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THESIS

SURVEY OF DOD PROGRAMMATIC USE OF ARTIFICIAL INTELLIGENCE

by

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13. ABSTRACT (maximum 200 words)

Artificial intelligence (AI) is changing the world. The Department of Defense (DOD) has published policy and directed the adoption of AI across its military services; however, the Department of the Navy (DON) remains significantly behind the other services. This thesis explores to what extent the DON can learn from mature and successful AI initiatives across the DOD and how instituting these lessons learned can be federated across the DON. First, a review of current policy identified the current DOD definition of AI and its approach to AI development and experimentation. Then, interviews and field observations were conducted to try and observe those factors identified in the policy analysis and to detect previously unrecognized barriers to widespread AI adoption across each military service. Lastly, the lessons observed were applied to the hypothetical establishment of a Marine Corps AI Task Force. This research revealed significant divergence in military service approaches to workforce development, shortfalls in talent management policy and processes, and insufficient resourcing to training, operational, and experimental organizations across the forces. For the DON, formalizing the current ad hoc organizations and policies will allow for critical progress in pursuing an AI-literate workforce.

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SURVEY OF DOD PROGRAMMATIC USE OF ARTIFICIAL INTELLIGENCE

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ABSTRACT

Artificial intelligence (AI) is changing the world. The Department of Defense (DOD) has published policy and directed the adoption of AI across its military services; however, the Department of the Navy (DON) remains significantly behind the other services. This thesis explores to what extent the DON can learn from mature and successful AI initiatives across the DOD and how instituting these lessons learned can be federated across the DON. First, a review of current policy identified the current DOD definition of AI and its approach to AI development and experimentation. Then, interviews and field observations were conducted to try and observe those factors identified in the policy analysis and to detect previously unrecognized barriers to widespread AI adoption across each military service. Lastly, the lessons observed were applied to the hypothetical establishment of a Marine Corps AI Task Force. This research revealed significant divergence in military service approaches to workforce development, shortfalls in talent management policy and processes, and insufficient resourcing to training, operational, and experimental organizations across the forces. For the DON, formalizing the current ad hoc organizations and policies will allow for critical progress in pursuing an AI-literate workforce.

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List of Acronyms and Abbreviations

AI Artificial Intelligence

AIA AI Accelerator

AIET AI Expert Team

AI2C AI Integration Center

CDAO Chief Digital and AI Office

CMU Carnegie Mellon University

CNO Chief of Naval Operations

CONUS Continental U.S.

COTS Commercial-Off-the-Shelf

CSET Center for Security and Emerging Technology

CWC Composite Warfighting Command

DA Department of the Army

DAF Department of the Air Force

DAU Defense Acquisition University

DIU Defense Innovation Unit

DoD Department of Defense

DoN Department of the Navy

DS Data Science

FAR Federal Acquisition Regulation

FFRDC Federal Funded Research and Development Center

FMF Fleet Marine Force

FY Fiscal Year

IC Intelligence Community

JAIC Joint AI Center

JEL Joint Electronic Library

JROC Joint Requirements Oversight Council

MARFOR Marine Force

MEF Marine Expeditionary Force

MIT Massachusetts Institute of Technology

ML Machine Learning

MOS Military Occupational Specialty

NAVPLAN Navigation Plan

NCARAI Naval Center for Applied Research in Artificial Intelligence

NDAA National Defense Authorization Act

NDS National Defense Strategy

NIST National Institute of Science and Technology

NIX Naval Innovation Exchange

NPS Naval Postgraduate School

NRL Naval Research Lab

NRE Naval Research Enterprise

NSCAI National Security Commission on Artificial Intelligence

NSS	National Security Strategy
OCE	Office of Chief Economist
OMB	Office of Management and Budget
ONR	Office of Naval Research
RAI	Responsible AI
R&D	Research and Development
RDT&E	Research, Development, Test, and Evaluation
SME	Subject Matter Expert
TF	Task Force
TYCOM	Type Command
USA	U.S. Army
USAF	U.S. Air Force
USG	United States Government
USMC	U.S. Marine Corps
USN	U.S. Navy
USSF	U.S. Space Force
VC	Venture Capitalist

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Executive Summary

Various organizations across the United States Government (USG) have independently devised plans for AI deployment using different approaches and considerations. Using publicly available information, the USG appears to be trailing its primary strategic adversary in general artificial intelligence (AI) [1]. For the Department of Defense (DoD) to turn the corner from research to real-world application and implementation requires studying current policy and strategy documents to coordinate efforts across the department better.

This research aims to identify to what extent the Department of the Navy (DoN) can learn from mature and successful AI initiatives across the DoD and how instituting these lessons learned can be federated across the DoN.

A survey of current DoD and USG strategic policy was examined to accomplish this objective and open-source reporting was studied. Interviews were conducted with key personnel from the Chief Digital and AI Office AI Expert Teams (AIETs), Defense Innovation Unit, and Project Maven. When possible, in-person visits to relevant organizations were executed. To augment shortcomings in the availability of personnel for interviews due to scheduling, the author pulled from past experiences from emerging technology events, such as the Naval Postgraduate School AI Summits and other conferences and exercises within the DoD. The collected information, via the DOTMLPF-P framework, was used to compare AI development lessons learned and best practices to identify commonalities across successful projects and explore opportunities to bring these observations into the DoN.

Results of the background research indicate that current AI policy subjects fall into four areas: defining AI within the context of the DoD, developing responsible or trustworthy AI, operationalizing AI, and establishing government-academia partnerships to build AI. This research revealed significant divergence in military service approaches to workforce development, shortfalls in talent management policy and processes, and insufficient resourcing to training, operational, and experimental organizations across the forces. As AI matures and precedents are set for application across the range of military operations and all warfighting functions, the DoD needs to become a fast follower of commercial best practices and write policy to fill in gaps in current policy. For the DoN, this means heavily considering becom-

ing a fast follower of the USAF's Phantom Fellowship Program, establishing an AIET-like AI support structure with the necessary infrastructure, and ensuring the USN and USMC have the requisite workforce expertise to make it happen.

The USMC seems slow to take the necessary steps to set conditions for the enterprise to adopt AI effectively. To rectify this, the Marine Corps needs to shift to a culture that recognizes data as a strategic asset necessary for future innovation in pursuing asymmetric advantages. As the Joint Force's Stand-in force, the Marine Corps is too small to effectively collect the vast amounts of raw information available in highly dynamic areas like Southeast Asia without leveraging more intelligent technologies like AI. To sense, make sense of the vast amount of data from today's and future sensors, and, ultimately, close the kill chain more quickly and effectively from sensor to shooter, the Marine Corps needs to invest in an AI Task Force organization today.

The DoN can begin or continue to invest in some fundamental areas that will have long-standing positive effects in the pursuit of widespread AI adoption. These include a hybrid approach of top-down and bottom-up education and democratization of innovation and data to get the resources allocated to build the tools that the warfighters at the tactical edge of the military need. Those who will be educated need to be able to learn in a hybrid fashion. However, the author's operational experience indicates that, as the technology matures, it typically leads to individuals taking on more diverse work rather than less work. This push for individuals to have more responsibilities leads to fewer opportunities for commanders to release individuals to go to a brick-and-mortar learning institution for an extended period to get a technical degree or certification.

China intends to be the world leader in AI by 2030 [2]. Russia's president has emphasized the importance of AI, stating that whomever becomes the leader in AI will rule the world [2]. With the rapid innovation within AI, there is also an opportunity for the U.S. military to become early adopters and make up for lost ground. The National Security Commission on AI's final report recommended that the DoD and its military services be AI-ready by 2025 [3]. While each military service has made progress in the two years since this report was published, a significant amount of work still needs to be done to meet this goal. Fortunately, every military service seems to have taken this risk to heart and is aggressively moving forward to meet the challenge.

List of References

[1] J. Gaida, J. Wong-Leung, S. Robin, and D. Cave, "ASPI's Critical Technology Tracker: The global race for future power," Australian Strategic Policy Institute, Australia, Policy Brief 69/2023, Feb. 2023 [Online]. Available: https://techtracker.aspi.org.au/

[2] Y. Tadjdeh, "Big Data, AI to Advance Modeling and Simulation," *National Defense*, vol. 102, no. 770, p. 13, 2018. Publisher: National Defense Industrial Association [Online]. Available: https://www.jstor.org/stable/27022054

[3] E. Schmidt and R. Work, "NSCAI - Final Report," National Security Commission on Artificial Intelligence, Rep., Mar. 2021 [Online]. Available: https://reports.nscai.gov/final-report/

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CHAPTER 1: Introduction

1.1 Motivation

Artificial Intelligence (AI) is changing the world. Between 2017 to 2022, 62 countries to include the U.S., Russia, and China, have released AI strategies [1]. China has stated its intent to be the world leader in AI by 2030 [2]. Russia's president has emphasized the importance of AI, stating that whomever becomes the leader in AI will rule the world [2]. According to a 2023 report analyzing 10 areas of AI technology development, China was leading the world in seven key areas [3], with a risk of China being able to establish a monopoly assessed as medium or high in five of the seven technologies as seen in Figure 1.1. For the U.S. military, this means that currently, our pacing threat could have the advantage in critical and relevant technologies that could give them an asymmetric advantage in future conflicts and in the commercial marketplace.

Technology	Lead country	Technology monopoly risk
Artificial intelligence, computing and communications		
13. Advanced radiofrequency communications (incl. 5G and 6G)	China	high
14. Advanced optical communications	China	medium
15. Artificial intelligence (AI) algorithms and hardware accelerators	China	medium
16. Distributed ledgers	China	medium
17. Advanced data analytics	China	medium
18. Machine learning (incl. neural networks and deep learning)	China	low
19. Protective cybersecurity technologies	China	low
20. High performance computing	USA	low
21. Advanced integrated circuit design and fabrication	USA	low
22. Natural language processing (incl. speech and text recognition and analysis)	USA	low

Figure 1.1. List of AI-based Critical Technologies. Adapted From: [3]

However, with ongoing the rapid innovation within the field of AI there is also opportunity for the U.S. military to become early adopters and make up for lost ground. Fortunately, the United States Government (USG) is aware of the threat and has taken some policy action to guide the nation toward a better posture. Several strategic USG documents have directed the Department of Defense (DoD) to conduct focused research and identify opportunities to incorporate AI and/or Machine Learning (ML) solutions to achieve strategic advantage across the department's military services [2], [3], [15]-[21], [23], [28]-[32], [56], [69], [97]-[100]. As the principal organization leading the effort, the Chief Digital and AI Office (CDAO), formerly the Joint AI Center (JAIC), provided an on-call deployable group of AI experts to the nation's combatant commanders called the AI Expert Teams (AIETs).

This guidance, combined with other efforts from the CDAO, has encouraged some service branches within the DoD to organize to stand up AI workforce development and Research and Development (R&D) programs. At the operational level, military services are making progress. The U.S. Air Force (USAF) and U.S. Space Force (USSF) partnered with Massachusetts Institute of Technology (MIT) for an AI Accelerator as well as established over 15 software factories devoted to the adoption of AI and technical innovation [4]. The U.S. Army (USA), in addition to the activation of Army Futures Command, has partnered with Austin Community College for its first software factory, and established an AI Integration Center (AI2C) at Carnegie Mellon University [5]. DoD established AI-centric organizations, such as the USA's AI2C, facilitate the co-location of the customer and developer for more targeted, applied, and iterative solutions [5].

Despite the strategic guidance directing the critical need for AI investment and deployment, significant challenges still hamstring substantial progress. For example, no single organization has been given the authority and resources to enable the U.S. Navy (USN) to implement rapid AI development. So far, it has been left to each Type Command (TYCOM) to organize various AI development efforts under a Task Force (TF) concept [6]. By design, these functionally-aligned commands (e.g., Surface, Subsurface, Information Warfare) have the benefit of proximity and access to those with the latest experience in operational domains, but are limited in their ability to meet the manning, training, and equipping requirements needed to establish AI-literate organizations. This approach means that TFs are currently unable to effectively conduct research, develop, and integrate AI with their resident domain expertise to the benefit of their respective communities. Comparatively, the Marine Corps has a single data engineer Military Occupational Specialty (MOS), dedicated to the Intelligence Community (IC), and a number of disparate organizations that are individually attempting to experiment with AI with no deployable and adoptable solutions like each of the other military services.

Various organizations across the USG have independently devised plans for AI deployment using different approaches and considerations. In order for the DoD to turn the corner from research to real-world application and implementation, requires studying current policy and strategy documents. wholistically to better coordinate efforts across the department. It is imperative to balance service-level centralization with enabling smaller, more agile groups of experts to reach across the organization to collaborate and propose more effective solutions and metrics to assess the level of process of AI adoption across the different services. This research examines the different approaches to adopting AI and the allocation of resources within the Department of the Navy (DoN), the Department of the Air Force (DAF), and the Department of the Army (DA).

The primary question driving this research is: To what extent can the DoN learn from mature and successful AI initiatives across the DoD, and how can instituting these lessons learned be federated across the DoN? The three sub-questions that were used to break down the approach are: What is the overall status and historical progress of AI adoption and usage at select organizations across the DoD? What organizations in the DoN are positioned to influence the greater DoN most significantly for rapid adoption of AI technologies to address operational challenges? What are the current DoD AI training and education opportunities, and what are the requirements they are satisfying?

1.2 Purpose

This thesis is an organizational comparison of the policy, processes, structure, training, and equipping of personnel, for the purpose of adopting AI within mature programs in the DoD. Although there are a number of programs across the DoD that meet these limited criteria, the focus of this research will be the CDAO AIETs, Defense Innovation Unit (DIU), and the DoD's Project Maven.

This research is intended to help the greater DoD AI community garner a greater understanding of what are the markers and strategy of a successful AI program. For the purpose of the paper, a successful AI solution is characterized as transitioned from an R&D environment to an operational end-user community. Findings and understandings gained from this research may evolve into a decision-making aid for operational units as well as support to higher-level policy shaping and guidelines in future AI efforts.

As the DoN considers further investment in AI technologies, this research will help leverage best practices and lessons learned from other organizations both within and outside of the DoD. Students at the Naval Postgraduate School (NPS) studying AI with follow-on tours may learn what lessons will aid in the successful execution of their own responsibilities.

1.3 Thesis Organization

Chapter 2 covers key background points to consider for what AI-related innovation ecosystems could look like, how the DoD currently approaches the topic of AI, and a literature review on current DoD AI-related policy. Chapter 3 addresses the research approach, how data was collected, and which organizations and individuals were interviewed. Chapter 4 describes the results of the research and the application of the results to the hypothetical establishment of a U.S. Marine Corps (USMC) AI TF. Chapter 5 contains the conclusions, recommendations, and potential future work.

CHAPTER 2:
Background

This chapter will examine innovation ecosystems centered around AI, the strategic documents that guide the DoD through defining AI, the policies that define responsible and trustworthy AI, how the DoD and the different military services are approaching the challenge of operationalizing AI, and how the military services are establishing government-academic partnerships as a tool for workforce development.

2.1 Defining AI for DoD

The first National Security Strategy (NSS) to mention AI was released in 2017 [7]. In this document, AI is referred to as a critical enabling technology to the U.S. economy. In 2018, the first National Defense Strategy (NDS) to mention AI, references it as a necessary technology to engage in conflict [8]. As part of the directives within the 2018 NDS, as an departmental effort to move forward in adopting this critically enabling technology, the JAIC was established to be the agency tapped to lead the DoD in AI adoption and implementation. One year later, the DoD AI Strategy was released to the public as an unclassified summary. The strategy gives the first government's official definition of AI: "the ability of machines to perform tasks that normally require human intelligence...whether digitally or as smart software behind autonomous physical systems" [9].

The DoD AI Strategy outlines key mandates that form the foundation for current on-going efforts across the department. These include a training platform for all members of the DoD workforce, the need for private-public-government partnerships, a centralized information system for data and models, and focused research into the ethical and safety implications for the operational use of AI.

As part of the 2019 National Defense Authorization Act (NDAA), the USG definition of AI was expanded to include:

1. Any artificial system that performs tasks under varying and unpredictable circumstances without significant human oversight, or that can learn from experience and improve performance when exposed to data sets.

2. An artificial system developed in computer software, physical hardware, or another context that solves tasks requiring human-like perception, cognition, planning, learning, communication, or physical action.
3. An artificial system designed to think or act like a human, including cognitive architectures and neural networks.
4. A set of techniques, including machine learning, that is designed to approximate a cognitive task.
5. An artificial system designed to act rationally, including an intelligent software agent or embodied robot that achieves goals using perception, planning, reasoning, learning, communicating, decision-making, and acting. [10]

In January 2021 within its final report, the National Security Commission on Artificial Intelligence (NSCAI) defines AI as "[t]he ability of a computer system to solve problems and to perform tasks that have traditionally required human intelligence to solve" [11].

By no means is the definition for AI settled business, either within the DoD, research community, or general public. Since the NSCAI published its final report, this definition has become the default for policy documents and guidance and is the definition used for this research. Certain senior leaders at key organizations have yet another perspective, one that simply sees AI as just a buzzword. That is not to say that this definition is perfect. The definition still leaves ambiguity. Some shortfalls with the current definition include: what it means to be intelligent, what exactly is the lower/upper threshold for human intelligence, and whether a computer system is truly capable of being intelligent (however it is defined) or if AI should just be defined as nothing more than a complicated database or as sets of heuristic decision trees. These questions are not solved, and are outside the scope of this research. The benefit of this ambiguity is that opportunity is created and maintained to enable creativity and innovation within this space. However, the immediate potential negative impact of the remaining ambiguity places more of a need for clarity and allows for individual interpretation for organizations and individuals within the DoD.

2.2 Responsible/Trustworthy AI

Today, there is no DoD policy that clearly defines what trustworthy or responsible AI is. Despite this shortfall, DoD has taken important steps in characterizing what AI should look like if it can be described as trustworthy and/or responsible. Despite the following documents, many issues today can be traced back to documents such as this that caution against setting an unrealistic bar but also do not describe realistic goals for a technology with such technologically revolutionary potential.

The DoD effort to begin to define how the rest of the organization should consider the development of responsible and trustworthy AI began in February 2020, when the DoD officially adopted five principles for the ethical use of AI: it must be responsible, equitable, traceable, reliable, and governable [12]. Although these principles were recognized, there was no accompanying direction on how to implement this directive. In response, DIU developed Responsible AI (RAI) Guidelines to be iterated, and used with partners across DoD.

1. Responsible: DoD personnel will exercise appropriate levels of judgment and care while remaining responsible for the development, deployment and use of AI capabilities.
2. Equitable: The department will take deliberate steps to minimize unintended bias in AI capabilities.
3. Traceable: The department's AI capabilities will be developed and deployed such that relevant personnel possess an appropriate understanding of the technology, development processes and operational methods applicable to AI capabilities, including with transparent and auditable methodologies, data sources and design procedures and documentation.
4. Reliable: The departments AI capabilities will have explicit, well-defined users, and the safety, security, and effectiveness of such capabilities will be subject to testing and assurance within those defined uses across their entire life cycles.
5. Governable: The department will design and engineer AI capabilities to fulfill their intended functions while possessing the ability to detect and avoid unintended consequences , and the ability to disengage or deactivate deployed systems that demonstrate unintended behavior. [12]

Through this set of guidelines, DIU set the foundation for the framework and metrics that are currently in use to aid in the ethical development of AI across all phases of the development lifecycle. In the same month, these guidelines were published, the DoD also released its Data Strategy Framework which defined the characteristics of usable data for the future AI enabled workforce: visible, accessible, understandable, linked, trustworthy, interoperable, and secure [13]. This can be seen in Figure 2.1. Toward the end of the year, in November 2020, the Office of Management and Budget (OMB) published Memorandum M-21-06, Guidance for Regulation of Artificial Intelligence Applications. This guidance promoted the ideas of experimenting rather than the bureaucratic tradition of reflexive over-regulating, avoiding setting an unrealistic bar of expectation and performance for AI, and recognizing that previous regulations and specifications for technology adoption would likely not apply to AI without due updates [14]. These series of documents laid out important and needed guidance leading toward a framework for how the DoD should consider on-going and future investments into AI. What was needed next was a set of tenets or directives to tie everything together and set in motion the next series of policy guidance.

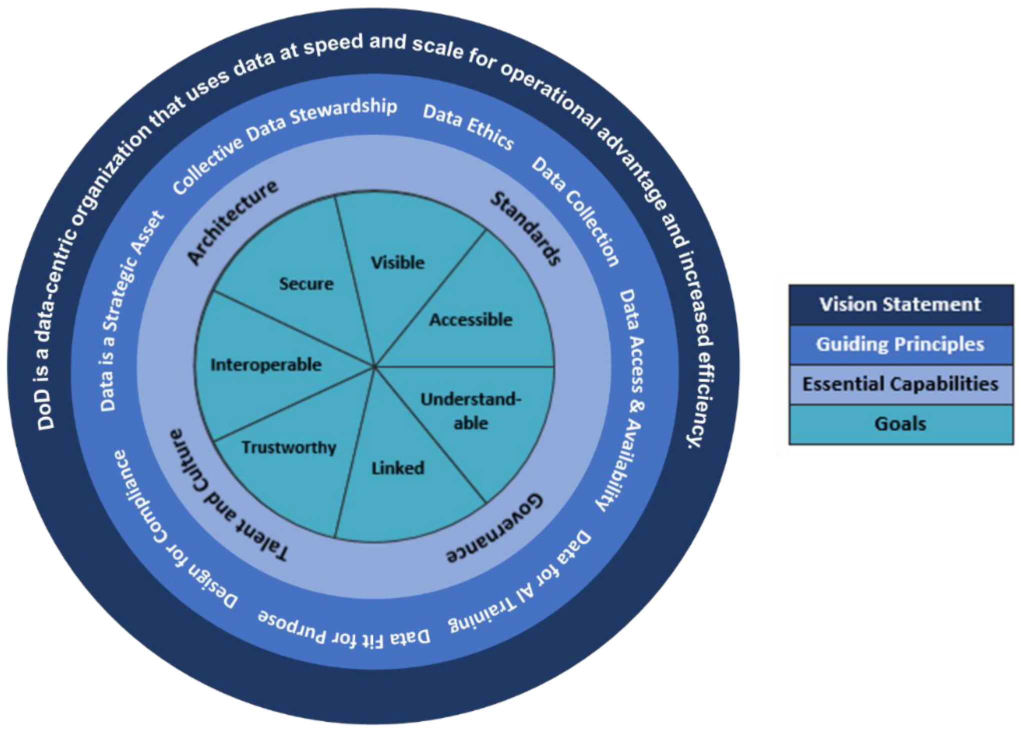

Figure 2.1. DoD Data Strategy Framework. Source [13].

In May 2021, Deputy Secretary of Defense Kathleen Hicks directed six tenets to be followed as the DoD implemented its AI principles:

1. RAI Governance: Ensure disciplined governance structure and processes at the Component and DoD-wide levels for oversight and accountability and clearly articulate DoD guidelines and policies on RAI and associated incentives to accelerate adoption of RAI within the DoD.
2. Warfighter Trust: Ensure warfighter trust by providing education and train-

ing, establishing a test and evaluation and verification and validation framework that integrates real-time monitoring, algorithm confidence metrics, and user feedback to ensure trusted and trustworthy Al capabilities.
3. AI Product and Acquisition Lifecycle: Develop tools, policies, processes, systems, and guidance to synchronize enterprise RAI implementation for the AI product throughout the acquisition lifecycle through a systems engineering and risk management approach.
4. Requirements Validation: Incorporate RAI into all applicable AI requirements, including joint performance requirements established and approved by the Joint Requirements Oversight Council (JROC), to ensure RAI inclusion in appropriate DoD AI capabilities.
5. Responsible AI Ecosystem: Build a robust national and global RAI ecosystem to improve intergovernmental, academic, industry, and stakeholder collaboration, including cooperation with allies and coalition partners, and to advance global norms grounded in shared values.
6. AI Workforce: Build, train, equip, and retain an RAI-ready workforce to ensure robust talent planning, recruitment, and capacity-building measures, including workforce education and training on RAI. [15]

From the above tenets, the DoD and its military services seem to have made varying amounts of progress. Described in more detail in sections 2.3 and 2.4, almost all of the military services have taken steps toward satisfying the first tenet. In further pursuit of meeting the first tenet, in March 2023 the DoD took an important step of marrying up [13] and [16] by issuing department-wide metadata guidance with the expressed purpose of promoting easier data discovery and increased accessibility [17]. For the second, fifth, and sixth tenets, we will explore how the DoD has taken important strides in providing education and training resources in the section 2.4. The third tenet is partially satisfied by the DIU's RAI principles, but there is still significant room for improvement. For the fourth tenet, it can be reasonably assumed, the JROC will have implemented this recent guidance in the latest Joint Warfighting Concept. As this document is classified, this research cannot further comment beyond what has been released to the public. In comments made in March 2023, the Vice Chief of Staff of the Air Force noted four supporting areas where AI can play a significant role: fires, information, logistics, and command and control [18].

Although the above guidance documents are needed, the terms and characteristics of responsible and trustworthy AI are not well-enough defined terms to be actionable within the acquisition, research, or application spaces of the DoD. Through the six tenets, DoD was mandated by Deputy Secretary of Defense Hicks to develop clear and actionable guidance, but it has not yet done so. This can be attributed, in part, to the increasing complexity of AI development [19], the organizational readiness requirements [20], and the most important aspect, human-machine teaming rather than one or the other [21]. As a result, a standardized definition of what responsible means in the context of AI development and deployment is not clear or consistently characterized. The DIU guidance seems to describe what would really be accountability. In a similar vein, the DoD chose not to define what trustworthy AI is, but simply gave a number of descriptions about what it would look like when its data was trustworthy. The underlying assumption here seems to be that when the data is trustworthy, and the RAI framework that Deputy Secretary of Defense Hicks describes is realized, responsible AI or trustworthy AI will be guaranteed. Though this descriptive characterization of responsibility - rather than defining specifically what responsibility means - may be an appropriate solution for now, this may not last.

2.3 Operationalizing AI

One of the more well-known cases of AI being operationalized was established in April 2017 through the Algorithmic Warfare Cross-Functional Team, more commonly known as Project Maven [22]. Established prior to the release of the first NSS to mention AI in 2017, Project Maven's first task was to leverage computer vision to "reduce the human factors burden of [Full Motion Video] analysis, increase actionable intelligence, and enhance military decision making" in the fight against the Islamic State of Iraq and Syria [22]. According to Lieutenant General John Shanahan, the Air Force General charged with overseeing Project Maven, moving fast through leveraging pre-existing efforts from the DoN and Commercial-Off-the-Shelf (COTS) [23]. Though Project Maven is notable for many reasons, it should not be overlooked how important this initiative was [24], and continues to be [25], to DoD AI operationalization efforts. Project Maven leadership assumed significant risk in leveraging a promising but largely unproven emerging technology in an operational environment without any guiding policy or doctrine. Today, through guidance documents such as those mentioned in the preceding sections, commanders today do not have to face the same reality for leveraging AI as Project Maven did.

Once clear and actionable policy is written, the next step needed to ultimately bring a new capability to the tactical edge is to push it through operational-level commands. In the first step from policy-makers to put the documents into action in 2019, the DoD published the DoD Modernization Strategy, where AI is identified one of the Chief Information Officer's top four priorities [26]. One year later, in October 2020, the DoD released the Campaign for an AI Ready Force, which identified individuals and their organizations as both the center of gravity and the critical vulnerability to an AI-enabled workforce [27]. Four key components were highlighted: people, data, technological infrastructure, and organizational design [27]. Additionally, recommendations were made to DoD Components to establish and deploy assessment teams, nest team findings with senior decision making agents, codify talent pathways, and align future resourcing along two groups: technical roles and enablers [27].

In September 2020, in response to Fiscal Year (FY) 2020 NDAA Section 256, the CDAO, at the time operating as the JAIC, published the DoD AI Education Strategy [28]. This education strategy built upon the foundation set by the DoD's campaign plan for an AI ready force that had incorporated the envisioned data strategy. In this seminal piece, six archetypes seen in Figure 2.2 were defined that still drive the lines of effort for AI education material and resourcing today. At the time of the strategy's publication, four key pillars for future success were identified: develop senior-leader buy-in, develop a cadre of cross-disciplinary teams of experts, create a collaborative and integrated infrastructure, and build a pathway to credential developed talent [28]. To this day, the DoD as a whole is still wrestling with these aims.

Archetype	Description	Concentration	Role Explanation
Lead AI	Decides policy and doctrine, including how AI tools can or will be used; builds AI vision and plan	Policy	• Creates overarching guidance on DOD AI use
		Command	• Ensures AI policy carried out by personnel they lead
		Agency/Function Lead	• Ensures AI policy carried out in non-combat agencies
Drive AI	Ensures appropriate AI tools and capabilities are developed and delivered across DOD	Acquisitions Manager	• Supports technology/capabilities through total life cycle
		Capability Manager	• Evaluates and develops force structure resources and reqs
		Technical Manager	• Defines the tech strategy across a project portfolio
		Product Manager	• Ensures the creation of AI-enabled tools, from start to finish
Create AI	Creates AI tools to meet current and future needs	AI Researcher	• Pushes DoD AI capability by preparing for future use cases
		AI/ML Engineer	• Builds, tests, codes, integrates, and delivers AI tools
		Testing & Evaluation Engineer	• Evaluates system capabilities, limitations, operational risks
		Data Scientist	• Applies AI tools to perform analytics and create solutions
		Deployment Engineer	• Manages integration, deployment, and operation of AI systems
Embed AI	Embedded with Employ AI, establishes AI systems and provides end-user support at tactical edge	Technician	• Deploys, maintains, adapts, and collects data for AI/ML systems at the tactical edge
Facilitate AI	Represents users to ensure appropriate AI tools are developed and delivered to address use cases	Product Owner	• Provides voice of customer; turns product vision into backlog
		UI/UX	• Designs AI tool interface for usability and accessibility
		Other Technical Experts	• Delivers discrete elements of system not specific to AI
Employ AI	End-users of AI tools, provide feedback on and requirements for AI tools	Operations	• Prepares for and delivers operational requirements
		Intelligence	• Gathers and analyzes info to support decision-making
		Logistics & Maintenance	• Enables troop / gear movement, maintain equipment
		Health	• Maintains health and wellbeing of the Warfighter
		Support	• Supports the Warfighter in non-combat requirements

Figure 2.2. AI Workforce Archetypes and Concentrations. Source [28]

In 2021 the NSCAI final report was published, which outlined a series of required actions needed to operationalize AI within the DoD. This report covers a vast number of topics, all centered around what a whole-of-government approach to the many factors that go into setting national, not just government, policy and long-term strategy for the research, development, application, and sustainment of AI along with impacts to the U.S., its partners, and its allies [11]. One of the key takeaways from this extensive research was that the DoD needs to become AI-enabled by 2025. To complete this requirement meant a number of tasks needed to be undertaken, some of which included the allocation of resources to research and development, workforce education, modernized talent management processes, critical data source identification and data storage, and the acquisition of the appropriate tools and software to establish a environment for development and deployment.

In 2019, as the DoD Modernization Strategy was written, the USA published its force modernization strategy highlighting AI as number five of the nine Army Priority Research Areas [29]. Since then, a public update of the report has not been released to integrate the key components highlighted by [16] or the archetypes from [28]. Also in 2019, the Commandant of the Marine Corps issued his initial planning guidance to force which highlighted that the Marine Corps needed to make investments into artificial intelligence, machine learning, and data science capabilities and technologies [30]. In January 2021, as part of the USN force modernization initiative titled the Chief of Naval Operations (CNO) Navigation Plan (NAVPLAN), AI is called out as one of four critical enablers to maintaining U.S. maritime supremacy [31].

On the subject of taking the policy and direction set by the highest levels of the USG to the operational and tactical forces that make up each of the military services, it can be said with certainty that every military service has begun the process of widespread AI adoption. The USA and USAF appear to have the lead over the USN and USMC in this regard. With this first mover advantage comes the risk and inevitability of failure but also the satisfaction of success as seen in Army Futures Command's experiences in Yuma in 2020 [32]. In the scenarios setup for this event, the USA saw an improvement in the sensor-to-shooter chain decrease from 20 minutes to 20 seconds. At the same time, the USA also saw a number of failures, but rather than dwell on the loss or potential embarrassment of the units involved, the commander and team recognized these as learning opportunities and signs that AI is promising but not infallible. For the DoN, this trade-off provides the opportunity to be a fast follower. By watching others, it gives leadership and decision makers the chance to observe what works and what fails, resource those initiatives with a proven record of positive impact and the more favorable cost-benefit analysis, and focus in application and innovation rather than fundamental experimentation.

2.4 Government-Academic Partnerships

Since the DoD AI Strategy was published, not every military service has released a public annex outlining their respective implementation plan. In 2019, the USAF was the first and only military service to publicize their annex to the DoD. In this annex, every member of the USAF is explicitly tasked to leverage AI to contribute to their assigned mission, and data is identified as a strategic capability. Shortly following this, the agreement that established the DAF-MIT AI Accelerator (AIA) was written [33]. As a relatively new military service with origins within the USAF, the USSF also has a connection to the DAF-MIT AIA. Within a year, the USA Futures Command established the AI2C, a formal TF of which one component is a research and development agreement with Carnegie Mellon University (CMU) [5].

The DoN has not established a similar agreement with a research university to parallel the efforts of the USA, USAF, or USSF. Rather, it continues to invest in the Naval Research Enterprise (NRE) research organizations such as Office of Naval Research (ONR), Naval Research Lab (NRL), and sub-organizations within NRL such as the Naval Center for Applied Research in Artificial Intelligence (NCARAI) [34]. One undeniable benefit to 100% DoN R&D development is comparative cost, lack of need to develop new processes or to move personnel and equipment to new locations, and the up-to-date real-world experience such as what is seen with students at NPS. Although up-to-date real-world experience cannot be completely substituted, one shortfall in this approach is that DoD-sourced organizations such as NPS are not resourced with the facilities and resources that are seen at world-leading research institutions such as MIT and CMU.

In summary, there has been significant headway made amongst the DoD with respect to policy production on the topic of AI adoption, employment, and sustainment. However, as anyone tasked with implementing the strategy document above can appreciate, this is only the beginning. With an end goal defined, now comes the hardest part: implementation.

2.5 Mapping an Innovation Ecosystem

In the 1960s, the U.S. as a nation and the DoD each played a significant role in the global landscape of funding R&D efforts [35]. As the years have passed, this spending has decreased and with it, the influence of the DoD to affect R&D trends and priorities, or to be the first to benefit from insights [36].

In the past, the DoD has been able to rely upon active involvement in conflict to justify rapid acquisition, more risk-taking, and agile action that fosters and promotes innovation. As the DoD shifts away from Counter-Terrorism operations of the past two decades and focuses on strategic competition, leadership at all levels must acknowledge two distinct realities: that this is a competition below the threshold of conflict in the pursuit for asymmetric advantage across the warfighting domains and that we are in a time of competition for innovation [37]. Alongside this acknowledgement of innovation as a critical foundational layer for future success, is the need for a complementary shift in culture. Put bluntly, the bottom line is to innovate or die.

Today, Venture Capitalist (VC) investment firms and companies doing independent research and development massively outspend the DoD, and it seems there is no slowing down on this front as disruptive technologies with huge revenue-generating commercial applications such as 5G/6G, AI, and cloud computing continue to mature [38], [39]. Government spending reported by the NSCAI showed an expected investment in 2022 of around $22 billion USD, as seen in Figure 2.3, while VC investment in that same time period was expected to be more than four times that level [39]. There is a limited usefulness of a direct comparison between VC and DoD R&D spending because the DoD is much more limited in its ability to effective execute exploratory research. However, the effect of this shift away from defense industry-led R&D funding is a corresponding shift away from products designed to be implemented in a national security environment to the commercial space. This leaves the DoD community constrained to take commercial products and, whenever possible, work with companies (large and small) to collaborate on adapting products into dual-use technology.

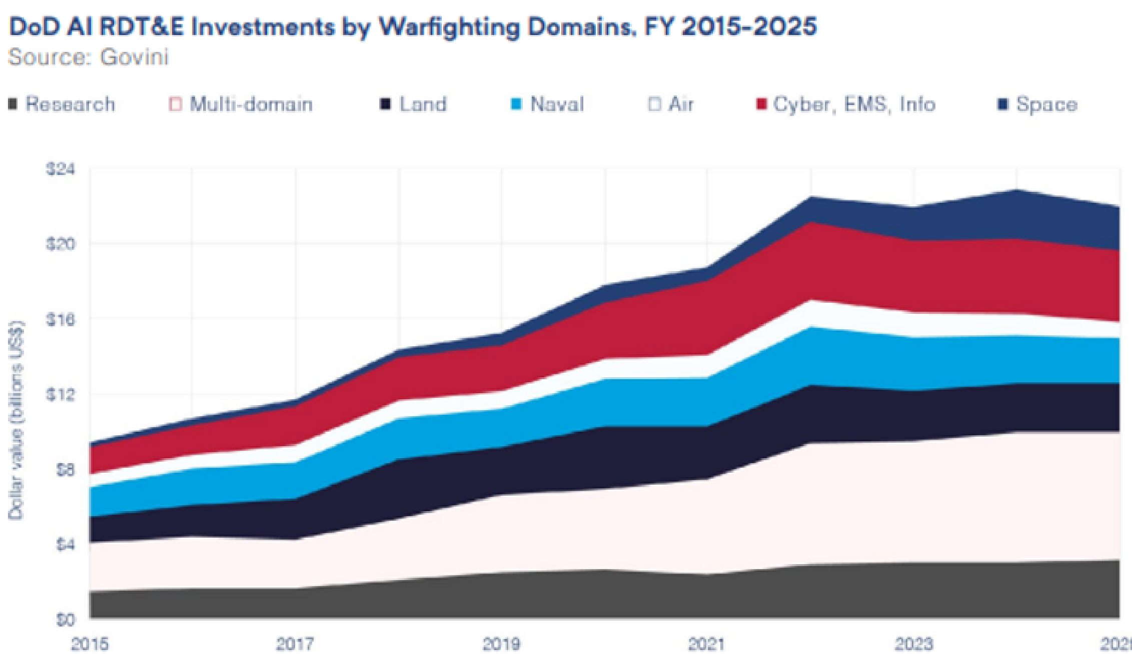

Figure 2.3. DoD AI investments from FY 2015-2025 (reports after FY 2021 are estimates). Source [11]

This is not an emerging problem. The shifting landscape has been observed by the highest levels of the USG and the associated challenges appreciated. Potential solutions implemented have been wide-ranging from the establishment of not-for-profits like In-Q-Tel in supporting the IC in 1999, and the Army Venture Capital Initiative in 2002, to name a couple [36]. The latest initiative in this line has been the establishment of the Office of Strategic Capital, and though it is given a mission of working with VCs to potentially align national and VC interests, it has a supremely limited budget and is working in an environment where the unspoken truth is that VCs are tired of unrealized government promises of contracts [40]. The role of these organizations is to take subject matter experts from relevant backgrounds in national security interests and have those individuals integrate within innovation hubs across the Continental U.S. (CONUS) to identify potential products, companies, and partnerships that may aid in the realization of national security capabilities.

This culture shift will involve some level of adoption of commercial products adapted in some way to fit a national security need. This is widely referred to as dual-use technology [41]. It is slightly different from simply taking commercial gear and, unaltered, applying it in an operational context (commonly referred to as COTS), in that there is an adaptation as the system/technology moves from commercial to the national defense domains [42]. Additionally, there will be a shift as commanders and the innovators who work for them cultivate an environment that encourages a venture-capitalist-inspired mindset.

Failing fast, as soon as possible so that lessons observed can be captured and incorporated in the agile development cycle, is just one way in which successful, mature programs are distinguishing themselves from the pack. Many efforts fail for reasons beyond technology shortfall such as legal issues, mistiming product launch within a market, or a shift in organizational priorities [43]. None of these examples are necessarily the fault of the original innovator [43]. However, lessons can be learned from each of them and certainly implemented in the future. As risk to resources and time must be acknowledged as part of the process, the DoD and its military services, are not the first to make this realization.

As the innovation ecosystem is mapped between producers, end users, resource providers, capability developers, matchmakers, and policymakers, the DoD must carefully balance innovation at speed with quality [44].“Innovating fast” gives a user/organization “early mover [advantage]” and more opportunities to learn as they fail fast and integrate lessons learned [44]. The additional consideration in a defense context is where to release the advantage to announce a capability for deterrence effects, for example, or to hold and exploit the advantage. Alternatively, by innovating, limited resources are more responsibly spent at the potential cost of greater influence in future development.

The lead organization for the DoD to manage adoption of AI is the CDAO. A component of the mission of the CDAO is to bring AI and data science, and the inherent advantages of these two tools, to the DoD [45]. The CDAO was established by combining previous silos of technical innovation and modernization, namely the digital transformation office and the JAIC. The CDAO is tasked with coordinating across the various independent organizations and communities of excellence to create a measure of synchronization and coordination of resource allocation. To provide a backstop to the organization's mission, the Secretary of Defense has required that this organization, the DoD in entirety, be capable of implementing and integrating AI across the force by 2025. While discrete timelines are a fundamental tool of mission planning and execution, when compared with expert analysis of when technologies will be capable for wider adoption, assessments indicate that not even the commercial space will be ready by 2025 as seen in Figure 2.4.

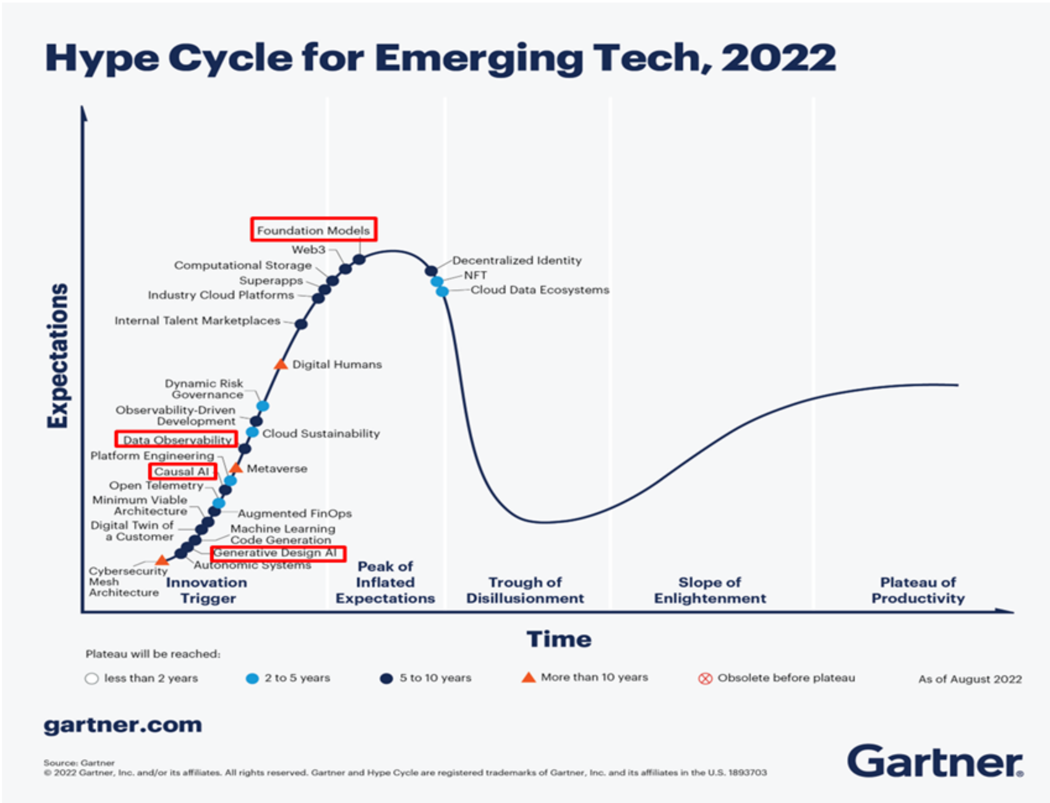

Figure 2.4. Emphasis added to some technologies that are AI-centric or AI-enabled. Adapted from [46].

The current fascination with the research and application of AI is not a new event. In fact, research into AI, as we talk about it today, has been on-going since the 1950s [47]. First in the mid-1970s to 1980 and again from the late 1980s to 1995, there were AI winters [48]. These are periods in which the hype and promises of AI had not come to fruition and as such, resources and funding to large projects were cut. During each of these periods in the U.S., there were economic troubles and there was a transition from war-time to a period of relative peace. As promises of how AI will revolutionize the world abound, inflation of the U.S. dollar, and indications of potential economic turmoil are on the horizon, it is worth considering what an alternative future may look like if investments to AI in the commercial space become deprioritized [49] , [50]. One potential risk if the U.S. government/commercial investors opt to not invest in AI, state or non-state actors will fill that gap. An example of this is shown in Figure 2.5) , which depicts commercial investment into the major AI innovation communities across the U.S. Although $200 million is a small portion of the $15 billion total U.S. investment, what may be of more interest is the area of investment: Silicon Valley, located far from any significant military presence like Seattle, San Diego, Boston, New York, or Washington D.C.

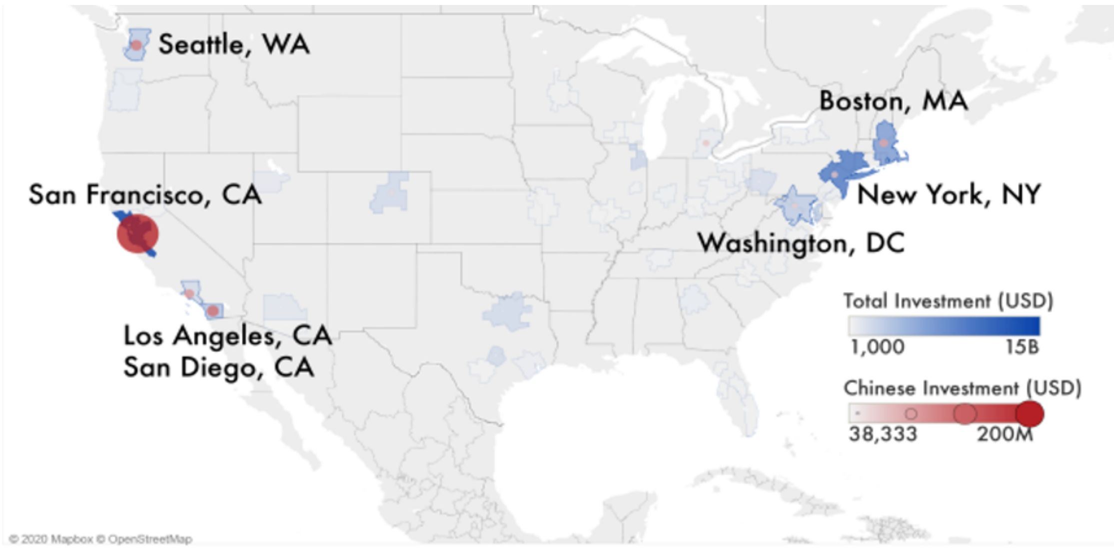

Figure 2.5. Map of commercial investment in AI companies from 2000 to 2020. Source [51].

Turning back from what may or may not be the circumstances of the future to focus on the trends from past to present, there has been a significant increase in AI-related patent application and grants from the 1990s to 2018. According to a report from the Office of Chief Economist (OCE) [52] in October 2020, AI has a significant presence across nearly 20% of all public patent applications during that time. During that same window, across the eight categories used by the OCE, patents are most commonly being submitted or granted in areas that have clear dual-use application with the government space: planning/control and knowledge processing [52]. The report goes on to list who the top U.S. owners are during this time period and fortunately for the DoD, many of those on the list have a proven history of working for or alongside government researchers and institutions. Some of these include the likes of Microsoft, Amazon, Qualcomm, and Verizon [52].

The core of the national ecosystem is made up of start-ups, academia, and five specific commercial industries: aerospace, pharmaceuticals and biotech, computers, scientific instruments, and semiconductors and communications equipment [53]. These sectors are critically important, due to their ties to national security objectives and interests. Historically, the DoD has not played a particularly essential role within the contemporary startup ecosystem, and it seems as if this may not fundamentally change in the future. The DoD is limited in its ability to bring in new technology, when compared to the public sector for a myriad of reasons. Particularly, the DoD struggles in supporting startups because startups are funded based on equity investments and have an expected low success rate [53]. As such, it must focus its limited resources and investments within academic halls and commercial companies willing to work with the government.

One of the ways to link academia with application is through the applied research space. According to a November 2022 report from the Congressional Research Service, of the $122.9 billion allocated for FY2022 Research, Development, Test, and Evaluation (RDT&E), 2.3% was allocated to 6.1 (Basic Research) funding [54]. The report explains that 6.1 funding is the line of funding used to support federal university R&D. The report further identifies that 6.8 (Software and Digital Technology Pilot Programs) only accounts for 0.6% of the FY2022 RDT&E budget. Despite AI being a revolutionary technology [7] that justified the establishment of the JAIC [9], AI piloting programs do not seem proportional with the stated importance of AI.

The U.S. government funds and manages nearly 50 unique and independent research organizations split between the National Lab and Federal Funded Research and Development Center (FFRDC) networks [55]. These organizations are comprised of world-class technical talent, that work to investigate and solve the country's technical and scientific challenges. This is critically important, as only 10-20% of start-ups will make a significant profit [53]. Given the current standard of long dwell times between funding and contracts within the current acquisition process, this means we have to rely heavily on steadier institutions such as these labs and FFRDCs to alleviate the reliance on a community with such high turn-over rates.

Where FFRDCs and National Labs are best known for their work is in the applied research phase. For the stage of research that will occur before applied research, known as basic research, academic institutions are irreplaceable. To create a true innovation ecosystem, users need to be involved throughout the research prioritization and development stages. From the author's analysis, when the laydown of facilities for FFRDCs, CDAO Innovative Centers, and DoD CONUS bases and stations are mapped out, there are only six locations that have all three elements within a 100-mile radius. They are proximate to these cities: Boston, West Point, Washington D.C., Austin, Colorado Springs, and San Francisco. Of these six, Boston, West Point, Austin, and San Francisco could be argued as not truly meeting this criterion in that military personnel assigned are not from an active-duty unit but rather are active-duty personnel assigned to an organization of the supporting establishment. In Figure 2.6, red pins indicate FFRDCs, and yellow/green indicate CDAO AI Innovation Centers. Red circles indicate where there is an FFRDC, a CDAO AI Innovation Center, and an operational unit from the DoD. Purple circles indicate where only two of the three previous elements mentioned are present in that location.

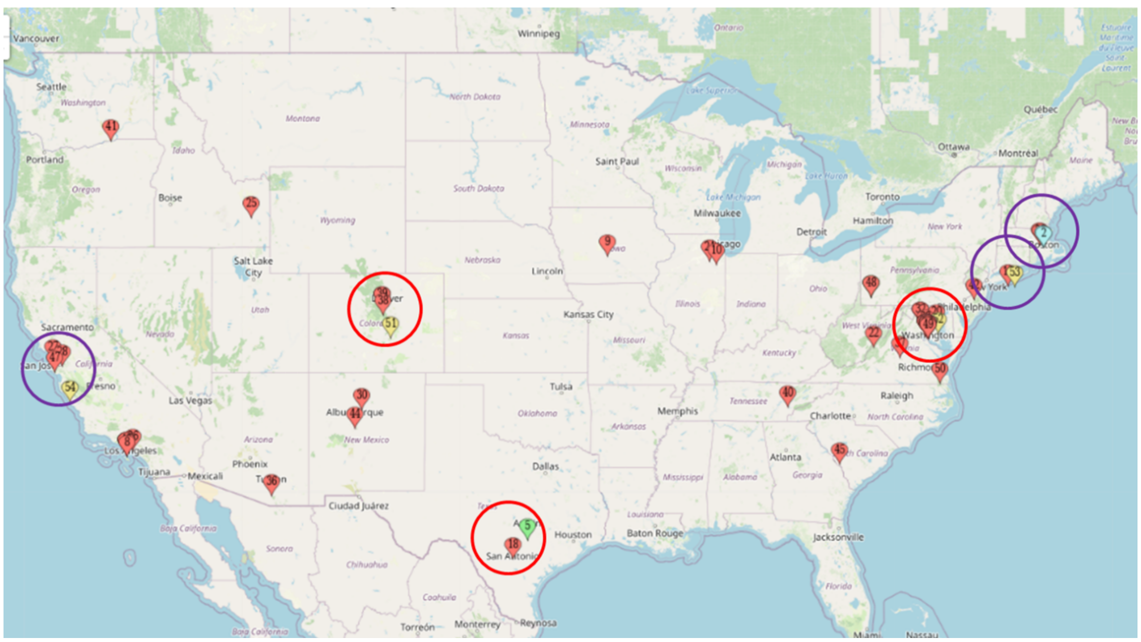

Figure 2.6. Map of US with FFRDCs, CDAO innovation centers, and (where present) DoD operational units. Adapted from: [56]

2.6 Summary

In the first section, the gaps in policy - continuously changing and vague definitions of AI - are highlighted as an opportunity for clarification through working with leaders in the industry and academia to find a better answer for the DoD. The second section examined how the DoD has, so far, responded to the calls for not just building and deploying AI, but rather to do it in line with American values such as being trustworthy and responsible. The next section covered how each of the military services are making efforts to operationalize AI, with particular consideration for the DoN to take the role as fast follower of the USAF and USA. In the final section, it was highlighted that AI innovation cannot be done just anywhere, that others are as interested in American ingenuity as the DoD is, and future investments need to be targeted to those innovation hubs that already exist and are thriving rather than trying to build our own.

CHAPTER 3:
Method

3.1 Overview

This research was conducted utilizing an organizational comparison methodology. The first stage of the research, within the literature review, analyzed previous and current DoD AI-related policy and AI projects that are currently underway within the DoD.

The second stage of the research required conducting interviews with personnel from Project Maven, DIU, and CDAO to gain understanding of an AI project lifecycle and key lessons learned. In these programs/organizations, the intent was to interview personnel from the decision-making team, the operational team, and a customer. To augment shortcomings in availability of personnel for interviews due to scheduling, the author pulled from past experiences from emerging technology events, such as the NPS AI Summits and other conferences and exercises within the DoD.

The third stage of research was an analysis, using the DOTMLPF-P framework as defined in the Joint Chiefs of Staff Joint Electronic Library. In conducting this analysis, it was assumed that the policies previously mentioned will not be amended or adjusted. Impacts and shortcomings of current policy from the first stage, in combination with lessons learned from the second stage will be used to fill in recommendations for the DoN as potential areas to explore for future investment.

The fourth stage of research was to take the analysis and lessons learned in the previous stages, and apply them to the hypothetical stand up of a task force within the USMC, which is currently the only service branch without a formal AI-focused organization. This application will include a proposed vision, description of the investments needed using the DOTMLPF-P framework, and how the organization's mission, functions, and tasks might change as it progresses from initial operational capability to final operational capability.

3.2 DOTMLPF-P

The elements of DOTMLPF-P are commonly known across the DoD as a way to describe the various elements or attributes of a capability; however, there are different definitions of these terms from trusted DoD resources. The definitions used for each term are pulled from the Joint Electronic Library (JEL) as seen in Table 3.1 [57]. To clarify the difference between doctrine and policy, as those are authoritative documents, one interpretation is for policy to drive doctrine. Specifically, the JEL states that policy “directs and assigns tasks and forces, prescribes desired capabilities, and provides guidance to ensure the Armed Forces of the United States are prepared to perform their assigned roles” [58]. The JEL goes on to explain that doctrine then “makes policy and strategy more effective by providing a unified description of the principles of applying U.S. military power... by providing standardized terminology...”. An example of this would be in the development of tentative landing operations manual. In this situation, USMC planners predicted a scenario, developed policy through the manual and it became doctrine [59]. An alternative interpretation is that doctrine informs policy, as what was seen with German stormtroopers during World War II. The stormtroopers were given equipment and directed to experiment in the field. As after action reports were given, successful tactics or doctrine was eventually formalized into policy and distributed to the other formations [60]. In this research, the former interpretation is used.

Table 3.1. Table of DOTMLPF-P terms and definitions. Source [57]

Term	Description
Doctrine	Fundamental principles by which the military forces or elements thereof guide their actions in support of national objectives. It is authoritative but requires judgment in application.
Organization	A unit or element with varied functions enabled by a structure through which individuals cooperate systematically to accomplish a common mission and directly provide or support warfighting capabilities.
Training	Instruction and applied exercises for acquiring and retaining skills, knowledge and attributes required to complete specific tasks. The focus of training is on the instruction of personnel to enhance their capacity to perform specific functions and tasks.
Materiel	All items necessary to equip, operate, maintain, and support military activities without distinction as to its application for administrative or combat purposes.
Leadership and Education	To provide the education needed to complement training, experience, and self-improvement to produce the most professionally competent individual possible.
Personnel	Individuals required in either a military or civilian capacity to accomplish the assigned mission.
Facilities	Real property consisting of one or more of the following: a building, a structure, a utility system, pavement, and underlying land. Key facilities are selected command installations and industrial facilities of primary importance to the support of military operations or military production programs.
Policy	Prescriptive guidance for ensuring the Armed Forces of the United States are prepared to perform their assigned roles. Joint policy can direct, assign tasks, and prescribe desired capabilities.

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CHAPTER 4:
Results

Today, the U.S. appears to be following in trace [3] of its strategic pacing adversary [61]. If the DoD is going to effectively address the gaps that exist within senior policy documents, it first must have a clear understanding of what those gaps are and associated impact of either addressing or leaving a gap. If a gap is chosen to be an issue that the military services could, and necessarily should, solve within their respective organizations, that should be clear as well. Where those gaps already been addressed at the DoD or military service policy level, it is important to assess if the gaps have been addressed or if there still exist issues that need to be further addresses.

This chapter begins with an analysis of the potential future capabilities as well those capabilities already realized through investment into AI as identified in chapter 2, the lessons learned garnered from interviews, and the author's experience. Currently, the USMC is the only service that does not have an AI-focused TF or any other organization with a specific focus on the adoption and application of AI to operational problems. Next, the research will apply the results of the analysis to the hypothetical stand-up of a USMC AI TF.

4.1 Analysis of Gaps

4.1.1 Doctrine

As mentioned in Chapter 2, the definition of AI has changed consistently, with the latest version captured in the NSCAI final report as "[t]he ability of a computer system to solve problems and to perform tasks that have traditionally required human intelligence to solve" [11]. While this is the commonly accepted version within the DoD, this may not be accepted across the USG [62] and does not seem to be viewed as the optimal definition by the academic or commercial communities either [21]. In this space, those personnel within the DoD and its sub-organizations must maintain cognizance of this disconnect and work to a common definition while executing training, education, or work with external agencies and partners. Naturally, this will mean that the DoD definition may adapt to include new technologies or better describe technologies current with the times.

Beyond the definition of AI itself, there is a need for the DoD services to more clearly define and scope what trustworthy and responsible AI means in the context of the respective organizations and communities. The RAI Guidelines are prescriptive to a degree, in that it describes principles that must be followed, but falls short of adequately defining all the necessary terms within those descriptions. This leaves tough questions unanswered, such as who is ultimately responsible for the unintended negative consequences of a technology that relies on AI? Is it the commander, a special staff officer that is the command Subject Matter Expert (SME), the program management office, the Commandant of the Marine Corps, the Joint Chiefs of Staff, or someone else entirely? Could it be a combination of all the above and more? Furthermore, for what biases should DoD personnel be on the lookout? These are questions that eventually need to be answered if AI is truly going to be adopted across the enterprise.

Some may offer that these questions of need for risk mitigation and accountability in the case of unintended consequences are similar to other technologies and processes already in use. The dangers of AI falling short can in part be linked to its non-deterministic behavior, or in its explainability. Using the definition from a 2021 National Institute of Science and Technology (NIST) report, explainability is "the ability to accurately describe the mechanism, or implementation, that led to an algorithm's output...". This challenge exists in even some of the cutting edge products such as Generative Pre-trained Transformer 4, more commonly recognized as GPT-4 [63]. In their report and accompanying system card, OpenAI explains that GPT-4 cannot be blindly trusted as it may, at unpredictable points, produce inaccurate or fabricated results [64], [63]. Based on the author's research and personal experiences, there is not another piece of technology that is as prevalent and plagued by explainability challenges as AI.

Doctrinally, the DoD acknowledges that bias is a concern but stops short of explaining for what biases to be alert for signs of. Since the writing of [12] in 2020, there has been a significant amount of research into the topic of bias and AI. One particular example of notable research comes from a 2022 NIST publication, which categorizes bias in AI into three general buckets: systemic, statistical, and human [62]. This study goes further to not only categorize bias, but the authors further identify subcategories and associated definitions along with guidance for mitigation techniques [62]. The categories and subcategories are seen in Figure 4.1.

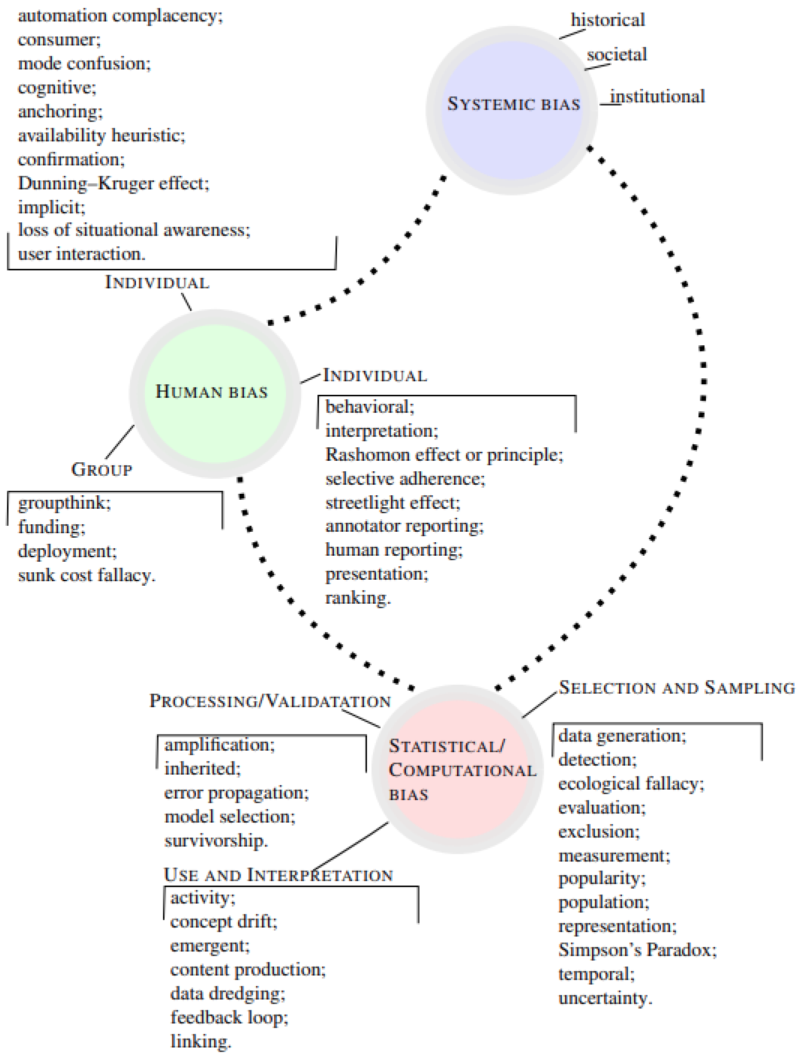

Figure 4.1. AI Bias Categories, Source [62]

Finding a definition upon which the key organizations within the USG, to include the DoD, can agree will lead to significant progress for AI widespread adoption. Up front, it will better allow for further definitions and concepts to be developed for commanders and their staffs, to then understand and articulate what trustworthy and responsible AI is to those men and women at the tactical edge. Without a clear understanding for the end users, the developers, and the supporting personnel, trust will be a main blocking force to adoption and progress within the DoD.

4.1.2 Organization

Doctrinally, the DoD has not laid out what AI is and why it is important. Organizationally, the DoD military services cannot then align themselves, as there is no over-arching governing concept. Each military service has taken a unique approach to organizing for the adoption of AI [6], [65], [66]. Each has established an organization built around the mission of taking AI from whiteboard to operating environment, with the exception of the Marine Corps. The USN has taken the widest scope, organizing TFs that are functionally and geographically aligned [6], [67].

In late 2022, the USN announced it had officially instituted TFs to address the challenge of integrating AI as a foundational component of its maritime supremacy mission [6]. Through this, the USN demonstrated the institutional capacity and interest in leveraging AI by transitioning from an experimental program to a more permanent, task-organized capability-provider. Resourcing a task force also reflects executive buy-in, through allocating resources and committing to these sub-organizations formal structure and purpose that didn't come through additional Congressional funding but rather from reallocation.

Aligning along functional communities parallels the USN warfighting setup known as Composite Warfighting Command (CWC) [68]. One notable shortfall with the USN TF TYCOM structure is that there is no single authority to manage the entire concept like there is in CWC. Though these TYCOM-aligned organizations are traditionally tasked to organize, train, and equip assigned forces to meet more traditional mission sets such as Surface Warfare, this is also the ideal organization-type to pair AI developers with domain experts. In paralleling the operational arm of the USN, the USN-internal research and development environment is effectively prepared for integration between research initiatives within the TFs and their stakeholders actively engaged in deployed areas all over the globe.

In addition to these functionally aligned TFs, the USN established separate TFs under Maritime Component Commanders. With both functional TFs and geographically oriented TFs, the USN is taking various approaches at the organization's operational level to experiment with AI adoption. One example is TF-59 which belongs to the Naval Forces Central Command, a military service command of U.S. Central Command. Based on the author's experience, TF-59 is uniquely positioned to be at the forefront of this aspect of organizational experimentation. TF-59 has the advantage of being in a location that allows for experimentation. For the TF, being located in the Kingdom of Bahrain allows for experimentation in a more diverse and less predictable environment like the Middle East. Not being in the U.S. also allows the DoD an opportunity to better evaluate vendors by exposing systems to data not traditionally available for testing and evaluation.

Within the DoN, the USMC is taking an approach best characterized as wait-and-see. The USMC seems to be at the bottom, if AI adoption is the metric. One observation, annotated in a report of a 2023 Weapons Tactics Instructor course, captured that the USMC was "incapable of effectively leveraging its data for automation, data science, and [AI] to gain a decision advantage over its adversaries, at one of its highest profile, most well-resourced training venues" [69]. Certainly, there are disparate applications of AI in specific communities, such as predictive maintenance efforts and "smart" warehouses [70]. However, these development efforts do not seem to currently have a scalable impact to ongoing activities across the organization.

Having top-down buy-in through strategic-level documents that are publicly available, a formal structure with which to align manning and resources, and an organization structure that aligned instead of changed the identity are all common themes across services that indicate markers of a successful program. From Project Maven and DIU, it was highlighted that non-traditional acquisitions through contracting solutions such as Commercial Solutions Offerings or Other Transaction Authorities, rather than Federal Acquisition Regulation (FAR)-based contracting, had a positive impact and, in some cases, were critical for a successful program [71], [72]. Both organizations had their own contracting offices and support staff organized for this function.

From the CDAO, the structure of the AIETs was an iterative process. It first began with identifying organizations of similar capability to the JAIC and executive leadership coming to the decision to combine the contractor-dominant and the military-dominant organizations, thus creating the CDAO. Through the iteration, several configurations were tested and interviews with the deploying team and supported staff drove refinements along the way [73].

In the end, the final form of the teams yielded two-to-three-person deployable detachments with approximately a dozen support personnel that served as a stay-behind element, which proved to be critical to success [73].

Out of the respective organization experiences, there were many lessons learned. One of the more prominent challenges for Project Maven that many organizations within the USG experience today is the lack of a scalable labeling force and an affordable and long-term data storage solution [73]. One other particular challenge that ultimately was a decision to move from the JAIC to the CDAO was the reorganization of complementary capabilities under the same chain of command. In this example, the operational data teams from the Defense Digital Service were exclusively contractors, and the teams from the JAIC were exclusively government employees. Generally, both organizations provided a capability to properly address the AI and data-science problem sets, on-demand. Effectively, they were two potential tools in the Office of Secretary of Defense's toolbox that had the capability to solve the similar challenges [73]. Each provided a component of a highly technical and desired capability at the highest levels of the DoD, and the administrative requirements to deconflict and coordinate actions that could be eliminated through merging the organizations under a single, unified structure.

Within DIU, particularly in the earlier years, success was predicated upon connections across the DoD to manage actions within funding cycles. Specifically, DIU is focused on six technology portfolios: AI, autonomy, cyber and telecommunications, energy, human systems, and space [74]. Through the Defense Engagement Teams, DIU's objective is to survey across the commercial sector to build relationships, be able to identify DoD-relevant trends, understand what work is being worked on in the commercial sector, identify the cutting-edge success stories through the Commercial Engagement Teams, and finally, to reach across the Tech community to build trust from the DoD as well as with Science and Technology communities [72].

Within an organization, this section has highlighted the different approaches that each of the services have taken to establish units with the purpose of facilitating widespread AI adoption. Whether by warfighting function, by geographic combatant command, in partnership with public academic institutions, or as standalone organizations, there are many options from which to learn. From Project Maven, the CDAO AIETs, and DIU, the importance of how to manage not just the people but also the resources has been identified as a significant consideration. Increasing manpower within the organization, without due consideration for the increase in data literacy and technical literacy across the organization, is analogous to executing an operation without a plan. As the phrase often heard at initial training and throughout a military career goes: Failing to plan is planning to fail.

4.1.3 Training

The function of training is to develop a more competent and capable workforce. The complexity of the issue blues the line between training and education. Currently, the DoD has forgone most training in AI for education. For the doctrinal difference between training and education, see Table 3.1. Each service takes its own unique approach to training. The first to publicly attack the problem with respect to AI was the USAF, when it became the first service to publicly release its AI strategy in 2019 [75]. Shortly after, the USAF capitalized on its first mover advantage, through the effort of a single leader, which led to the formation of the first cooperative research agreement for an AI Accelerator [33]. Focused on basic rather than applied research, the DAF-MIT AIA was, and is still, singular in this endeavor as a service-owned organization. As one of its first acts as a new organization, the DAF-MIT AIA identified a critical gap for a future workforce that would need to understand AI and, in response, developed a solution that now serves as a model for other services: The Phantom Fellowship Program [65]. This program is the ideal example of a workforce development and up-skilling program within the DoD that connected to a pre-existing innovation community that was focused on AI application. Through the Phantom Fellowship and other education-centric initiatives, the DAF-MIT AIA has become a core contributor to AI education across the DoD. Beyond setting the foundation for service-run AI workforce development programs, the USAF was also first to establish a software factory, Kessel Run [76], and, at the time of writing, has the largest array of software factories across the DoD as seen in Figure 4.2.

Figure 4.2. Geographic Laydown for USAF Software Factories. Adapted from: [4]

While being the service with the largest quantity of software factories is notable, the location of these factories is also worth considering. In each of the areas highlighted in 4.2, where there is an established innovation ecosystem, the USAF has a software factory. These factories have theoretically enabled the USAF to integrate AI into warfighting functions across the warfighting domains. As the apparent military service leading the way in terms of workforce development and leveraging AI in operational environments, the USAF has continuously made headlines for its application of AI as a tool for targeting combat environments [77], aiding U.S. and NATO air operational planning [78], augmenting human pilots for a subset of airborne intelligence tasks aboard reconnaissance aircraft [79], and completing piloting of a fighter jet [80].

These stories exemplify how the USAF recognized the potential benefits of AI and is willing to allocate significant resources to this end. The USAF also seems to be establishing a norm, within the DoD, with consideration of current technology capabilities and within the current political environment, that AI as a tool makes the most sense as an augment to humans rather than as a replacement. Furthermore, it shows the organizational flexibility and willingness to not only pursue the general adoption, but also the operational application of AI within core doctrinal functional areas such as intelligence, operations, and support.

The USA has taken a different training approach than the USAF. Like the DAF-MIT AIA, AI2C established a cooperative agreement with CMU in 2020 [5]. This agreement enables the USA to grow its officer and civilian Corps AI talent pool through existing Master's Degree programs at CMU and follow-on tours with AI2C to do applied research [66]. Additionally, the USA has two software factories, with one dedicated to AI solutions, within AI2C. USA takes a blended approach between the USAF software factories and the task force approach. Rather than the USAF style for a task force general employment model, it takes a more specialized approach. What the USA does better than all other branches: the formalization of the communities that produce these unique skill sets.

Taking a step away from the service-level and up to the Joint level, training was a key component for the CDAO AIETs to maintain their technical education and skills, as well as to keep abreast of developing trends and technologies within the field of AI. Those platforms and resources that did well were naturally then shared where possible. As part of the need to keep its AIETs current with the cutting edge while also democratizing AI resources across the DoD, the CDAO found value in leveraging commercially available and widely-reputed AI education resources, such as Udemy and Udacity, which were critical to success [73]. Other well-known resources like Codecademy, Kaggle, and Medium were also often leveraged for maintenance, up-skilling, or simply keeping a pulse on what others are doing [73].

Some of the critical contracting lessons learned for contracting and program management leaders when working with AI technology are often attributed to some of the early efforts of Project Maven and shortfalls in how it conducted internal training. One such lesson is the need to have access to data throughout the data preparation process for the purpose of auditing, verification, and validation. In the case of a sensitive undertaking such as Project Maven, this was recognized as the need to own both the pre-processed and post-processed data during the development and deployment phases of the AI Lifecycle [73]. In many circumstances, particularly early on in the DoD adoption process where there are not a large number of foundational datasets for developers to work with or hand over to partners, there should be a keen interest to own the data. In others, this may be less important. Either way, there should be a preference to own the data but it may not always be necessary. Once data is prepared, which is cited as a large majority of any AI project, then comes challenges associated with the rest of the development lifecycle [81]. While there are many interpretations of what the AI lifecycle phases and steps are, one example from the NIST is shown in Figure 4.3 [62], [82], [83].

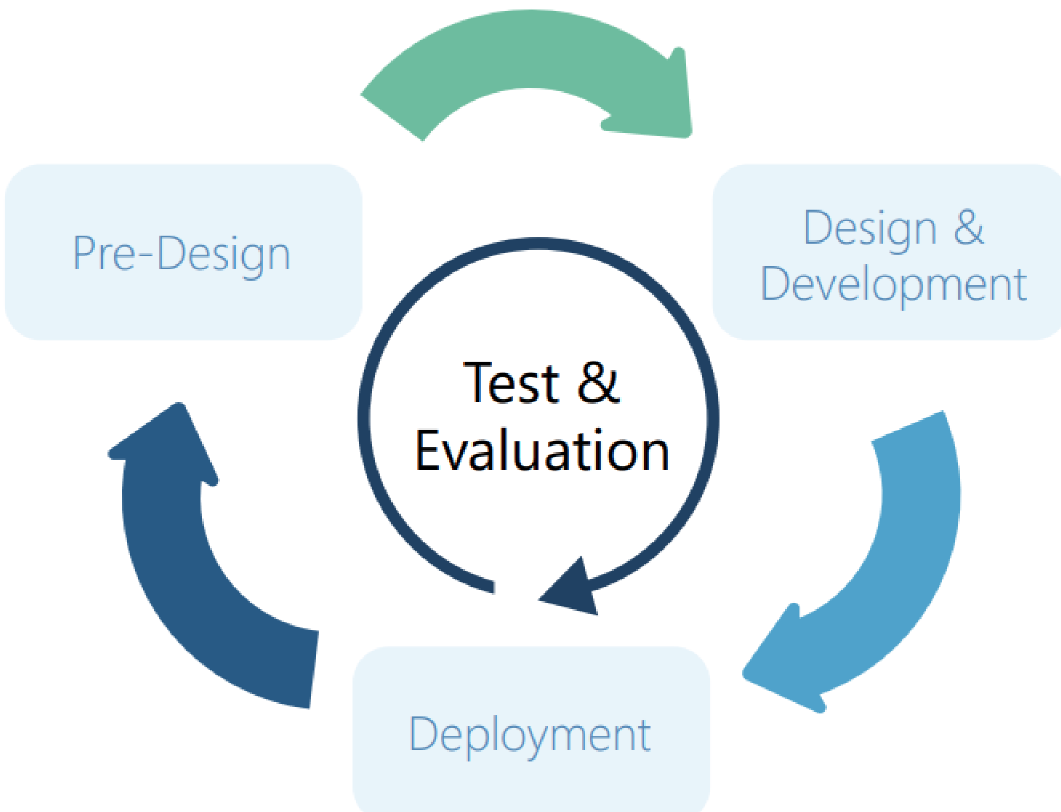

Figure 4.3. Example of AI Lifecycle. Source [62]

One particularly striking lesson learned was highlighted from the CDAO - the curation and promulgation of appropriately-scoped training for the AI archetypes across the joint force [73]. This is best seen in the transition of education resources offered by the CDAO. At first, there was a heavy reliance on commercial solutions, then in turn to its development of courses for each of the AI archetypes that were centrally managed. Today, the CDAO is releasing resources to academic institutions to teach their courses instead [45]. This trend is particularly important, as it not only indicates the maturation and quality of the CDAO educational packages but it also highlights the growing AI literacy across the force. As the DoD becomes increasingly AI literate, this will further enable the cultivation of AI innovation cells to solve problems across an increasingly complex geopolitical landscape.

4.1.4 Materiel

In order for the DoD to succeed in its endeavor of democratizing data and AI innovation to the enterprise, there are significant investments into the coding development and production infrastructure that need to be made. Mainly, this research focused on software solutions, hence this is being covered in this section of the DOTMLPF-P framework, rather than in the Facilities portion.

First and foremost, what is needed is a commonly-accessible environment that is capable of supporting data storage and labeling that is also equipped with commercial-grade analysis and visualization tools [73]. At all levels of networks, this would ideally include support for the more common AI and ML development frameworks such as TensorFlow or PyTorch, but further research would be needed to determine if this is a feasible and realistic request. This would also need to include a mechanism by which components of the joint force that have needs that are not satisfied by this collaborative environment are able to set up standalone environments to test and integrate approved commercial or government off-the-shelf solutions. What we have today is that each service has many disparate and disconnected environments that are being spun up or shifted around as communities of interests grow, as commanders are able to allocate resources, or as personalities in key positions change out.

From both DIU and Project Maven, other generally accepted practices to support long-term initiatives into material investments include the following: avoiding vendor lock whenever possible; ensuring data ownership of both the labeled and unlabeled data; providing sample data to customers to enable better evaluation of reported capabilities; having customers leverage their own funds in order to have a vested interest in the project; and having a well defined priority list with identified key stakeholders to ensure effort and resource allocation are spent on those investments that have the customer's ideal balance between most payoff and most affordable capabilities [84], [71], [72].

4.1.5 Leadership and Education

One cross-organization lesson learned was the challenge of non-standardized lexicons for those who were charged to develop, acquire, or manage operationalized AI. Different communities have individually unique lexicons, which can lead to misunderstandings, or improper expectations, about what AI could achieve [73]. For example, if one uses the term AI interchangeably with their platform's capabilities, which is primarily computer vision-based, and another uses AI to refer to their platforms recommender-system capabilities, the common leadership is left to decipher what AI could really mean.

As a direct result of what is or is not AI versus ML vs Data Science (DS), capabilities were at times requested that were not necessarily compatible with the true requirement. What most organizations were truly asking for is not AI; it was organizing, labeling, and then visualizing their data streams in order to make informed decisions [73]. Beyond incongruence on definitions, this lack of clearly defined terminology led to confusion and inconsistency on standardized expectations of the roles/responsibilities/expectations of the Chief Data Office personnel within a command and how it complements current existing structure such as the Information Management Officer [73].

4.1.6 Personnel

When it comes to leadership within the DoD, one thing leaders across the branches agree - if words if not in action - on is what their most important asset is: their people [75], [85], [86], [31]. Part of building the best team is picking the best members possible to be a part of it. Logically, it follows that the more control an organization has over this process, the better product is on the other end. Project Maven found great success in its ability to be highly selective on recruitment. Starting at the top, those core members that made up the different leadership teams had an established history of success and innovation from their respective communities [71].

From the top down, leadership within the project maintained ability to remove anyone at any time to weed out poor performers without having to go through the typical bureaucratic process of coordinating assigning orders [71]. Instead, personnel were assigned to local organizations and sent on temporary duty orders to the project. Personnel remained as long as they were successful or until they self-selected to step away for a period of time [71]. Members were not always removed due to poor performance. The long hours and high demands of the job, much like anywhere else in the world, meant that individuals could not perform at peak levels constantly, and would shift back when they needed to recover or reset [71].

Having just established that identifying talent, controlling aptitude testing, and recruiting, then retaining the most qualified individuals are collectively the most important component of any DoD organization, we must turn to how the military services are tracking personnel who have acquired AI, ML, or DS training. Currently, the only branch to formally track this is the USA. In the Army, Officers can acquire functional areas designations such as Operations Research/Systems Analysts or Information Systems Engineers [87]. Out of the aforementioned training opportunities, along with others, Warrant Officers in the USA can earn additional skill identifiers such as AI Cloud Technicians or Autonomous Systems Engineers [87]. Enlisted soldiers can attain skill identifiers as a Data Engineer, Data Analyst, Artificial Intelligence Engineer, or Operations Research/Systems Analysis [87].

Today, there is no community within the USN where the primary mission is centralized around the challenge of data management, analysis, and data engineering. Different communities may address bits and disparate components of this problem, but no single community owns both the resourcing and authority to sufficiently address and solve these gaps. Despite organizational initiatives, there is a lag in workforce development to support the institutions. No fellowships develop this skill set and then leverage it for the enterprise. For those opportunities that do exist in places such as NPS, talent management is such that even if there is a lucky individual who finds themselves in a position that is directly or tangentially related to AI, the skill set will likely not be maintained for the remainder of that individual's career. This experience is similar within the USMC. Much like the USN, there is not a unique Air Force Specialty Code for AI or Data Engineers [88], [89], [90]. Within the USN and USAF, there is not a talent management process for targeted long-term employment of these individuals within the enterprise.

In this way, the USMC has the advantage of having a primary MOS to address a portion of the challenge of available manpower to align against the challenge of enterprise-wide adoption of AI. Only one MOS in the USMC directly addresses some of its data needs, but it is limited only to the IC: Intelligence Data Engineer [91]. Even within the IC, as of an assessment from October 2022, it did not have enough talent, resources, management, doctrine, or training to have an impact at scale [92].

Notable shortfalls that should be highlighted in the current USMC MOS solution for the 2652 community includes the length of training time, and the current professional pathway. Assuming there are no delays, the current pipeline for taking a Marine from one of the feeder MOSs and produce an Intelligence Data Engineer requires 10 months [93]. Competency requirements include database management, data visualization, scripting, and various machine learning techniques [94]. These are all valuable skill sets that the Marine Corps, within this community or for potential future AI professional fields, cannot afford to keep solely within the E-3 to E-7 ranks [93].

If nothing changes, this is just a much newer variant of what is currently being experienced by the Officer communities across the Navy and Marine Corps. The impact is that personnel will be trained, gain necessary experience and knowledge, and then have to shift to other positions with no formal opportunity to use this hard-earned skill set for the rest of their careers. The USMC establishing a software factory, co-located with the USA, and developing an MOS for application developers (software engineers) is a positive step for future investment in formalizing related skill sets [95]. It also has the benefit of following Porter's guidance for integrating into an established AI innovation cluster. This unfettered good spirit is quickly dampened by what would best be described as cautious optimism by the length of the training program (12 months) and the observation the MOS does not have its progression pipeline for Senior Non-Commissioned Officers. This does not even mention the fact that developers, though they will likely deal with AI in some capacity, are not and should not be employed as software, data, or AI engineers.

Much of Project Maven's success can be tied to the fact that, in addition to total control of its recruiting pipeline, assigned personnel had an IC background, quickly establishing credibility with the units they were tasked/tasked themselves to support as a key cultural consideration [71]. For example, if someone was going to go work with an element from

Special Operations Command, they needed to have prior experience with the command. Predominantly, the military component of the team was made of human intelligence officers [71]. This was an important factor, as that line of work produces a select population known for dealing with highly sensitive, high-risk scenarios that require the ability to act under a level of independence not commonly seen across the rest of their respective branches [71]. The core team was primarily reservists and civilians, which was ideal for their need to have more granular control of who filled the roles [71]. Within the team, the work rate was at a high pace but also highly decentralized in structure due to the constrained size of the core team [71].

Although there were significant advantages to maintaining a small team, there were lessons learned as the mission continued to expand over the years. Specifically for Project Maven, there were instances where service support representatives were not always technically proficient on the complete array of Project Maven's capabilities [71]. Though errors were eventually corrected, in a small community where reputation is what gets doors opened, mistakes had occasionally out-sized ramifications. One of the downsides of having a preponderance of team members with only a human intelligence background is that they occasionally lacked appreciation for working with all potential organizations and customers for holistic feedback and maximal usage of developed tech [71]. This limited the impact that Project Maven could have, as well as the ability of the Project Maven test and evaluation component to receive more diverse feedback from a larger customer base.

From the CDAO AIET personnel standpoint, friction was found less in service support representatives. More so, the iterative make-up of the forward deployed teams was heavily influenced by critical down-selection in available personnel to fill the roles of the AIETs due to deployment eligibility (clearance, passport, short tether for short-notice/no-notice deployments), contract adjustment, and potential for indefinite deployment as a crises response asset [73]. These challenges were not only for the civilian contractors assigned to support the team, but also to the reservist personnel [73].

4.1.7 Facilities

If one believes that having researchers, prototypes, and customers co-located is good enough for some measure of business success, then the key attribute that separates startups from a traditional business is logistics: scalability of production. When Figure 2.6 is augmented with an overlay of AI talent being produced and employed, as seen in Figure 4.4, the potential hubs of innovation seem to overlay quite well with established federal research hotbeds. Interestingly, according to the previously mentioned report from Center for Security and Emerging Technology (CSET), Austin and Colorado Springs are developing hotbeds and there is untapped potential in Seattle that has yet to be realized [51]. If another overlay is added, relating to AI from 2001-2018, both yield the comforting realization that most of the innovation hubs have the major indicators of success present. Now, these positive factors are only missing one key piece to solidify the case that the DoD AI Innovation Ecosystem is in a decent place: sustainment of outside investments. Looking at commercial investments across the country in 2020, according to CSET, there are significant investments being made along the coasts, but little is happening in the middle of the U.S. [52].

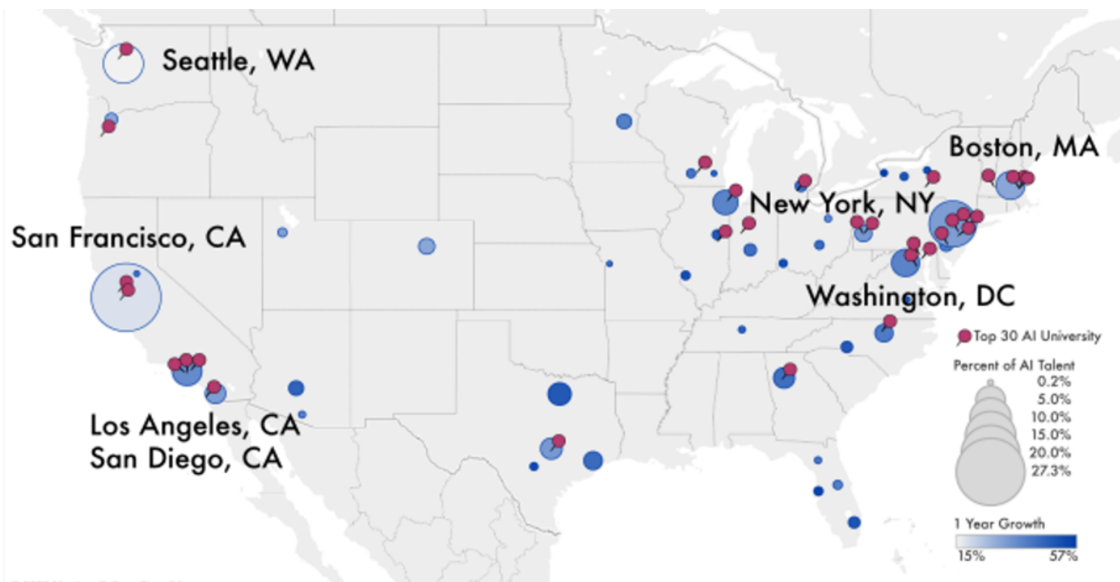

Figure 4.4. Map of AI Talent across the US. Source [51]

As the DoD looks forward and designs future battlefields and situations, there needs to be a well-balanced approach between innovation and budgetary discipline, or exploration and exploitation of opportunities. As author of "Zero to One on the DoD: The Material Innovation Pipeline" Kevin Landtroop explains there is no crystal ball to give accurate assessments of what the fight in 2035 or 2040 will look like, and it does not matter if service members do not understand the emerging technology landscape or how to use its outputs [96]. The DoD cannot predict the future and thus, it needs to be good at adapting which is the antithesis of a mature bureaucracy. Nevertheless, the leadership at all levels must work toward the common goal of making quicker adaptation possible for the DoD to be a relevant organization in a future fight. Education in innovation and how to facilitate innovation at various positions within an organization or bureaucracy is required at every level of the organization to better understand and appreciate designing for innovation, how/why the current acquisition processes can be made a more viable option for startups and small companies, and promoting a more agile and risk-tolerant culture.

As a hypothetical example, based on the potential costs in manpower, time, and resources, it will be more of a fiscal challenge to justify investing heavily in establishing innovation hubs in places like Monterey, California. In Monterey, there seems to be little to no pre-established AI startups or hubs of industry-leading technical production. There are also no FFRDCs and/or national labs that have permanent facilities in Monterey. Assuming today's resource constraint environment applies, it would seem as if moving the allocation of resources north to establish an innovation center near or within the San Jose area would be more effective. If resourcing could be coordinated to establish a satellite campus within the San Jose area to better bridge the two communities, the product would likely have more positive emergent properties to cultivating DoD-relevant innovation than either could produce independently. This is not to say that cultivating and maintaining an AI innovation ecosystem in Monterey is impossible, but rather that research seems to indicate there are more efficient and effective alternative solutions.

Critics may offer that in this day-and-age, co-location is not as important as it used to be, with the proliferation of tools such as Microsoft Teams and Zoom. There is certainly validity to this argument as the trend in jobs and entire markets shifted to semi-virtual or completely virtual setups since COVID-19 [97]. For some portion of the organization, there is already a precedent for remote work and science to provide a potential backstop to a supporting argument [98]. However, if the entire organization transitioned to remote work, this would violate world-leading business strategists Dr. Michael Porter's principle of proximity, in that if one entity wants to impose change and have a lasting influence, being face-to-face is the preferred method rather than via an easily-ignored or missed e-mail [99].

To be sure, the tech startup and venture capital space is not a "silver bullet" solution, but by adding the option to the table, the system will already be many times better than what is currently available for DoD servicemembers today. Organizations that are well-known for executing non-FAR-based acquisitions, such as DIU, AFWERX and many others, are in a unique position to integrate nascent start-up capabilities. In certain circumstances, connecting into the DoD innovation ecosystem can lead to a scaling solution by enabling exposure to, and subsequent connection with, defense industry primes such as Lockheed Martin or Booz Allen Hamilton. In areas where the technological risk is too high for a startup, this is where FFRDCs, National Labs, and the like can step in [100]. Conceivably, this system could reasonably be augmented through coordination with close international allies and select partners [101]. One only needs to look at the news of the coordination between NATO countries and Ukraine to see the plethora of examples and potential domains that could be impacted and vastly improved upon from their current states.

The geographical co-location of key components within an innovation ecosystem are described as clusters. Porter says "clusters are geographic concentrations of interconnected companies institutions in the particular field" [44] and goes into further describe that success is owed to the networking and complementary components within these clusters that allow for both healthy competition and cooperation [99]. Local clusters are more realistic and resilient to change than larger dispersed clusters as a result of their ability to cultivate and strengthen relationships with competitors, customers, and suppliers. Secondary and tertiary benefits of clusters for the competitors include access to academic and commercial institutions and public goods, as well as powerful incentives for productivity innovation that would otherwise be difficult to utilize for distance. If the DoD is going to be successful at promoting and sustaining AI innovation ecosystems, our best chance for success is through the investment into already well-established commercial clusters rather than trying to recreate them around itself.

4.1.8 Policy

At the beginning of section 2.1.2, Responsible/Trustworthy AI, it was noted that the DoD has not yet adopted and published any formal definition for what responsible AI or trustworthy AI is. The NSCAI, referencing an independent study done by the European Commission [102], describes trustworthy AI as lawful, ethical, and robust [11]. While the DoD and military service policy-writing processes are both bureaucratic and lengthy processes, the military service process is inherently significantly faster and may benefit from adopting this description as a temporary placeholder. In Appendix C of [11], the NSCAI describes the values for a system that responsibly develops AI as being auditable, traceable, interpretable, and reliable. These are different words to communicate the same message as DIU in the RAI Guidelines.

Ultimately, the application of AI will be the commander's decision. The risk in the application of AI will need to be balanced with the risk to force and mission if AI is not used. Bias, depending on the context, could be acceptable or not, but the commander will likely have to be the one to make that decision. For example, if a unit is tasked to track a particular vehicle type in a village in Sub-Saharan Africa, then a model that is tuned to detect and track animals in the jungles of Southeast Asia may not be the appropriate object-to-model match. Furthermore, the developers, program managers, and those others who are in a position to understand and articulate a model's capabilities, limitations, and assumptions made during the AI lifecycle must communicate these attributes to aid in risk management. Lastly, the model and underlying data foundation will need to be iterated on to ensure that the model is appropriately used for the duration of its deployment time [20].

4.1.9 Summary

For traditional systems and technologies, the DoD acquisition process is started through two methods: requirements pull or technology push. If the solution is determined to be predominately non-materiel-based, then the solution goes through a DOTMLPF-P analysis and what changes may be required to satisfy this new requirement. As AI matures and precedents are set for application across not only the range of military operations, but across all warfighting functions, the DoD needs to become a fast follower of commercial best practices and write policy to fill in gaps in current policy. For the DoN, this means heavily considering becoming a fast follower of the USAF's Phantom Fellowship Program, establishing an AIET-like AI support structure with the necessary infrastructure, and ensuring the USN and USMC have the requisite workforce expertise to make it all happen. Future research should consider the potential establishment of a single community within each service that has both the resourcing and authority to sufficiently address these issues.

4.2 Hypothetical USMC Task Force

In this section, the lessons learned and analysis from earlier in this chapter will be applied to the hypothetical stand up of a task force-like organization within the Marine Corps that is charged with the mission of managing and leading AI development and adoption efforts within the enterprise.

4.2.1 Concept

Within the scope of this mission is joint force integration at the tactical, operational, and strategic levels of command. Out of scope will be recommendations of changes to organizations or policies external to the Marine Corps as well as recommendations regarding from where resources would need to be reallocated in order to make the sustainment of this unit feasible. Recommendations contained herein are not intended to be prescriptive, but are an attempt to minimize need for additional investment of manpower or other resources for activation of this hypothetical unit.

The role of AI should be as an augment to the human operator, rather than as the replacement. The TF should be the military service's foremost experts for best practices and strategies on how to develop AI, experiment, make it available for users to innovate with at all levels of the enterprise, how Marines at all levels of leadership should interact, and how to consider the benefits and risks associated with AI employment.

4.2.2 Doctrine

To accomplish the mission of managing and leading AI development across the Fleet Marine Force (FMF), the Marine Corps will need to publish new or updates to doctrine to describe the role of AI within the service. All publications, new or updated, will need to be explicit about how the Marine Corps defines AI and how this capability should be considered with respect to other communities. As an example, if there is to be a section of a publication that explains how AI could be used to augment combat operations of an infantry unit, there should be a reference to this relationship in both the overall doctrinal publication for AI and infantry operations.

There are critical gaps in the current doctrine that the Marine Corps would need to address in order for this highly-technical and expansive effort to succeed. First and foremost would be the establishment of clear guidance on data governance standards, what data readiness needs to look like, how is it measurable, and what tools are used to take commanders and their units from their current disposition to this new standard. Next, clear doctrine would need to be written for commanders to understand how to integrate AI, manage that risk, ensure ethical use, provide training resources, and meet all other responsibilities of a commander when it comes to on-boarding a new technology or piece of equipment. Where clear guidance may not exist or is not clear, leadership would need to integrate with on-going efforts to review the current Defense Acquisition Workforce talent management framework to ensure that AI acquisition learning resources are available. This would include identifying potential gaps and possibly creating resources to bring Marines up to speed prior to enrolling in course offerings at the Defense Acquisition University (DAU).

This TF will have the general support mission to identify and exploit how AI can be used to improve effectiveness of the supported commands. Implied within the task to explore is the requisite skill and acumen to assess potential use cases on a wide range of factors to include remaining steps to project implementation, cost-benefit analysis, and current problem scope maturity level. For exploitation, this implies the need to effectively manage projects at supported commands, capture and integrate lessons learned within the FMF and beyond, identify and effectively communicate constraints and blockers inhibiting scaling of promising technologies, and, as needed, communicating those constraints to higher headquarters for resourcing and/or resolution.

4.2.3 Organization

To effectively manage and lead AI development and deployment across the FMF, this TF will have to necessarily start small and built out to support the operational and supporting establishment. Due to the technical skill set, anticipated large demand, and the likely need for significant resourcing upfront beyond what a tactical or operational command could reasonably provide, the initial customer base for this TF would be at a senior command within the USMC. The recommended endstate for this organization is that AI professionals would available across the FMF.

Due to the need for domain expertise and the reality that different geographic commands have vastly different operating environments, initial research indicated that support may need to be aligned with Marine Corps components within the unified combatant commands - MARFORs - during the time period between establishment and the proposed recommended endstate. The stand up of this TF would task-organize into at least eleven teams, not including the headquarters element. Having eleven teams, assuming each Marine Force (MARFOR) within the unified combatant commands affirms a need for AI professionals, would enable the TF to be aligned to MARFORs.

As the community matures and is able to expand, the next investments should be prioritized between the at the service-level for targeted development within the major subordinate elements at each of the MEFs (e.g. Marine Division, Marine Logistics Group, Marine Air Wing). An additional team or element within the TF may be required for the sole function of connecting already existing and disparate communities across the FMF. Much of this could be enabled through collaboration with organizations such as the NPS AI Naval Innovation Exchange (NIX) Team [103] as well as current capabilities such as the Marine Corps Warfighting Lab, TF.

Though likely not feasible at the initial establishment of the TF, the location of liaison officers at critical nodes in the Naval AI ecosystem should be heavily considered. These locations should, at a minimum, include the NPS AI NIX, Navy Warfare Centers, select research universities and University-Affiliated Research Center Laboratories, ONR, and other Naval TFs. This would allow for the AI professional community to have a necessary balance between providing a needed capability to deployed units, exposure across a larger number of operating concepts and employment methods than if assigned at the Marine Expeditionary Force (MEF) level, as an example, which would effectively provide bottom-up refinement to decision-makers making the top-down guidance for the community development.

The organization should exist at the Headquarters Marine Corps-level. This will enable the allocation of resources and access to the appropriate talent and executive leaders needed to make this monumental mission successful. Similar to the AIETs, the function and application of this unit will be to organize as teams and provide support to commanders. Anticipating that the TF will be somewhere between a company-reinforced and a battalion (-) element, the expected typical supported unit would be an O-6 command or higher. Functionally, support to the Marine Corps supporting establishment will be typically be a secondary objective to the operational FMFs, but this could shift based on service objectives.

4.2.4 Training

To manage and lead AI development across the FMF, a large number of skill sets and background will be required. Today, the only primary MOSs that are ready in any form to take on some of these responsibilities is the 2652, Intelligence Data Engineer [91] and portions of the Geospatial Intelligence community (see section 4.2.7 for further details). If the scope is expanded to also consider secondary MOSs, there are more options, but are currently mostly exclusive to the officer population.

Though not a complete list, those trained and awarded the following additional MOS could be part of the considered population to makeup this unit (MOS code- NPS degree program pairing): 8825 (Modeling, Virtual Environments, and Simulation), 8846 (Computer Science), and 8850 (Operations Analysis). Not listed here, but certainly valuable are Marines and civilians that have a background in business management with a focus on information technology systems, systems engineering, and non-traditional acquisitions. There is also likely a reasonable employment opportunity for those personnel who are considered for the 0673 Application Developer MOS, as well as many other communities across the active and reserve Marine Corps formations.

As part of the secondary mission set, AI-related training of middle level and executive leadership should, in part or in whole, be the responsibility of the TF. The benefits of spreading the responsibility of training allow for context-dependent training to be done by local commands that have received the appropriate 'train-the-trainer' model common within the Marine Corps. The benefits of centralizing the training better enable control of quality and standardization of the training experience. This balance will certainly change over time, but at the beginning, it is expected that training would be centralized with the TF. Similar to acquisition guidance that COTS should be leveraged as much as possible [104], the TF should follow the path established by the CDAO and leverage open source educational tools to the maximum possible extent.

Additional research is required to first understand how much of the training, if any, can be pulled from the 2652 pipeline, what other communities not listed above should be considered, and if utilization tours should be looked at/adjusted to provide more utility to the service. A recommended starting point could be going to the Northern Virginia Community College as outlined in MARADMIN 198/23.

4.2.5 Materiel

Currently, the Marine Corps does not have a suitable solution to meet the goals outlined in the DoD Data Strategy Framework [12]. Similar to the CDAO, this TF commander should be allocated resources and granted acquisition authority for non-FAR-based acquisitions. This will enable the rapid testing, and when appropriate, integration and deployment of commercial-off-the-shelf and government-off-the-shelf technologies. When assessing technologies and associated technology readiness levels, the TF should follow the lead of AI2C or the USN TFs. This would scope the technologies as early on as level 5, but typically somewhere between 7 and 8, defined in Table 4.1 [104].

Where organic USMC resourcing was not available, leadership should be authorized a pathway to coordinate with the CDAO to potentially leverage external resources. Other potential materiel solutions include working through organizations within the DoD innovation ecosystem such as DIU, the National Security Innovation Network, and the Office of Strategic Capitol.

Table 4.1. Table of TRLs and definitions. Adapted from: [104]

Technology Readiness Level	Description
1. Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development.
2. Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology.
4. Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system.
5. Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment.
6. System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness.
7. System prototype demonstration in an operational environment	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space.
8. Actual system completed and qualified through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development.
9. Actual system proven through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation.

4.2.6 Leadership and Education

To manage and lead AI development across the FMF, buy-in from every stakeholder will be necessary to bridge the venerable 'valley of death' from ideation to widespread adoption. Field grade officer, Senior Non-Commission Officer, and executive-level buy-in is critical for the viability and sustainment of a niche, but critical capability such as this TF. Senior Company Grade/junior Field Grade officers, many of whom may have just completed graduate degree programs, will be critical in the role as team leaders. In this role, they serve as the linkage between strategic guidance and the supporting commands along with their senior enlisted/contractor/government-service employee counterpart. As the Marine Corps Talent Management efforts mature, to include the possibility of civilians with particularly low-density but important skills finding non-traditional pathways into the ranks, there should be the possibility of those "limited duty Marines" with relevant skill sets to find billets within this TF.

A change of this type would require an adjustment to the graduate education selection process from the current format to one that is more transparent regarding which billets are aligned to which degree programs. Additional changes include which billets could be available upon graduation, and what the remaining professional progression for the MOS could be. Specifically for Marines with graduate programs at NPS in AI-related fields, more research should be done regarding the viability of electing to remain employed as an AI professional. Today, Marines are offered the opportunity to apply with little transparency of what a utilization tour might look like after graduation and are given little to no information during the program.

Better planning tools, increased transparency, and the opportunity to transition into a career field that would build upon a technical education for the long-term would allow for the professionalization of a highly-technical and needed career track. The beginnings of this are outlined in the Talent Management 2030 Update - March 2023; however, this guidance only references the international affairs community [105]. If future research indicates that an AI career field is necessary for the Marine Corps, this could stabilize the transparency requirements for those interested in pursuing this path and enable the Marine Corps to better track and manage a talent pool that will also be highly sought after by outside employers.

4.2.7 Personnel

Meeting the mission of managing and leading AI development and adoption efforts within the enterprise will, initially, mean that most of the TF structure will come out of the officer corps. As the force at large receives access and the necessary resourcing to upskill, the balance will shift to that of a more traditional unit. With the limited number of currently identified personnel, the preponderance of initial forces assigned to the TF would be senior Captains and junior to mid-grade Majors.

The envisioned final TF structure should be a mix of active duty, reserve, and civilian personnel. This mixture would be necessary to ensure that certain skill sets, such as what would be expected of an AI professional, be a reservist or civilian, as this is a constantly evolving field. As methods, techniques, and subsequent education requirements for AI continue to evolve and the field itself becomes more complex, this is a potential example of a situation in which it may not be feasible for an active duty Marine to be able to keep current. Research and coordination with manpower personnel would need to be done to highlight personnel who have completed training at civilian institutions and, for those interested and who can screen positively, they should be provided the opportunity to join the TF.

Although the 2652 community may serve as an starting point for the AI professional community establishment, the previously mentioned shortfalls in professional pathways and training time must be carefully considered. Portions of other communities that should be considered as models include the 026X Geospatial Intelligence field. The 026X community faces similar requirements to manage large databases used by multiple agencies across the USG and its allies and partners [106], have an data governance strategy [107], and the need for technical skill sets that will translate to those needed for an AI professional [108].

The TF would need to look at similar units across the DoD and establish an appropriate assessment and selection process based on its needs, the assessed AI work role archetypes aligned with available billets, and expected progression both within the community and within the service. TF personnel will have to serve multiple roles: advisor and SME to supported commands, exploration team to support ideation and experimentation, and linkage to broader Naval/DoD AI communities to share and extract lessons learned.

Further research should also be done as to the appropriate number and composition of personnel that could be moved from their current positions within the supporting establishment at places such as the Marine Corps Warfighting Lab and the Marine Corps Tactical Systems Support Agency based on technical background relating to AI. Beyond those communities typically identified as having some level of familiarity with AI, such as Computer Science and Operations Research, the TF will need personnel with experience in acquisitions and project management to effectively implement an AIET-like model.

4.2.8 Facilities

The Marine Corps software factory is an excellent example of Porter's cluster theory and the importance of tying into an existing innovation community for AI development and adoption [95]. By plugging into the Army's existing innovation center, the Marine Corps has positioned itself to leverage hard-earned organizational knowledge already gained. For the TF to meet its mission, it would need to similarly integrate into communities and networks where successful and productive AI development is already occurring such as the AI2C.

During the initial establishment, remote work opportunities should be maximized to give the leadership an opportunity to evaluate and validate what work roles within the organization should be accomplished by civilian subject matter experts or service member AI professionals. For example, certain industries or sectors of the government such as agriculture and the intelligence community may be assessed to have the foremost expertise in computer vision. Thus, the TF computer vision-focused professionals should have regular interaction and co-location with the appropriate personnel from this community which may require additional facility investment to facilitate housing/work spaces for those necessary in-person events, and other necessary functions. Continuing down this scenario, if the foremost experts in the USG for natural language processing are predominantly located in places like Washington D.C., then additional facilities may not need to be invested in, due to pre-existing infrastructure at nearby locations.

Beyond housing and work location infrastructure, this TF should be the lead and have the ability to execute acquisitions on necessary data infrastructure and compute power to facilitate AI development. As industry leads the government in engineering these materials, this would facilitate rapid acquisition and establishment at the initial stage. As requirements and capability of the TF increase from its initial operational capability to final operating capability, the speed of execution from initial acquisition to utilization by operational forces may be correspondingly slow. Innovative acquisitions strategies, such as those offered by the DoD Tradewind marketplace [109], should be leveraged as much as possible, over FAR-based acquisitions.

As the information technology infrastructure matures, so too will data storage, transport, and management requirements. This will require a much more capable infrastructure than what is available to the FMF today. This shortfall, both today and throughout the stand up of this TF, could be mitigated through leveraging currently available support infrastructure, such as the Joint Warfighting Cloud Capability's Hosting and Computer Center to integrate and scale cloud capability across the force.

4.2.9 Policy

From a talent management standpoint, the Marine Corps has taken early and important steps to adjust from its archaic personnel management system [105]. In the latest update from March 2023, the opportunity for the professionalism of more technical career tracks is mentioned; however, it does not address the growing need for AI professionals within its ranks. Increasing demands for education and other requirements often mean that Marines and Sailors do not have time to complete the long list of training and education requirements without compromises already being made along the way. To that end, adding highly technical studies to this already long list will likely not lead to any significant understanding or adoption of AI leaving the TF incapable of meeting its mission to manage and lead AI development across the FMF, a large number of skill sets and background will be required.
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The Marine Corps senior leadership should work with DoN leadership to identify what work roles are required across the force and then fill the gaps between what the DoN needs as a whole and what the Marine Corps needs that the USN may not. As commercial technology advances and companies like Udemy and others work to develop low/no-code tools for AI development, these policies will need to be re-defined. By keeping policy actions within the DoN, it maximizes the ability to remain agile rather than be marred by the much slower DoD bureaucratic processes of policy creation and updates. These policy recommendations should start with, and be refined by, experts within this TF.

4.2.10 Summary

AI is a rapidly evolving technology, both in terms of complexity and capability, that the USMC is failing to harness. To rectify this, the Marine Corps needs to shift to a culture that recognizes that data is a strategic asset that is necessary for future innovation in the pursuit of asymmetric advantages. As the Joint Force's Stand-in force, the Marine Corps is too small of an organization to effectively collect the vast amounts of raw information that will be available in highly dynamic areas like those in Southeast Asia without leveraging smarter technologies like AI. To sense and make sense of the sensors we already have and will have in the future across all domains, and to more quickly and effectively close the kill-chain from sensor to shooter, the Marine Corps needs to invest in AI today.

CHAPTER 5: Conclusion

The potential for AI to have a transformative impact on the DoN, and greater DoD, is difficult to understate. In every warfighting function, there is likely a role for AI to eventually play. Today, the DoD should emphasize resourcing and near-term investments into narrow AI application. Primarily, this is due to limited resources, nascent capability to explain and trace outputs from AI systems, and very limited manpower to support the development and maintenance of these complex, technical systems.

As force modernization efforts across the military services mature, and challenges across the DOTMLPF-P are addressed or at a level in which the problem is not the responsibility of the DoD, then limited expansion into more demanding and novel systems should happen. One litmus test could be if the commercial space has not solved the problem without widespread controversy or objection to the legal, ethical, or other significant considerations, then the DoD should begin to experiment with related AI. An example of this is in the application of AI to assist in recruiting, retention, and similar human resource-related functions.

To harness AI quickly and at scale, the DoN needs to adopt the mindset of internal disruptive innovation. The Navy and Marine Corps mission sets are not going away, so we have to maintain our current capabilities while rapidly integrating approved dual-use technologies. This will require top-down direction and resource allocation, paired with bottom-up experimentation and feedback. Different warfare areas and disparate communities will have different needs for AI, and will need to have the tools and supporting infrastructure to successfully experiment. What they do not have now is a dedicated team of AI professionals to support their needs. Due to the revolutionary potential of AI, the maturation and adoption of AI technologies cannot be left to the current, archaic processes. The potential benefit and risk associated with AI adoption calls for a coordinated effort to identify and drive critical use cases.

The primary competitors to the U.S. already recognize the potential asymmetric advantage of AI and are making significant investments to unseat the U.S. as a global leader. In some critical technology areas it is argued that this may have already happened [3]. When

USG leaders saw the writing on the wall, CDAO was established to address some of these concerns at the DoD level. The foundation has been laid, and the time has come for the military services to more effectively address these strategic issues.

5.1 Limitations

The original intent of this thesis was to conduct an in-depth case study of Project Maven, the CDAO AIETs, and DIU. From Project Maven, due to difficulty in locating and interviewing leadership with the executive level of the staff, information used as reference comes from a long-time member of the core team and personnel from the user and support communities. From the CDAO, a senior member from the JAIC was interviewed who facilitated the transition to the CDAO and led several AIETs. Other details were gathered from open source or the author's experience. From DIU, a project manager was interviewed along with operational customers and partners. As a result of these challenges, the methodology for research had to adapt from a series of case studies to an organizational comparison.

5.2 Recommendations

Stepping below the strategic level of consideration, there are some fundamental areas that the DoN can begin or continue to invest in now that will have longstanding positive effect in the pursuit of widespread AI adoption. First, there needs to be a hybrid approach of top-down and bottom-up education and democratization of innovation and data in order to get the resources allocated to build the tools that the warfighters at the tactical edge of the military need [11]. Those who are going to be educated need to be able to learn in a hybrid fashion. As technology matures, the author's operational experience indicates that it typically leads to individuals taking on more diverse sets of work, rather than less work. This then leads to less opportunities for commanders to release individuals to go to a brick-and-mortar learning institution for an extended period of time to get a technical degree or certification. There will need to be additional research, some of which is already well underway at institutions such as NPS, as to how to bring micro-learning to the DoD for those who are interested in learning about AI through communities of interest such as the AI NIX Team [103].

5.2.1 Doctrine

1. Common definition for the USG as to the definition of AI and it's relation to autonomy, ML, Computer Vision, Natural Language Processing, etc. There's a standard Venn Diagram for data scientists: math, computer science, and domain expertise. The domain expertise portion, which includes contracting and program management, within the DoD needs to be more clearly defined.
2. Clear guidance written for commanders on how to leverage AI within their commands. This includes how to integrate AI, manage that risk, and what trustworthy and responsible AI should look like.

5.2.2 Organization

1. Identify and empower a single individual, with appropriate authorities and resources, to direct DoN AI adoption.
2. Explore potential of putting CDAO AIET-like capability within military services and where makes the most sense.
3. Placing key personnel in positions at military service component commands with organic computer science/data science education and training to be liaisons with AIET and allow increase flexibility within AIET deployment structure.
4. As highlighted by TF-59, cutting edge experimentation should include some portion of the test and evaluation process be conducted outside the U.S. where a more realistic operational environment can be constructed.

5.2.3 Training

1. If unit is a small team, all personnel should receive basic introductions into acquisition/project management.
2. Educate users about high-level overview of AI models used for general understanding of strengths/weaknesses, capabilities, where it does and does not work.
3. Make courses that are available in other resources like Joint Knowledge Online linked but visible in other service-learning platform catalogues.
4. School for service (SFS) type model for CS/OR students at NPS where they are getting standard education for 16 months, then step away for a quarter or a period of time to

do something operationally relevant or something more real world, then return, finish educational requirements, and then move on to next command.

5. Potentially update DAU course catalog, in coordination with the CDAO, for any courses specialized for AI acquisition and lifecycle management.

5.2.4 Materiel

1. Aligning incentives with military service interest to get capability acquired on O&M (Operational and Maintenance) funds, rather than just a research grant.
2. Provide sample data to customers/vendors to use (when feasible)
3. Align well-defined interests in priority-order to optimize for a respective organization's need for the balance between cost and performance.
4. 80% of time and resources of an AI project will be spent on gathering, cleaning, and preparing data to be able to input into a model. Spend the time and due diligence up front to ensure the infrastructure can support this trend.
5. Build with the endstate environment in mind. A cloud server that stores data and is positioned on the east coast of the U.S. may be too latent of a connection with even the most optimal network configuration for a forward deployed unit in the Indo-Pacific that is required to interface with it in order to run a model on the edge.
6. Prioritize an enterprise infrastructure that supports data labeling, analysis and visualization that is integrated, but allows each military service to adapt to specific needs.

5.2.5 Leadership and Education

1. Educate users about why we are collecting data, why it is important to consistently organize, what kinds of things we should record. If we need 5 years' worth of data for a model today, we are 5 years behind in development.
2. Leverage currently existing agreements with commercial platforms and integrate with service-specific learning platforms.
3. Manpower intensive processes (e.g. porting information locally recorded on a spreadsheet into a cloud environment) need to be identified and if possible, automated.
4. Customer-base cannot be expected to have all the details and terminology to explain the problem in the way that a software engineer/data scientist can easily attack; this

is the role of the senior military representative on the team.

5. Staffs need to be enabled to provide leadership with more detailed analysis in reports (if applicable): confidence interval, variance, right/left-tailed distribution, work-arounds if there's a situation that's well outside previously seen data. If there're no analytical rigor, the information make lead to inappropriate conclusions based off insufficient analysis.

5.2.6 Personnel

1. Leadership needs to maintain ability to be highly selective and dynamically adjust team roster, as required.
2. Balance between professional background (i.e. HUMINT) and service origin for maximal access to customer base (USA, USAF, USN, USMC, and USSF).
3. Uniformed data science/OR/CS trained individuals placed in positions where they can leverage their experience and tools to effectively empower the commander.

5.2.7 Facilities

Prioritize investing in areas where there is already an established AI innovation community at first to decrease risk of failure and delay due to lack of available expertise or resources. As efforts across the force mature and necessary infrastructure is built out, then the DoN should consider trying to establish stand-alone communities.

5.3 Future Work

Throughout this research, several opportunities for further research have been identified. Although much work has gone into doing a DOTMLPF-P analysis for the recommendation of a Marine Corps AI TF, this should be further investigated. Along these lines, evolving manpower management and talent management processes in the USN, such as a Robotics rating and the formalization of Operations Research as an additional profession for the warrant officer and officer communities, to investigate the need for an AI profession within the DoN. Complementary to the research of the potential need for an AI profession, there should be a collaboration between the NPS AI NIX team, the USN TYCOM TFs, and the equivalent commands from the USMC to develop a prioritized list of current capability requirements that could be augmented or replaced by AI for future investment. The NPS AI NIX team should work with the appropriate action officers and decision makers from across the DoN to adapt the DoD Cyber Workforce Development AI-related Knowledge, Skills, Abilities, and Tasks to DoN critical workforce positions. Lastly, further research should be done to explore how the DoD is currently leveraging DoD RDT&E 6.8 (Software and Digital Technology) funds for enabling DoN AI adoption and how should these funds be leveraged in the future.

5.3.1 Conclusion

In the NSCAI's final report, the DoD and its military services were recommended to be AI-ready by 2025 [11]. While each of the military services has made progress in the two years since this report was published, a significant amount of work still needs to be done to meet this goal. The only way to feasibly occur is if doctrine is updated and investments are made into the organization, workforce, technology, and supporting infrastructure. If any of these foundational components are lagging or insufficiently resourced, the warfighter at the other end of the strategic vision will not have the tools to complete the mission in future conflict spaces. Fortunately, every military services seems to have taken this risk to heart and is aggressively moving forward to meet the challenge.

List of References

[1] N. Maslej *et al.*, "The AI Index 2023 Annual Report," AI Index Steering Committee, Institute for Human-Centered AI, Stanford University, Stanford, CA, Rep., Apr. 2023 [Online]. Available: https://aiindex.stanford.edu/report/

[2] Y. Tadjdeh, "Big Data, AI to Advance Modeling and Simulation," *National Defense*, vol. 102, no. 770, p. 13, 2018. Publisher: National Defense Industrial Association [Online]. Available: https://www.jstor.org/stable/27022054

[3] J. Gaida, J. W. Leung, S. Robin, and D. Cave, "Critical Technology Tracker: The global race for future power," Australian Strategic Policy Institute, Policy Brief 69/2023, Feb. 2023 [Online]. Available: http://www.aspi.org.au/report/critical-technology-tracker

[4] U.S. Air Force, "Geographic Laydown for USAF Software Factories" [Online]. Available: https://software.af.mil/software-factories/

[5] Carnegie Mellon University, "CMU Selected by U.S. Army to Lead Artificial Intelligence Innovation Framework - News - Carnegie Mellon University," *The Piper: Campus & Community News*, Apr. 2020 [Online]. Available: http://www.cmu.edu/news/stories/archives/2020/april/army-ai-innovation-framework.html

[6] B. Vincent, "New Navy task forces supporting DOD establishment of 'AI hubs'," *DefenseScoop*, Oct. 2022 [Online]. Available: https://defensescoop.com/2022/10/19/new-navy-task-forces-supporting-dod-establishment-of-ai-hubs/

[7] The White House, "National Security Strategy 2017," Washington, DC, USA, Rep., Dec. 2017 [Online]. Available: https://history.defense.gov/Portals/70/Documents/nss/NSS2017.pdf?ver=CnFwURrw09pJ0q5EogFpwg%3d%3d

[8] Department of Defense, "Summary of the 2018 National Defense Strategy: Sharpening the American Military's Competitive Edge," Washington, DC, USA, Rep., Jan. 2018 [Online]. Available: https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf

[9] Department of Defense, "Summary of the 2018 Department of Defense Artificial Intelligence Strategy: Harnessing AI to Advance Our Security and Prosperity," Washington, DC, USA, Rep., Feb. 2019 [Online]. Available: https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF

[10] U.S. House, 115th Congress, (2018, Aug. 13), "John S. McCain National Defense Authorization Act for Fiscal Year 2019," Aug. 2018. Archive Location: 08/13/2018 [Online]. Available: https://www.congress.gov/bill/115th-congress/house-bill/5515/text

[11] E. Schmidt and R. Work, "NSCAI - Final Report," National Security Commission on Artificial Intelligence, Rep., Mar. 2021 [Online]. Available: https://reports.nscai.gov/final-report/

[12] Department of Defense, "DoD Adopts Ethical Principles for Artificial Intelligence," Feb. 2020 [Online]. Available: https://www.defense.gov/News/Releases/Release/Article/2091996/dod-adopts-ethical-principles-for-artificial-intelligence/

[13] Department of Defense, "Data Strategy," Washington, DC, USA, Rep., Oct. 2020 [Online]. Available: https://media.defense.gov/2020/Oct/08/2002514180/-1/-1/0/DOD-DATA-STRATEGY.PDF

[14] Office of Management and Budget, "Guidance for Regulation of Artificial Intelligence Applications," Washington, DC, USA, Rep., Nov. 2020 [Online]. Available: https://www.whitehouse.gov/wp-content/uploads/2020/11/M-21-06.pdf

[15] K. Hicks, "Implementing Responsible Artificial Intelligence in the Department of Defense," May 2021 [Online]. Available: https://media.defense.gov/2021/May/27/2002730593/-1/-1/0/IMPLEMENTING-RESPONSIBLE-ARTIFICIAL-INTELLIGENCE-IN-THE-DEPARTMENT-OF-DEFENSE.PDF

[16] D. Vergun. "DoD Modernization Relies on Rapidly Leveraging Commercial Technology." Jan. 2023 [Online]. Available: https://www.defense.gov/News/News-Stories/Article/Article/3277453/dod-modernization-relies-on-rapidly-leveraging-commercial-technology/https%3A%2F%2Fwww.defense.gov%2FNews%2FNews-Stories%2FArticle%2FArticle%2F3277453%2Fdod-modernization-relies-on-rapidly-leveraging-commercial-technology%2F

[17] C. Martell, "DoD Metadata Guidance and Memorandum," Washington, DC, USA, Rep., Mar. 2023 [Online]. Available: https://nps01-my.sharepoint.com/personal/eric_jimenez_nps_edu/Documents/Microsoft%20Teams%20Chat%20Files/DoD%20Metadata%20Guidance%20and%20Memorandum_MAR%202023.pdf

[18] L. Heckmann, "Joint Warfighting Concept 3.0 'Definitely Coming,' Official Says," *National Defense*, Apr. 2023 [Online]. Available: https://www.nationaldefensemagazine.org/articles/2023/4/5/joint-warfighting-concept-30-definitely-coming-official-says

[19] J. Jöhnk, M. Weißert, and K. Wyrtki, "Ready or Not, AI Comes— An Interview Study of Organizational AI Readiness Factors," *Business & Information Systems Engineering*, vol. 63, no. 1, pp. 5–20, Feb. 2021 [Online]. Available: https://doi.org/10.1007/s12599-020-00676-7

[20] M. Weber, M. Engert, N. Schaffer, J. Weking, and H. Krcmar, "Organizational Capabilities for AI Implementation—Coping with Inscrutability and Data Dependency in AI," *Information Systems Frontiers*, June 2022 [Online]. Available: https://doi.org/10.1007/s10796-022-10297-y

[21] A. Trunk, H. Birkel, and E. Hartmann, "On the current state of combining human and artificial intelligence for strategic organizational decision making," *Business Research*, vol. 13, no. 3, pp. 875–919, Nov. 2020 [Online]. Available: https://doi.org/10.1007/s40685-020-00133-x

[22] R. Work, "Establishment of an Algorithmic Warfare Cross-Functional Team (Project Maven)," official memorandum, Washington, DC, USA, Apr. 2017 [Online]. Available: https://dodcio.defense.gov/Portals/0/Documents/Project%20Maven%20DSD%20Memo%2020170425.pdf

[23] M. Weisgerber, "The Pentagon's New Artificial Intelligence Is Already Hunting Terrorists," *Defense One*, Dec. 2017 [Online]. Available: https://www.defenseone.com/technology/2017/12/pentagons-new-artificial-intelligence-already-hunting-terrorists/144742/

[24] C. Pellerin, "Project Maven to Deploy Computer Algorithms to War Zone by Year's End," *U.S. Department of Defense*, July 2017 [Online]. Available: https://www.defense.gov/News/News-Stories/Article/Article/1254719/project-maven-to-deploy-computer-algorithms-to-war-zone-by-years-end/https%3A%2F%2Fwww.defense.gov%2FNews%2FNews-Stories%2FArticle%2FArticle%2F1254719%2Fproject-maven-to-deploy-computer-algorithms-to-war-zone-by-years-end%2F

[25] T. Hitchens, "Pentagon's flagship AI effort, Project Maven, moves to NGA," *Breaking Defense*, Apr. 2022 [Online]. Available: https://breakingdefense.sites.breakingmedia.com/2022/04/pentagons-flagship-ai-effort-project-maven-moves-to-nga/

[26] Department of Defense, "DoD Digital Modernization Strategy 2019: DoD Information Resource Management Strategic Plan FY19-23," Washington, DC, USA, Rep., July 2019 [Online]. Available: https://media.defense.gov/2019/Jul/12/2002156622/-1/-1/1/DOD-DIGITAL-MODERNIZATION-STRATEGY-2019.PDF

[27] Department of Defense, Research and Engineering, "Campaign for an AI Ready Force," Washington, DC, USA, Rep., Oct. 2019 [Online]. Available: https://media.defense.gov/2019/Oct/31/2002204191/-1/-1/0/CAMPAIGN_FOR_AN_AI_READY_FORCE.PDF

[28] Joint Artificial Intelligence Center, "DoD AI Training and Education Strategy 2020," Washington, DC, USA, Rep., Sep. 2020 [Online]. Available: https://www.ai.mil/docs/2020_DoD_AI_Training_and_Education_Strategy_and_Infographic_10_27_20.pdf

[29] R. D. McCarthy, J. C. McConville, and M. A. Grinston, "2019 Army Modernization Strategy," Department of the Army, Washington, DC, USA, Rep. 211847, Oct. 2019 [Online]. Available: https://www.army.mil/e2/downloads/rv7/2019_army_modernization_strategy_final.pdf

[30] D. H. Berger, "Commandant's Planning Guidance," Department of the Navy, Washington, DC, USA, official memorandum, July 2019 [Online]. Available: https://www.marines.mil/Portals/1/Publications/Commandant's%20Planning%20Guidance_2019.pdf?ver=2019-07-17-090732-937

[31] M. Gilday, "CNO NAVPLAN 2021," Washington, DC, USA, Rep., Jan. 2021 [Online]. Available: https://media.defense.gov/2021/Jan/11/2002562551/-1/-1/1/CNO%20NAVPLAN%202021%20-%20FINAL.PDF

[32] J. Judson and N. Strout. "At Project Convergence, the US Army experienced success and failure — and it's happy about both." Oct. 2020. Section: AUSA [Online]. Available: https://www.defensenews.com/digital-show-dailies/ausa/2020/10/12/at-project-convergence-the-us-army-experienced-success-and-failure-and-its-happy-about-both/

[33] J. Casserly, "MIT partnership helps acquisition officer expand toolkit," *Air University (AU)*, Apr. 2021 [Online]. Available: https://www.airuniversity.af.edu/News/Display/Article/2558493/mit-partnership-helps-acquisition-officer-expand-toolkit/

[34] L. Schuette, "Navy Center for Applied Research in Artificial Intelligence," *Director of Innovation, Volume 3*, Nov. 2009 [Online]. Available: https://apps.dtic.mil/sti/pdfs/ADA525387.pdf

[35] Pr Newswire, "Report: Without Bold R&D Investments, United States Risks Losing Position as one of the World's Top Innovators," Business Insider, Press Release, Nov. 2021 [Online]. Available: https://markets.businessinsider.com/news/stocks/report-without-bold-r-d-investments-united-states-risks-losing-position-as-one-of-the-world-s-top-innovators-1030981493

[36] C. Zember and P. Khooshabeh, “Defense Innovation Is Falling Short,” *War on the Rocks*, Sep. 2020 [Online]. Available: https://warontherocks.com/2020/09/defense-innovation-is-falling-short/

[37] The White House, “U.S.-Indo-Pacific-Strategy,” Washington, DC, USA, Rep., Feb. 2022 [Online]. Available: https://www.whitehouse.gov/wp-content/uploads/2022/02/U.S.-Indo-Pacific-Strategy.pdf

[38] U.S. Office of Management and Budget, “Research and Development (2022),” May 2021 [Online]. Available: https://www.whitehouse.gov/wp-content/uploads/2021/05/ap_14_research_fy22.pdf

[39] A. Kelley, “US Teams Up With Partner Nations to Release Smart City Cyber Guidance,” *NextGov*, Apr. 2023 [Online]. Available: https://www.nextgov.com/cybersecurity/2023/04/us-teams-partner-nations-release-smart-city-cyber-guidance/385412/

[40] L. Walker and A. Wehsener. “Pentagon’s Office of Strategic Capital must win over Silicon Valley.” Dec. 2022. Section: Commentary [Online]. Available: https://www.defensenews.com/opinion/commentary/2022/12/13/a-new-pentagon-office-faces-a-historic-test/

[41] Cornell Law School. “15 CFR § 730.3 - “Dual use” and other types of items subject to the EAR.” [Online]. Available: https://www.law.cornell.edu/cfr/text/15/730.3

[42] General Services Administration. “FAR 2.101 Definitions.” Mar. 2023 [Online]. Available: https://www.acquisition.gov/far/2.101#FAR_2_101

[43] E. Ofek and M. Eiran, “From Start-Up to Grown-Up Nation: The Future of the Israeli Innovation Ecosystem,” *Harvard Business School Case 517-066*, p. 35, Dec. 2018.

[44] M. E. Porter, “The Competitive Advantage of Nations,” *Harvard Business Review*, no. March-April 1990, p. 21, Mar. 1990 [Online]. Available: https://hbr.org/1990/03/the-competitive-advantage-of-nations

[45] Department of Defense. “CDAO - Chief Digital and Artificial Intelligence Office” [Online]. Available: https://www.ai.mil/

[46] Gartner, “What’s New in the 2022 Gartner Hype Cycle for Emerging Technologies,” Rep., Aug. 2022 [Online]. Available: https://www.gartner.com/en/articles/what-s-new-in-the-2022-gartner-hype-cycle-for-emerging-technologies

[47] M. Roser. “The brief history of artificial intelligence: The world has changed fast – what might be next?” Dec. 2022 [Online]. Available: https://ourworldindata.org/brief-history-of-ai

[48] S. Schuchmann, “History of the first AI Winter,” *Medium*, May 2020 [Online]. Available: https://towardsdatascience.com/history-of-the-first-ai-winter-6f8c2186f80b

[49] E. Schmidt and W. Schmidt, “We’re Not Using AI to Its Fullest Human Potential,” *Time*, Nov. 2022 [Online]. Available: https://time.com/6227118/eric-schmidt-ai-human-intelligence/

[50] F. Richter, “Investors predict US recession in 2023 - here are the facts,” World Economic Forum, Rep., Apr. 2022 [Online]. Available: https://www.weforum.org/agenda/2022/04/recession-investor-bank-pandemic-united-states/

[51] Center for Security and Emerging Technology, J. Olander, and M. Flagg, “AI Hubs in the United States,” Center for Security and Emerging Technology, Rep., May 2020 [Online]. Available: https://doi.org/10.51593/20200006

[52] Office of the Chief Economist at the United States Patent and Trademark Office, USPTO’s Patent Organization, and the Office of Policy and International Affairs, “Inventing AI: Tracing the diffusion of artificial intelligence with U.S. patents,” U.S. Patent and Trademark Office, Rep. 5, Oct. 2020 [Online]. Available: https://www.uspto.gov/sites/default/files/documents/OCE-DH-AI.pdf

[53] J. A. Lewis, “Mapping the National Security Industrial Base: Policy Shaping Issues,” Center for Strategic and International Studies, Rep., May 2021 [Online]. Available: https://www.csis.org/analysis/mapping-national-security-industrial-base-policy-shaping-issues

[54] J. Sargent Jr., “Defense Primer: RDT&E,” Congressional Research Service, Washington, DC, USA, Rep. CRS Report No. IFI0553, Nov. 2022 [Online]. Available: https://crsreports.congress.gov/product/pdf/IF/IF10553

[55] National Science Foundation, “Master Government List of Federally Funded R&D Centers,” Feb. 2023 [Online]. Available: https://www.nsf.gov/statistics/ffrdclist/

[56] PinMaps, “United States” [Online]. Available: https://www.pinmaps.net/mymaps/

[57] Office of the Chairman of the Joint Chiefs of Staff, “Terminal Repository for DoD,” Aug. 2022 [Online]. Available: https://jdeis.js.mil/jdeis/index.jsp?pindex=4

[58] Office of the Chairman of the Joint Chiefs of Staff, “Joint Doctrine Development System,” Department of Defense, Washington, DC, USA, Rep., Nov. 2020 [Online]. Available: https://www.jcs.mil/Portals/36/Documents/Library/Instructions/CJCSI%205120.02E.pdf?ver=l7dd_h4MNeLd3_NvBjWYaQ%3d%3d

[59] Naval History and Heritage Command, “Landing Operations Doctrine, USN, FTP-167,” Nov. 2020 [Online]. Available: https://www.history.navy.mil/research/library/online-reading-room/title-list-alphabetically/l/landing-operations-doctrine-usn-ftp-167.html

[60] B. I. Gudmundsson, *Stormtroop Tactics: Innovation in the German Army, 1914-1918*. Westport, Connecticut, US: Praeger, June 1995. OCLC: 34558935.

[61] The White House, “National Security Strategy 2022,” Washington, DC, USA, Rep., Oct. 2022 [Online]. Available: https://www.whitehouse.gov/wp-content/uploads/2022/11/8-November-Combined-PDF-for-Upload.pdf

[62] R. Schwartz, A. Vassilev, K. Greene, L. Perine, A. Burt, and P. Hall, “Towards a Standard for Identifying and Managing Bias in Artificial Intelligence,” National Institute of Standards and Technology, Gaithersburg, MD, Rep., Mar. 2022 [Online]. Available: https://doi.org/10.6028/NIST.SP.1270

[63] OpenAI, “GPT-4 Technical Report,” Mar. 2023. arXiv:2303.08774 [cs] [Online]. Available: http://arxiv.org/abs/2303.08774

[64] OpenAI, “GPT-4 System Card,” Mar. 2023 [Online]. Available: https://cdn.openai.com/papers/gpt-4-system-card.pdf

[65] S. Mann. “DAF-MIT AI Accelerator Phantom Fellowship Program Integrates Enlisted Expertise.” Mar. 2022 [Online]. Available: https://aia.mit.edu/2022/03/02/daf-mit-ai-accelerator-phantom-fellowship-program-integrates-enlisted/

[66] Army Futures Command. “Artificial Intelligence Task Force Welcomes Inaugural Class of AI Scholars.” July 2020 [Online]. Available: https://www.army.mil/article/237258/artificial_intelligence_task_force_welcomes_inaugural_class_of_ai_scholars

[67] P. Ong. “U.S. Navy’s New Task Force 59 Teams Manned with Unmanned Systems for CENTCOM’s Middle East.” Sep. 2021 [Online]. Available: https://www.navalnews.com/naval-news/2021/09/u-s-navys-new-task-force-59-teams-manned-with-unmanned-systems-for-centcoms-middle-east/

[68] E. D. McGrady, “Military Organizations and the Navy,” Jan. 2001 [Online]. Available: https://www.cna.org/archive/CNA_Files/pdf/d0001732.a1.pdf

[69] P. Ortiz and J. Fischer, “Data Usage, Automation, and AI/ML,” Naval Postgraduate School, Rep., Jan. 2023.

[70] OUSD PAO Office of the Under Secretary of Defense. “Marine Corps Logistics Base (MCLB) Albany, Georgia 5G Smart Warehouse Press Release.” Oct. 2020 [Online]. Available: https://www.logcom.marines.mil/Home/Article/2378273/marine-corps-logistics-base-mclb-albany-georgia-5g-smart-warehouse-press-release/https%3A%2F%2Fwww.logcom.marines.mil%2FNews%2FArticle%2F2378273%2Fmarine-corps-logistics-base-mclb-albany-georgia-5g-smart-warehouse-press-release%2F

[71] Project Maven Developer, interview, Aug. 2022.

[72] DIU Program Manager, interview, Oct. 2022.

[73] CDAO Team Leader, interview, Aug. 2022.

[74] DIU. “Technology Portfolios” [Online]. Available: https://www.diu.mil/solutions/portfolio

[75] D. Goldfein and M. Donovan, “USAF AI Annex to DoD AI Strategy,” Washington, DC, USA, Rep., Sep. 2019 [Online]. Available: https://www.af.mil/Portals/1/documents/5/USAF-AI-Annex-to-DoD-AI-Strategy.pdf

[76] S. