15/content_305249.htm.
- 外交部. “中国关于规范人工智能军事应用的立场文件.” (2021.12.14.). https://www.fmprc.gov.cn/web/wjb_673085/zzjg_673183/jks_674633/jksxwlb_674635/202112/t20211214_10469511.shtml.

India's AI Military Innovation

- Abraham, Yuval. “‘Lavender’: The AI Machine Directing Israel’s Bombing Spree in Gaza,” +972 Magazine, (2024.04.03) <https://www.972mag.com/lavender-ai-israeli-army-gaza/>.
- Aayog NITI, “National Strategy for Artificial Intelligence - Discussion Paper” (NITI Aayog, June 2018), <https://indiaai.gov.in/documents/pdf/NationalStrategy-for-AI-Discussion-Paper.pdf>.
- Bhatia, Richa. “If The Future Of Warfare Is With Automated Weapons - Where Does India Stand In The Race?,” AIM, March 27, 2018, <https://analyticsindiamag.com/ai-origins-evolution/if-the-future-of-warfare-is-with-automated-weapons-where-does-india-stand-in-the-race/>.
- Bommakanti, Kartik. “Strengthening the C4ISR Capabilities of India’s Armed Forces: The Role of Small Satellites,” OCCASIONAL PAPERS, ORF, (2020.06.15). <https://www.orfonline.org/research/strengthening-the-c4isr-capabilities-of-indias-armed-forces-the-role-of-small-satellites-67842/>.
- Bordoloi, Pritam. “How Does the Indian Army Want to Use AI?,” AIM, (2022.08.04). <http://analyticsindiamag.com/ai-breakthroughs/how-does-the-indian-army-want-to-use-ai/>.
- Buchaniec, Catherine. “Russian Military to Develop Weapons Using Artificial

- Intelligence,” C4ISRNet, (2022.08.17). <https://www.c4isrnet.com/artificial-intelligence/2022/08/17/russia-military-to-develop-weapons-using-artificial-intelligence/>.
- Demarest, Colin, “US and India Launch Talks about Military AI,” C4ISRNet, (2022.04.18). <https://www.c4isrnet.com/artificial-intelligence/2022/04/15/us-and-india-launch-talks-about-military-ai/>.
- Fontes, Robin and Jorrit Kamminga, “Ukraine A Living Lab for AI Warfare,” National Defence, March 24, 2023, <https://www.nationaldefensemagazine.org/articles/2023/3/24/ukraine-a-living-lab-for-ai-warfare>.
- Gandharv, Kumar. “Top Three AI Initiatives for Indian Defence Forces in 2022,” Broadcast, INDIAai, (2024.05.24). <https://indiaai.gov.in/article/top-three-ai-initiatives-for-indian-defence-forces-in-2022>.
- Horton, Alex. “Russia Tests Secretive Weapon to Target SpaceX’s Starlink in Ukraine,” Washington Post, (2023.04.18). <https://www.washingtonpost.com/national-security/2023/04/18/discord-leaks-starlink-ukraine/>.
- IDRW. “Indian Navy Tests Indigenously Developed Autonomous Fast Interceptor Boats,” Indian Defence Research Wing, (2024.05.05). <https://idrw.org/indian-navy-tests-indigenously-developed-autonomous-fast-interceptor-boats/>.
- _____. “Indian Navy Seeks Advanced Autonomous Underwater Vehicle,” Indian Defence Research Wing, (2024.07.13.). <https://idrw.org/indian-navy-seeks-advanced-autonomous-underwater-vehicle/>.
- Jeevanandam, Nivash. “Exploring the Significance of AI in the Indian Navy,” INDIAai, (2023.12.05). <https://indiaai.gov.in/article/exploring-the-significance-of-ai-in-the-indian-navy>.
- JOHANSSON, ANDERS C. “CHINA’S AI ECOSYSTEM” (Stockholm: Stockholm School of Economics, 2022.11.) <https://www.hhs.se/contentassets/bc962221471a415ba8ac01fbbf160277/chinas-ai-ecosystem-nov-2022.pdf>.
- Johnstone, Richard. “Israel Developing National Artificial Intelligence Strategy,” March 28, 2022, <https://www.globalgovernmentforum.com/israel-developing-national-artificial-intelligence-strategy/>.

