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TRANSFORMATION IS THE KEY TO SPACEPOWER: HOW HYBRID HUMAN-AI TEAMS GAIN THE ADVANTAGE IN GREAT POWER COMPETITION AND CONFLICT

by

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Biography

Lieutenant Colonel Tanisha Saunders is assigned to the Air War College, Air University, Maxwell AFB, AL. Lt. Col. Saunders received her commission from the Air Force Reserve Officer Training Corps program at The Ohio State University in 2005. She completed intelligence officer training in November 2006 and has held a variety of intelligence positions related to intelligence analysis, production, targeting, cybersecurity, staff and space intelligence, surveillance, reconnaissance, and space intelligence training. After 16 years in the Air Force, Lt Col Saunders commissioned into the Space Force in July 2021. Previously, Lt. Col. Saunders was the commander of the 22nd Training Support Squadron, Officer Training School, Maxwell Air Force Base, Ala. where she ensured the commissioning of approximately 2,200 Department of the Air Force active duty, Reserve, and Air National Guard officers annually. She holds a Bachelor of Arts in Communications from the Ohio State University and a Master of Arts in Strategic Intelligence from American Military University.

Abstract

EO 14110 on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence issued a landmarked order in December 2023 directing the whole of government to ensure the US continues to lead the way in harnessing the advantages, innovation, and advances of AI while managing any risk incorporating this transformational change. The Department of Defense's Responsible Artificial Intelligence Implementation and Strategy Pathway document provides guidance and oversight to all services on how and when to incorporate AI capabilities into their missions. AI technology in the space domain can enhance how the Space Force executes its core competencies but due the unique characteristics of operations and the additional synergies gained from pairing humans with AI technology, human-AI teaming and collaboration is the best way to maximize AI capabilities. Although human-AI teaming and collaboration in military operations is not a novel concept to speed adaptation in operations, warfighter trust must be addressed and gained.

Keywords: Artificial Intelligence, warfighter trust, responsible artificial intelligence, Human-Machine Collaboration, Human Machine-Team, space operations, space power, spacepower, great power competition, great power conflict, AI, AI strategies, AI technology, space competencies, AI capabilities

Thesis

Human-AI Teaming and Collaboration is the best way to employ AI capability in Space Operations, but to achieve this, teaming requires building warfighter trust.

Introduction

In 2022, the National Security Commission on Artificial Intelligence Final Report boldly stated among many recommendations, to the President, on artificial intelligence (AI) in relation to the US maintaining advantages in economy, overall prosperity, and most pointedly about national security and military might:

> "AI-enabled warfare will not hinge on a single new weapon, technology, or operational concept; rather, it will center on the application and integration of AI-enabled technologies into every facet of warfighting. AI will transform the way war is conducted in every domain from undersea to outer space, as well as cyberspace and along the electromagnetic spectrum."

Consequently, EO 14110 on the "Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence" took the 796-page report to heart and issued a landmarked order in December 2023 directed at the whole of government to ensure the US continues to lead the way in AI adaptation. The goal is to harness the advantages, innovation, and advances of AI while managing any risk incorporating this transformational change. In accordance with this order, the Department of Defense (DoD), among other departments within the executive branch, was directed to rapidly initiate development of and assurances that powerful AI systems are safe, secure, and trustworthy, underscoring the public's trust in the military institution, yet still be lethal and reliable in military operations to protect national interests. The answer on how lies in the DoD's Responsible Artificial Intelligence Implementation and Strategy Pathway document (RAI I&S Pathway) which identifies six tenants that provides overarching guidance. However, a speedy adaptation of AI technology hinges on warfighter trust and progress is only in the

beginning stages. Most champions of AI envision machines taking the place of humans in most military tasks as the technology develops to do so. However, there is a small number of AI advocates which believe paring human and AI systems as a collaborative team produces far greater results than human or AI alone performing the same tasks.[1] Adding to that, the space domain presents a unique set of changes because it not only touches all other domains, but its overall strategic nature of its capabilities spills over into commercial, military, economic, and political arenas. Due to the space domain's unique data dense and dynamic ecosystem, Human-AI pairing is the best way to employ AI capability in Space Operations but to achieve this, teaming requires building warfighter trust.

[1] Sidharth Kaushal et al., "Leveraging Human– Machine Teaming," Special Resources Report, January 2024, https://www.scsp.ai/wp-content/uploads/2024/01/human-machine-teaming-sr-jan-2024.pdf.

Background

According to the Department of Defense, "AI refers to 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." [2] The National Security Commission on AI, explains in more detail, "AI is not a single piece of hardware or software but a constellation of technologies that depend on interrelated elements…[it is] technologies that solve tasks requiring human-like perception, cognition, planning, learning, communication or physical action; and technologies that may learn and act autonomously, whether software agents or embodied robots." [3] AI is renowned for its abilities to process big data and produce related analysis, complete complex calculations, significantly increase response time in dynamic environments compared to humans and is currently deployed for use today in areas such as planning and optimization, computer vision, model and simulation, natural language understanding, robotic process automation, and prediction.[4] Incorporating these capabilities into the space domain can enhance how the Space Force executes its five core competencies of military spacepower as described in the US Space Force Space Capstone Publication. The competencies are space security, combat power projection, space mobility and logistics, information mobility and space domain awareness. [5] There are subsets of space missions that could benefit from AI, to include but not limited to, maneuvering satellites, controlling large

[2] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway," n.d.
[3] Eric Schmidt et al., "National Security Commission on Artificial Intelligence," Commission Report, accessed January 18, 2024, https://reports.nscai.gov/final-report/.
[4] Schmidt et al. See page 33 of the complete report for current real world applications of AI in key areas.
[5] "Space Capstone Publication, Spacepower," Doctrine (United State Space Force, June 2020). See publication for a detailed explanation of each core competency.

mega-constellations, automating object detection, debris tracking, identifying and countering anti-satellite threats, data analysis, target detection, and assistance in missile detection and defense.[6]

However, some futurists believe augmenting machine proficiencies with human operators can create interdependent teams that could outperform both humans and machines individually.[7] By this means, machines could cover the areas humans show some weaknesses in, like in rapid data assimilation and analysis, and still enable human counterparts to continue to be successful at processing contextual understanding of dynamic environments to apply military effects. Specifically, humans teaming with AI capabilities falls into two categories, Human-Machine Collaboration (HMC) and Human Machine-Team (HMT), both combine the human, the machine, and the interactions and interdependencies between them. HMC focuses on optimizing cognitive tasks, like decision-making, while HMT emphases on more effectively executing a wider range of complex tasks.[8] A joint report by Special Competitive Studies and the Royal United Services Institute, both US and UK think tanks respectively, provides the most complete explanation of these interactions:

> "*HMT should be considered as a complex military process with a feedback loop between the human and the machine which changes the behavior of both. A core*

[6] "Artificial Intelligence in Space" (European Space Agency, August 3, 2023), https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Discovery_and_Preparation/Artificial_intelligence_in_space; Captain George Galders, US Navy (Ret), "Get Moving with Human-Machine Teaming," Article (U.S. Navy Institute, August 2022), https://www.usni.org/magazines/proceedings/2022/august/get-moving-human-machine-teaming. Both sources speak to how AI can enhance space operations across common mission requirements across civilian or military applications. Emphasis is on military applications.

[7] Cheryl Pellerin, "Work: Human-Machine Teaming Represents Defense Technology Future," Press Release, November 8, 2005, https://www.defense.gov/News/Releases/Release/Article/2091996/dod-adopts-ethical-principles-for-artificial-intelligence/.

[8] Kaushal et al., "Leveraging Human– Machine Teaming."

> *concept of HMC and HMT is that humans and machines have comparative advantages and excel in different areas. Humans generally outperform machines on high-context tasks (those that focus on relationships between objects, rather than on a particular focal consideration) and on various types of creative exploration. Machines, on the other hand, often outperform humans on tasks that require processing extremely large volumes of data, or which need a high degree of precision, speed, or consistent repetition*."[9]

Unfortunately, Human-AI teaming is still in its infancy. To create these envisioned teams, there must be *trust* between the warfighters and the systems they are paired with in operations. Trust is critical to effective human-AI pairing because it affects the willingness of warfighters to adopt AI systems as aids, partners and teammates.[10] Trust is a multifaceted concept, to include human psychological processes. But in the context of human-machine pairing in any form, it speaks to an individual's confidence in the reliability of the technology, how its developed, individual self-assurance one can correctly employ the technology, and most importantly, its ability to accomplish desired military effects.[11] This discussion will cover how to achieve warfighter trust in relation to human-AI pairing in various forms.

How to Achieve Warfighter Trust

In December 2023, in a panel discussion regarding AI at the Reagan National Defense Forum, Secretary of the Air Force Frank Kendall emphasized the importance of developing and

[9] Kaushal et al.
[10] Margarita Konaev and Husanjot Chahal, "Building Trust in Human-Machine Teams," Commentary (Brookings, February 18, 2021), https://www.brookings.edu/articles/building-trust-in-human-machine-teams/.
[11] Konaev and Chahal; "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway."

deploying AI as a key element in meeting security challenges posed by China and Russia.[12] The DoD's Responsible Artificial Intelligence Implementation and Strategy Pathway (RAI I&S Pathway) addresses this departmental challenge by specifying design, deployment, and use procedures to rapidly employ AI as a larger part of DoD modernization efforts while summarizing six tenets to build foundational "trust" with warfighters and other stakeholders."[13] The tenets are "Governance, Warfighter Trust, AI Product & Acquisition Lifecycle, Requirements Validation, Responsible AI Ecosystem and AI Workforce". This section will focus on governance, product and acquisition cycle, and then requirements and validation. The Warfighter Trust and AI Workforce tenents will be covered later in the discussion.

Considered as the first step in establishing trust with warfighters and other stakeholders, governance refers to oversight, accountability, guidelines, and policies for fielding AI technology within the DoD.[14] The governance structure and its associated processes enable appropriate risk assessment and mitigation of unintended consequences while still allowing for innovative creation of AI capabilities.[15] This governing structure uses a top down approach while enabling innovation to work upward. Aided by the DoD's Responsible AI Toolkit, or RAI Toolkit, it accelerates the adaptation of intelligent machines within the DoD by providing clear guidance and mechanisms to developers in implementing the appropriate frameworks within the

[12] "DAF Leaders Emphasize Adapting Ai for Warfighting Success," Press Release (Air Edecation and Training Command, December 3, 2023), https://www.aetc.af.mil/News/Article-Display/Article/3605223/daf-leaders-emphasize-adapting-ai-for-warfighting-success/.
[13] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway." Other stakeholders include the American people, decision-makers and leaders. This document is built upon the DoD AI Ethical Principles. For more explanation see page 5 of the strategy.
[14] "DOD Adopts Ethical Principles for Artificial Intelligence" (U.S. Department of Defense, February 24, 2020), https://www.defense.gov/News/Releases/Release/Article/2091996/dod-adopts-ethical-principles-for-artificial-intelligence/.
[15] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway."

Department's AI ecosystem.[16] This approach grants Services and agency components the responsibility to create oversight policies with the ability to catch and fix critical failings within the life cycle of AI systems and the methods to report it. Taking it a step further, this structure also allows for individuals to raise concerns about potential irresponsible development not in line with specified guidance and hold those accountable. Additionally, it directs creation of a grievance process for individuals adversely affected by the actions of any AI system.[17] Lastly, the RAI Working Council serves as the working body to monitor and coordinate issues across the services and agency components and reports to a 4-star level governing body headed by the Office of the Chief, Digital and Artificial Intelligence Officer (CDAO) who reports to the Secretary of Defense. [18] Thus, every DoD service and component must ensure their AI capabilities are in alignment with AI development lifecycle, the RAI implementation end state (which is "trust"), policies, and guidelines. The resulting transparency throughout the AI development lifecycle shows consistency and the balance between accountability and integration speed for combat and non-combat related applications.[19] This Department standard prepares the groundwork for seeds of trust to be sown with the warfighter.

The next step to grow warfighter confidence is through the AI Product and Acquisition lifecycle, which dove tails into the four phases of design, development, deployment, and use. [20] This tenant ensures the best AI development occurs at the pace the Departments needs to meet the National Defense Strategy. The goal here to develop tools, policies, processes, and

[16] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway."
[17] Schmidt et al., "NSCAI Final Report,"; "DAF Leaders Emphasize Adapting Ai for Warfighting Success."
[18] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway"; Schmidt et al., "NSCAI Final Report."
[19] "RAI Toolkit," 2022, https://rai.tradewindai.com/. See AI development lifecycle diagram under "background".
[20] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway." See figure 1 in Appendix A for a complete explanation of each stage in relation to this tenet.

acquisition guidance to synchronize enterprise implementation of Al products through a system engineering and risk management approach.[21] This endeavor created the RAI Toolkit which supports the governance structure described above. Using the toolkit, developers and testers can incorporate assurance concepts throughout AI maturation. It draws on best practices and innovative research from industry, academia, and commercial communities.[22] The toolkit also provides a centralized process that identifies, tracks, and improves alignment of AI projects to the overall RAI strategy. The benefit here is the process provides "auditable methodologies of data sources, design procedures and documentation" and provides a measure of assurance that "appropriate levels of judgement and care" are used during the entirety of the lifecycle process.[23] This is where the bulk of the accountability mechanisms and risk assessments are built into each of the life cycle phases. The presences of these processes set the foundation to ensure projects are based on applicable legal frameworks, guidance and contextual circumstances, both appropriate risks and developmental progress are identified, evaluated, and mitigated; and systems are continuous monitored to look for opportunities or necessities for corrections and improvements.[24] Here we see the seeds of trust encouraged with the confidence of comprehensive methods underpinning how AI capabilities are brought to the warfighter.

There is one additional step that is needed before handing off the AI projects to warfighters and that is "requirements & validation". This tenet covers Test and Evaluation, Verification and Validation procedures (TEVV) and can be viewed as integrated quality control mechanisms which ensures AI capabilities "are aligned with operational needs while addressing

[21] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway."
[22] "RAI Toolkit."
[23] "RAI Toolkit."
[24] "RAI Toolkit."; applicable legal frame works include, but are not limited to, the U.S. Constitution, subsequent privacy laws, protections guaranteed to U.S. persons, POTUS Executive Orders, and Laws of Armed Conflict

relevant risks" unique to AI.[25] Here, the reliability and safety of systems prior to and during deployment are the focus. A formalized requirements validation process executed under TEVV scrutiny allows for assessments using methods and metrics to determine if the technology or AI systems meet design specifications and requirements.[26] A rigorous evaluation of AI capabilities include traceability and accountability (both required by the RAI guidance) but also traditional test and evaluation measurements of effectiveness, suitability, security, and safety, which applied in tandem creates a standardized DoD AI TEVV framework.[27] To complete rigorous evaluations on AI solutions, a wide range of testing methods, including user-centered approaches, are conducted on live, virtual and specialty test ranges. The resulting and approved AI systems are then ready for Operational Test and Evaluation (OT&E) to be exercised in actual or simulated employment by typical users under realistic operational conditions.[28] In the design phase, acquisitions must emphasize the ease of operator use and adaptability of interfaces so in the testing phase it's possible to continually evaluate risks and judge successes of human-AI tactics in the field.[29] Field experimentation that gradually reduce errors and improve awareness of the boundaries of a particular human-AI pairing or lone AI capability helps generate trust and speed adaptation by the force.[30] Defining trustworthiness in meaningful and testable ways will always be a work in progress but education and training of the warfighter can help bridge gaps and provides understanding and illumination on sprouting seeds of trust.

[25] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway."
[26] Schmidt et al., "NSCAI Final Report."
[27] Schmidt et al. See chapter 7 of this report for more details on AI TEVV framework.
[28] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway."
[29] Kaushal et al., "Leveraging Human– Machine Teaming."
[30] Konaev and Chahal, "Building Trust in Human-Machine Teams."

How to Employ AI While Continuing to Build Warfighter Trust

While it is advantageous to make AI more transparent, explainable, and reliable as described above but it is also necessary to account for the human element in acceptance and subsequent AI-pairing.[31] At this time, the bulk of research on human-AI interaction is focused on human trust in automation, such as the autopilot feature in cars or planes. But there is limited research on human, intelligent machine, and interactions and interdependencies between them to build meaningful relationships that can hold up in the high-stakes, stressful, and rapid timing of successful space operations.[32] Along with trust, positive interactions and feedback loops are critical pillars to forming successful teams. It must be acknowledged; warfighters cannot change the way they fight in near-pear or peer-to-peer conflicts without changing the way they think about AI in military operations in general.[33] Providing education on AI systems is essential to creating a RAI friendly shift in warfighting culture. Universally, education should underscore general concepts and provide a deeper understanding of how to optimize human-machine collaboration and teaming on a wider scope.

As stated before, HMC and HMT are still burgeoning fields but adjacent research on human behaviors paired with machine automation offer some insights to consider. For example, research shows humans tend to favor information shared by automated systems over information from non-automated systems showing no regard to which provides the most correct information, creating what is called automation bias.[34] On the other hand, there will be users who will be

[31] Konaev and Chahal.
[32] Konaev and Chahal.
[33] Schmidt et al., "NSCAI Final Report."
[34] John Christianson, Di Cooke, and Courtney Stiles Herdt, "Miscalibration of Trust in Human-Machine Teaming," Commentary (War on the Rocks, March 8, 2023), https://warontherocks.com/2023/03/miscalibration-of-trust-in-human-machine-teaming/.

reluctant to adapt said technology, let alone accept assistance from intelligent machines in space operations in favor of more analog processes. Therefore, identifying and educating users on the types of human bias toward AI technology can help increase human self-awareness and temper expectations. In addition, other studies show humans who do accept automated technology tend to engage in more risky behavior because it is believed to be much more of a safety net than intended and is known as "behavioral adaptation". [35] In this case, there is an overreliance on technology to execute without human engagement that does not lend well to high functioning teaming or collaboration with desired outcomes. Education on how to identify and mitigate bias and behavioral adaptation can help operators become more self-aware and pave the way for humans to self-correct and alleviate unwanted results thus discouraging mistrust.[36] Providing education on AI benefits, limitations, risk factors, security vulnerabilities, ethical awareness, is a transparent means of acknowledging AI is not a panacea and human interaction is still essential and needed.[37] Likewise, defining the difference between human-to human relationships, HMC, HMT, autonomous components and full automatous systems is vital to establishing desired interactions in space operations.[38] Lastly, articulating what "needs" a particular AI systems are satisfying and "how" it provides an advantage before it is deployed lays a foundation for a workforce that is prepared to interact with, appreciate and participate in the care and feeding of AI systems throughout its life cycle. Taken together, education on the learning objectives detailed above creates a stake in which vines of trust are able grow on.

[35] Christianson, Cooke, and Stiles Herdt. Behavioral adaptation is defined as the unintended change in behavior of the user with the introduction of a new system against the system's intended designated.
[36] Christianson, Cooke, and Stiles Herdt.
[37] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway."
[38] Schmidt et al., "NSCAI Final Report." "Full automation denotes systems making decisions with no human intervention outside of design and deployment."

While education introduces broader foundational concepts, training seeks to develop skills to change or enhance a behavior and to accomplish specific tasks through a much narrower scope. This is where the rubber meets the road in developing trust-based human-AI pairings in future space operations. AI systems contributing to key missions such as maneuvering satellites, debris tracking, and big-data analysis is an easy concept to accept. However, learning and comprehending its benefits despite limitations, risk factors, and vulnerabilities of AI enabled systems, across a quickly changing technological and geopolitical landscape is a complex undertaking.[39] Of course basic training on how to interact with AI or automated systems once deployed is needed but deeper training on how to form effective hybrid human and AI pairs is vital. For example, HMC focuses on optimizing cognitive tasks, like decision-making, which is could be useful in a number of missions in space operations like space mobility and logistics which in the future includes maneuvering, servicing and refueling satellites in orbit. Using AI as a decision aid in data rich, dynamic environments where warfighters can quickly select the best course of action is forthcoming. The strength of decision analysis is the ability to calculate the value and cost of waiting for additional information before deciding.[40] Delaying decisions too long may translate to the loss of capability, initiative, or assets in a threat scenario but ultimately it depends on the situation and the circumstances. Realizing the best of what HMC has to offer depends on the specifics of any decision value-cost matrix, training and practice to operate in a

[39] "RAI Toolkit"; Schmidt et al., "NSCAI Final Report"; Nick Starck, David Bierbrauer, and Paul Maxwell, "Artificial Intelligence, Real Risks: Understanding and Mitigating Vulnerabilities in the Military Use of AI" (Modern War Institute at West Point, January 18, 2022), https://mwi.westpoint.edu/artificial-intelligence-real-risks-understanding-and-mitigating-vulnerabilities-in-the-military-use-of-ai/. The NSCAI Final report recommends training. The RAI Strategy mandates workforce training. The RAI Toolkit enables accountability of training. The article by Starck, et all, details four potential risks in using AI in military operations and how to mitigate them. Desired interactions will be determined by specific mission stakeholders, users, developers, and policy makers.
[40] George Nacouzi et al., "Artificial Intelligence and Machine Learning Applications for Defensive Counterspace: A Decision Support Tool Capability Demonstration" (RAND Corporation, 2024), https://doi.org/10.7249/RRA582-1.

data congested, dynamic environment with greater ease. The best way to codify these concepts is through wargaming and experimentation.

Wargames can provide complexity and uncertainty in a closed environment to explore and examine a variety of challenges and concepts along the strategic, operational, and tactical echelons.[41] As a tool, wargaming can help foster critical thinking and innovation, and most of all develop core competencies needed in high functioning human-AI teaming and collaboration. These required competencies include familiarity with and skills in data-informed decision-making, computational thinking, innovation methods, organizational transformation, and most importantly an agile learning mindset, all of which can be introduced through educational channels and reinforced during training.[42] Data-informed decision-making with AI involvement promotes the use of data to generate insights and act on them rather than using intuitive or experience-based decision making.[43] This skill is not meant to replace intuitive or experience based decisions made by warfighters in the competition or conflict phases but add another layer of cognizance and options. The final call would be based on contextual understanding of the environment, rules of engagement and commander's intent so in some space operations tasks, like collision avoidance, due to the speed of AI automation, it's recommendations may be most appropriate and accurate. This also speaks to warfighters being versed computational thinking which is how to use information processing agents to perform beneficial computations that could not normally be done quickly by humans.[44] Both skill sets can be reinforced in structured wargames aimed at exploring how the mechanics of different processes, pairings, and situations

[41] Paul Joon Bae and Paul Kerney, "Use Wargaming to Sharpen the Tactical Edge," *War Room* (blog), March 8, 2021, https://www.rand.org/pubs/commentary/2021/03/use-wargaming-to-sharpen-the-tactical-edge.html.
[42] Schmidt et al., "NSCAI Final Report."
[43] Schmidt et al.
[44] Schmidt et al.

influence decisions including with AI support.[45] In this way, warfighters can concentrate on application, synthesis, and the nuances of a value verses cost decisions in space operations.

That said, enhanced human-AI interaction and teaming needs more research and funding to advance the understanding of methods for augmenting human reasoning abilities. [46] While research is looking to close that critical gap, supporters who advocate for AI systems in military operations agree that successful human-AI pairings will need warfighters that are well-versed in innovative methods.[47] This speaks to the ability and wiliness to experiment with and participate in the development of new concepts and strategies. This couples well with understanding organization transformation, which speaks to knowing when and how to integrate AI in missions, organizations and units that can ride the wave of innovation and increase buy in by participating in research and testing. Warfighters contributing in this way increases trust as they help build, test or improve AI systems they will eventually field and use.

Taking it a step further, when warfighters get better at understanding how AI systems behave and react in the anticipated environment performing the required mission, they will have greater confidence in them as partners or teammates in daily use. [48] To this end, Army, Air Force and Navy have all AI systems built for human AI-teaming in various stages of TEVV.[49] Space Force can observe those programs for lessons learned as it develops its own AI systems for collaboration and teaming. As these systems become fully mission capable, according to the RAI

[45] Joon Bae and Kerney, "Use Wargaming to Sharpen the Tactical Edge."
[46] Schmidt et al., "NSCAI Final Report."
[47] Schmidt et al.; "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway."
[48] Konaev and Chahal, "Building Trust in Human-Machine Teams."
[49] Konaev and Chahal; Christianson, Cooke, and Stiles Herdt, "Miscalibration of Trust in Human-Machine Teaming"; Captain George Galders, US Navy (Ret), "Get Moving with Human-Machine Teaming."

I&S pathway guidance, it is still incumbent on the warfighters to maintain continuous monitoring to ensure performance parameters are within expectations. Ensuring task specifications remain applicable, data inputs remain valid and secure, and new data doesn't degrade the system is a skill set that only comes with daily interaction, teaming and collaboration.[50] These skills underscore the value of human-AI pairings and supports continuous a test and evaluation processes and mindsets that can conceive changes in operational concepts, human degradation/deskilling errors and identifying sources of drifts.[51] Because the warfighters will be involved in the care and feeding of their AI counterparts, this nourishes the vine of trust supported by education and training.

Achieving Desired Effects with human-AI pairing

The final employment of AI capabilities and human-AI pairings provide a mirid of possibilities in space operations without displacing existing abilities although it is likely to produce a combination of new and current capabilities to achieve commander's objectives. [52] All of this is only possible due to the trust nurtured by all the steps described above. As with a greater understanding of human-AI pairings through research and wargaming, previously unfeasible or impossible maneuvers in space can become sound concept of operations if developed over time. For example, massed autonomous machines, assigned by a human counterpart could outwit red counterspace defenses with less risk to friendly orbital regimes. Human-AI pairing may also change the ratio of human to machines to perform certain tasks. As an example, Defense Advanced Research Projects Agency or DARPA is experimenting with

[50] "RAI Toolkit."
[51] "U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway."
[52] Kaushal et al., "Leveraging Human– Machine Teaming."

using teams of 25 soldiers to control up to 250 uncrewed air and ground vehicles each![53] If this is proven viable, this concept could be extended to controlling mega constellations which, in the future, could have more autonomous features for self-protection.[54] It is also possible the pairings would centralize command and control to solve information chokepoints and provide greater assistance in tactical operations. Human-AI pairing is an open door which can enhance military effects and bring the best available data to shape competition and conflict earlier which creates greater decision space for commanders and in most case can lead to a decision advantage.

Conclusion and Recommendations

The Department of Defense's Responsible Artificial Intelligence Implementation and Strategy Pathway in conjunction with the RAI Toolkit provides guidance and oversight on how and when to incorporate AI capabilities into military missions. AI technology in space can enhance how the Space Force executes its core competencies but there is opportunity to harness synergies from human-AI teaming and collaboration. To take advantage of these opportunities warfighter trust must be addressed, developed, cultivated, and sustained. To do this Space should invest in the following:

- For each space competency, develop a decision matrix which is viable in the global campaign, competition and conflict phases of military operations. Much of this information is already available but needs to be organized into a loose framework. This is important to identify the complexities, risks, information requirements and other intricacies involved in each competency. Once accomplished, the stakeholders can pinpoint which modes of operations according to the missions within the

[53] Kaushal et al.
[54] "Artificial Intelligence in Space."

competencies would benefit from increased decision space. Through that lens determine which instances the stakeholders want to benefit from human-AI pairing, which is the most advantageous result vice human or machine alone.[55]

- Create a spectrum of wargames that educate and train warfighters on how to collaborate and team with AI systems. Education on how to team with AI systems builds reliability and matures interaction between humans and machines. In addition, warfighter trust is a psychological process and scenarios which train to new concepts or induce stressful conditions with mental and cognitive pressures help mitigate mistrust, builds familiarity, and instills confidence by learning how to respond as a pair, then a team and ultimately a lethal force. [56]
- Finally, provide greater opportunities for operational units, who have been educated and trained on AI systems, to be a part of testing in some manner. As new AI capabilities are rolled out warfighter buy-in is critical. Early inclusion opens the door to cultural changes which encourage innovation and creation of new concepts of thinking and execution.

All together these recommendations will speed a strategic transformation in space power and thus catapult the Space Force into the digital force it aspires to be.

[55] Kaushal et al., "Leveraging Human– Machine Teaming.".
[56] Konaev and Chahal, "Building Trust in Human-Machine Teams."

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