- Joshi, Prem Lal. "From a Nation of 'snake Charmers' to a Global Power: The Rise of India - Indiaweekly," *India Weekly*, (2022.12.07). <https://www.indiaweekly.biz/from-a-nation-of-snake-charmers-to-a-global-power-the-rise-of-india/>.
- Kamath, Bhuvana. "Union Minister Dharmendra Pradhan Launches Three AI Centres of Excellence," *Your Story*, (2024.10.15). <https://yourstory.com/2024/10/union-minister-dharmendra-pradhan-launches-3-ai-centres-of-excellence>.
- Kulkarni, Nihar. "AI for National Security: Indian Military Perspective" *FINS India*. (2022.10.12). <https://finsindia.org/ai-for-national-security-indian-military-perspective.html>.
- Lee, Lizzi C. "Implications of China's AI Strategy: State Engineering, Domestic Challenges, and Global Competition | Asia Society," Asia Society Policy Institute, (2024.02.21). <https://asiasociety.org/policy-institute/implications-chinas-ai-strategy-state-engineering-domestic-challenges-and-global-competition>.
- Majumdar, Oishee. "Indian Navy Looks to Bolster AI, ML Capabilities," *News, Janes.com*, (2022.04.22) <https://www.janes.com/defence-news/news-detail/indian-navy-looks-to-bolster-ai-ml-capabilities>.
- Markotkin, Nikolai, Chernenko Elena, "Developing Artificial Intelligence in Russia: Objectives and Reality," Carnegie Endowment for International Peace, (2023.07.26), <https://carnegiemoscow.org/commentary/82422>.
- Mishra, Abhinandan. "Indian Army Gets Future Ready with AI-Based Equipment," *The Sunday Guardian Live*, (2022.07.16). <https://sundayguardianlive.com/news/indian-army-gets-future-ready-ai-based-equipment>.
- National Institute of Electronics & Information Technology (NIELIT), "Artificial Intelligence Courses," Text, National Institute of Electronics & Information Technology (NIELIT), (2022.11.28). <https://www.nielit.gov.in/content/artificial-intelligence-courses>.
- Pascual, Manuel G. "Lavender, Israel's Artificial Intelligence System That Decides Who to Bomb in Gaza," *EL PAÍS English*, (2024.04.17). <https://english.elpais.com/technology/2024-04-17/lavender-israels-artificial-intelligence-system-that-decides-who-to-bomb-in-gaza.html>.

- Peri, Dinakar. "Soon AI-Based Mandarin Translation Devices for Troops on LAC," *The Hindu*, sec. India, (2022.07.11). <https://www.thehindu.com/news/national/soon-ai-based-mandarin-translation-devices-for-troops-on-lac/article65626423.ece>.
- PIB. "Indian Army Establishes Quantum Laboratory at Mhow (MP)," Press Information Bureau, GoI, December 29, 2021, <https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=1786012>.
- ____. "SAFE CITY PROJECT," Ministry of Home Affairs, August 2, 2023, <https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=1945047>.
- ____. "CYBER WARFARE," Press Information Bureau Government of India Ministry of Defence, (2021.08.04). <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1742322>.
- Putin, Vladimir. "National Strategy for the Development of Artificial Intelligence Over the Period Extending up to the Year 2030," Decree (The Kremlin, Moscow: Office of the President of the Russian Federation), (2019.10.10). <https://cset.georgetown.edu/wp-content/uploads/Decree-of-the-President-of-the-Russian-Federation-on-the-Development-of-Artificial-Intelligence-in-the-Russian-Federation-.pdf>.
- Reddy, Shashank. "Artificial Intelligence in Defence," INDIAai, (2019.08.22). <https://indiaai.gov.in/article/artificial-intelligence-in-defence>.
- Royen, Emmanuel Selva. "From Civilian Sleuths to Military Strategy: Role Of OSINT In The Russia-Ukraine War and Lessons For India," CENTRE FOR JOINT WARFARE STUDIES, Issue Brief, (2023.08.06). 1-21, https://cenjows.in/pdf-view/?url=2023/08/Emmanuel_Royen_Issue_Brief_August_2023.pdf&pID=20847.
- Schmidt, Eric et al., "An Integrated National Strategy to Reorganize the Government, Reorient the Nation, and Rally Our Closest Allies and Partners to Defend and Compete in the Coming Era of AI-Accelerated Competition and Conflict." (Washington DC, National Security Commission on Artificial Intelligence (NSCAI), 2021), https://cybercemetery.unt.edu/nscai/20211005220330mp_/https://www.nscai.gov/wp-content/uploads/2021/03/Full-Report-Digital-1.pdf.

- Siddiqui, Huma. "Adoption of Artificial Intelligence in Indian Army's C4ISR: Here Is What the Chief Said," News, *The Financial Express*, (2022.05.09). <https://www.financialexpress.com/business/defence-adoption-of-artificial-intelligence-in-indian-armys-c4isr-here-is-what-the-chief-said-2518093/>.
- Shastri, Parth. "To Hone Defence, RRU to Help Set up Wargame Centre in Delhi | Ahmedabad News - Times of India," *The Times of India*, (2022.05.15). <https://timesofindia.indiatimes.com/city/ahmedabad/to-hone-defence-rru-to-help-set-up-wargame-centre-in-delhi/articleshow/91571128.cms>.
- Singh, Sarvjeet and Sharngan Aravindakshan, "Killer Robots or Soldiers of the Future: Legal Issues and India's Role in the Lethal Autonomous Weapons Debate," *Indian JL & Tech.* (2020) 16: 103.

UK's AI Military Innovation

- Burt, Peter, 'Proceed in harmony: The Government replies to the Lords on AI in weapon systems', *Drone Wars*, (2024.02.28) <https://dronewars.net/2024/02/28/proceed-in-harmony-the-government-replies-to-the-lords-on-ai-in-weapon-systems/>.
- Burt, Paul and Chris Cole, 'MoD AI projects list shows UK is developing technology that allows autonomous drones to kill', *Drone Wars*, (2023.07.29.). <https://dronewars.net/2023/07/29/mod-ai-projects-list/>.
- Chuter, Andrew, 'Britain unveils details on AI defense programs', *C4ISRNET*, (2023.10.31). <https://www.c4isrnet.com/artificial-intelligence/2023/10/31/britain-unveils-details-on-two-ai-defense-programs/>.
- Cole, Chris, (2017.09.13). 'New MoD document on use of drones, same old spin', *Drone Wars*, <https://dronewars.net/2017/09/13/new-mod-document-on-use-of-drones-same-old-spin/>.
- Crown Contract Award Service, 'Procurement details: RM1043.8-1-Defence AI Centre Agile Delivery Partner'. (2023). <https://redirect.contractawardservice.crowncommercial.gov.uk/digital-outcomes/opportunitiesDetails?projectId=8291&lot=1>.

HM Government Press Release, 'AI set to revolutionise military engineering capabilities', UK Ministry of Defence, (2023.10.31). <https://www.gov.uk/government/news/ai-set-to-revolutionise-military-engineering-capabilities#:~:text=An%20artificially%20intelligent%20tool%20will,equipment%20before%20they%20become%20problematic>,

HM Government, *Global Britain in a Competitive Age: The Integrated Review of Security, Defence, Development and Foreign Policy*, (2021.03). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/975077/Global_Britain_in_a_Competitive_Age-_the_Integrated_Review_of_Security__Defence__Development_and_Foreign_Policy.pdf,

Hodgen. Jeremy and David Pepper, 'Is the UK an outlier? An international comparison of upper secondary mathematics education', *Nuffield Foundation*, (2010). https://www.nuffieldfoundation.org/wp-content/uploads/2019/12/Is-the-UK-an-Outlier_Nuffield-Foundation_v_FINAL.pdf.

House of Lords. *Proceed with Caution: Artificial Intelligence in Weapons Systems*, (HL Paper 16), (2023.12). <https://lordslibrary.parliament.uk/ai-in-weapon-systems-committee-report-proceed-with-caution/#:~:text=A%20House%20of%20Lords%20special,artificial%20intelligence%20in%20weapon%20systems,>

Kamphuis, Yori and Stephan Leijnen, 'Here's what you need to know about the new AI "arms race"', *World Economic Forum*, (2021.02.22). <https://www.weforum.org/agenda/2021/02/heres-what-you-need-to-know-about-the-new-ai-arms-race/>

Lisvane, Lord, 'AI in Weapon Systems: Proceed with Caution' *The Wavell Room*, (2023.12.08.). <https://wavellroom.com/2023/12/08/proceed-with-caution-artificial-intelligence-weapon-systems-ai/>.

Martin, Tim, 'United Kingdom military is not AI-ready, procurement minister says', *Breaking Defense*, (2024.03.20.). <https://breakingdefense.com/2024/03/united-kingdom-military-is-not-ai-ready-procurement-minister-says/>.

Nadibaidze, Anna, 'The UK Defence AI strategy: Situating Global Britain in the "AI Race"', *Autonorms*, (2022.07.04.). <https://www.autonorms.eu/the-uk-defe>

- nce-ai-strategy-situating-global-britain-in-the-ai-race/.
- Norton-Taylor, Richard, 'AI Weapons and "killer robots" – the MOD's new plans to spend the public's money', *Declassified UK*, (2023.09.12.). <https://www.declassifieduk.org/ai-weapons-and-killer-robots-the-mods-new-plans-to-spend-the-publics-money/>.
- Saballa, Joe, 'UK military is not AI-ready, says Defense official', *The Defense Post*, (2024.03.25.). <https://www.thedefensepost.com/2024/03/25/uk-military-ai-ready/>.
- Saltini, Alice, *UK Thinking on AI Integration and Interaction with Nuclear Command and Control, Force Structure, and Decision-Making, European Leadership Network*, (2023.11). https://www.europeanleadershipnetwork.org/wp-content/uploads/2023/11/23_11_09_UK-bibliography.pdf.
- UK Ministry of Defence, *AI set to revolutionise military engineering capabilities*, October, 2023. <https://www.gov.uk/government/news/ai-set-to-revolutionise-military-engineering-capabilities>
- UK Ministry of Defence, *Ambitious Safe and Responsible: Our approach to the delivery of AI-enabled capability in Defence*, June 2022. https://assets.publishing.service.gov.uk/media/62a9b1d1e90e07039e31b8cb/20220614-Ambitious_Safe_and_Responsible.pdf
- UK Ministry of Defence, *British Army's Approach to Artificial Intelligence*, 2023. https://www.army.mod.uk/media/24745/20231001_british_army_approach_to_artificial_intelligence.pdf.
- UK Ministry of Defence, *Defence Artificial Intelligence Strategy*, June 2022. https://assets.publishing.service.gov.uk/media/62a7543ee90e070396c9f7d2/Defence_Artificial_Intelligence_Strategy.pdf.
- UK Ministry of Defence, *The Government Response to the Report by the House of Lords AI in Weapon Systems Committee: "Proceed with Caution: Artificial Intelligence in Weapon System"*, (Session 2023-24 HL Paper 16), (2024.02). https://assets.publishing.service.gov.uk/media/65cb77caa7ded0000c79e526/Government_response_to_the_House_of_Lords_AI_in_Weapon_Systems_Com

mittee_Report.pdf.

UK Ministry of Defence, MOD Science and Technology Strategy, (2020). <https://www.gov.uk/government/publications/mod-science-and-technology-strategy-2020>

UK Ministry of Defence, *The UK Approach to Unmanned Aircraft Systems*, JDN 2/11, (2011.03). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/644084/20110505-JDN_2-11_UAS_archived-U.pdf.

UK Ministry of Defence, *Unmanned Aircraft Systems*, Joint Doctrine Publication 0-30.2, (2017.08). <https://www.gov.uk/government/publications/unmanned-aircraft-systems-jdp-0-302>.

UK Parliament, *Autonomous weapons: Question for Ministry of Defence*, UIN HL5479, tabled on 18 January 2022. <https://questions-statements.parliament.uk/written-questions/detail/2022-01-18/HL5479>.

Wimble, Jeremy, 'British Army publishes approach to Artificial Intelligence', *TechUK*, (2024.02.06.). <https://www.techuk.org/resource/british-army-publishes-approach-to-artificial-intelligence.html>.

Wodecki, Ben, 'UK Defense official: The necessity of AI in modern warfare', *AI Business*, (2023.01.25.). <https://aibusiness.com/ml/uk-defense-official-on-ai-and-modern-warfare>.

Israel's AI Military Innovation

Confortes, Yeshuda. 'AI at war: High-tech again comes to the rescue', *Anashim Umachshevim (People and Computers)*, (2023.10.13). <https://www.pc.co.il/featured/397084/>.

Elmakias, Shay. 'Digital provides security just like a fighter plane or missile boat', *Makor Rishon*, (2023.01.16). <https://www.makorrishon.co.il/magazine/dyukan/566929/>.

Israeli Government Decision No. 212 of 1.8.2021, augmented later by Israeli

- Government Decision No. 173 of 24.2.2023. <https://www.globes.co.il/news/article.aspx?did=1001466779>.
- Peper, Anshil. 'They see and shoot: Hitting terrorists from a chair at a command center', Haaretz, (2010.07.02) <https://www.haaretz.co.il/misc/2010-07-02/ty-article/0000017f-e628-da9b-a1ff-ee6fcc1a0000>.
- Shpiro, S. "Israeli Intelligence and the Coronavirus Crisis". *International Journal of Intelligence and Counter Intelligence*, (2020). 34(1), 1-16. <https://doi.org/10.1080/08850607.2020.1805711>.
- Trabelsi, Nevo. 'Technology instead of the Head of AMAN: Could this have prevented the Hamas massacre?', Globes.
- Yanko, Adir. 'A month to the massacre: 1194 bodies of civilians and soldiers identified so far', YNET, (2023.11.08). <https://www.ynet.co.il/news/article/skt110vtxp>.
- YNET. 'This is the AI system which identified 37.000 targets and why the IDF is using it', YNET, (2024.03.03), <https://www.ynet.co.il/news/article/h1jypvj1c>.

NATO's AI Military Innovation

- Aronhime, Lawrence and Alexander Cocron, "NATO's Innovation Challenge", NATO. (2021.07.19.) <https://www.nato.int/docu/review/articles/2021/07/19/natos-innovation-challenge/>.
- Atkinson, Ryan. (2024.09-10)'Artificial Intelligence in Modern Warfare Strategic Innovation and Emerging Risks', *Military Review*.
- Berger, Federico. "The Alliance in the loop: NATO and Artificial Intelligence", NATO Defense College Foundation Paper, (2021) <https://www.natofoundation.org/wp-content/uploads/2021/12/NDCF-Paper-Berger-NATO-and-Artificial-Intelligence-151121.pdf>.
- Bielawski, Radosław. "Development of Security Technologies by NATO: Current Status and Development Prospects", *Safety & Defense*, (2022) 8(1), pp. 23-29, DOI: <https://doi.org/10.37105/sd.170>.

- Cheung, Sunny. "AI Frontlines: China's PLA evolution vs. NATO's counterplay", Freidrich Naumann Foundation. (2023.11.24.) <https://www.freiheit.org/taiwan/ai-frontlines-chinas-pla-evolution-vs-natos-counterplay>.
- Clement, Sven. "NATO and Artificial Intelligence: Navigating the Challenges and Opportunities", Preliminary Draft Special Report.
- Dembinski, Matthias and Caroline Fehl (eds.) Three Visions for NATO. Mapping National Debates on the Future of the Atlantic Alliance, (Friedrich-Ebert-Stiftung, Berlin, 021)
- Etl, Alex. "The Impact of AI on NATO Member States' Strategic Thinking", *Proceedings of International Scientific Conference "Strategies XXI"*, n.d., vol. XVIII.
- Fraser, Callum. "AI's baptism by fire in Ukraine and Gaza offers wider lessons", IISS. (2024.04.22.) <https://www.iiss.org/online-analysis/military-balance/2024/04/analysis-ais-baptism-by-fire-in-ukraine-and-gaza-offer-wider-lessons/>.
- Gilli, Andrea. "NATO-Mation": Strategies for Leading in the Age of Artificial Intelligence, *NDC Research Paper* (2020.12) No.15.
- Kasapoğlu, Can and Barış Kırdemir, "Artificial Intelligence and the Future of Conflict" [in] Tomáš Valášek (ed) *New Perspectives on Shared Security: NATO's Next 70 Years*, (Brussels : Carnegie Endowment for International Peace, 2019).
- Gray, Maggie, Amy Ertan, "Artificial Intelligence and Autonomy in the Military: An Overview of NATO Member States' Strategies and Deployment", (NATO CCDCOE, Tallin, 2021) https://ccdcoe.org/uploads/2021/12/Strategies_and_Deployment_A4.pdf.
- Hunter Christie, Edward. "Defence cooperation in artificial intelligence: Bridging the transatlantic gap for a stronger Europe" *European View*, (2022) 21(1), pp. 13-21.
- _____, "Artificial Intelligence at NATO: dynamic adoption, responsible use", NATO, (2020.11.24.) <https://www.nato.int/docu/review/articles/2020/11/24/artificial-intelligence-at-nato-dynamic-adoption-responsible-use/index.html>.

- Lin-Greenberg, Erik. "Allies and Artificial Intelligence: Obstacles to Operations and Decision-Making", *Texas National Security Review*, (2020) 3(2).
- NATO, "The Future Operating Environment Workshop Concludes in London", (2023.12.04.), <https://www.act.nato.int/article/foe-concludes-in-london/>.
- Hartmann, Jacques, et al., "Artificial Intelligence, Autonomous Drones and Legal Uncertainties" *European Journal of Risk Regulation* (2023) 14(1).
- Hooker, Jr., Richard D. 'A new NATO command structure', (2024.06.05.) <https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/a-new-nato-command-structure/>.
- Larsen, Rick. 'Russia's War and Allied Support for Ukraine, Preliminary Draft Report', 049 DSCTC 24 E, (2024.04.25.) <https://www.nato-pa.int/download-file?filename=/sites/default/files/2024-05/049%20DSCTC%2024%20E%20-%20RUSO-UKRAINIAN%20WAR%20-%20LARSEN%20REPORT.pdf>.
- Lawrence, Tony., Tomas Jermalavičius, and Jan Hyllander, "The Newest Allies: Finland and Sweden in NATO", International Centre for Defence and Security, (2024.03) https://icds.ee/wp-content/uploads/dlm_uploads/2024/03/ICDS_Report_The_Newest_Allies_Lawrence_Jermalavicius_Hyllander_March_2024.pdf.
- McDonald, Jordan. "Overseas Conflicts Spur NATO Tech Transitions", (2023.12.12) <https://govciomedia.com/overseas-conflicts-spur-nato-tech-transitions/>
- Medhat, Sam. "Innovation and Digital Technologies: Underpinning NATO's Warfare Development Agenda", *Science in Parliament*, (2023) Vol 79(3), Autumn, <https://www.scienceinparliament.org.uk/wp-content/uploads/2024/05/Innovation-and-Digital-Technologies-Underpinning-NATOs-Warfare-Development-Agenda.pdf>.
- NATO Science and Technology Organization. *Science & Technology Trends 2020-2040. Exploring the S&T Edge*, (NATO: Brussels, 2023.03) p. 14, https://www.nato.int/nato_static_fl2014/assets/pdf/2020/4/pdf/190422-ST_Tech_Trends_Report_2020-2040.pdf (4.07.2024).
- Nelu, Clarisa. "Exploitation of Generative AI by Terrorist Groups" *ICCT Analysis*, (2024.06.10.), <https://www.icct.nl/publication/exploitation-generative-ai-terrorist-groups>.

- Phillips, Trina Marie and August Cole (eds.), *Visions of Warfare 2036*, (Norfolk VA: NATO ACT. 2016)
- Rautio, Samu. Mika Broms M. 'Security scenarios: 3D printed firearms', *Security and Defence Quarterly*, (2024), 48(4). doi: 10.35467/sdq/181047.
- Rublovskis, Raimonds. "Impact of Ukraine War on NATO Development. NATO Vision 2030" Doctrina. *Studia Społeczno-Polityczne*, (2023) no 20, DOI: 10.34739/doc.2023.20.04.
- Soare, Simona R. "Digital Divide?" Transatlantic defence cooperation on Artificial Intelligence, (2020.03) UE Institute For Security Studies, Brief 3.
- _____. "Innovation as Adaptation: NATO and Emerging Technologies", 11 June 2021, <https://www.gmfus.org/news/innovation-adaptation-nato-and-emerging-technologies>
- Sweijs, Tim and Frans Osinga, (2019) "VIII. Maintaining NATO's Technological Edge", Whitehall Papers, 95:1, pp. 104-118, DOI: 10.1080/02681307.2019.1731216.
- Thiele, Ralph. "Artificial Intelligence – A key enabler of hybrid warfare", *Hybrid CoE Working Paper* 6, March 2020, https://www.hybridcoe.fi/wp-content/uploads/2020/07/WP-6_2020_rgb-1.pdf (4.07.2024).
- Wodecki, Ben. "NATO at risk of losing AI innovation race to Russia, China", 4 May 2022, <https://aibusiness.com/verticals/nato-at-risk-of-losing-ai-innovation-race-to-russia-china> (15.07.2024).

Conclusion

- Johansson, Anders C. "Chin's AI Ecosystem" (Stockholm: Stockholm School of Economics, November 2022)
- Johnstone, Richard. "Israel Developing National Artificial Intelligence Strategy," March 28, 2022.
- Markotkin, Nikolai and Chernenko Elena, "Developing Artificial Intelligence in Russia: Objectives and Reality," Carnegie Endowment for International Peace.

- Lee, Lizzi C. “Implications of China’s AI Strategy: State Engineering, Domestic Challenges, and Global Competition | Asia Society,” Asia Society Policy Institute, February 21, 2024.
- Eric Schmidt et al., “An Integrated National Strategy to Reorganize the Government, Reorient the Nation, and Rally Our Closest Allies and Partners to Defend and Compete in the Coming Era of AI-Accelerated Competition and Conflict.” (Washington DC: National Security Commission on Artificial Intelligence (NSCAI), 2021)
- Sedova, Katerina. Et al., “AI and the Future of Disinformation Campaigns-Part 1: The RICHDATA Framework,” CEST Policy Brief.

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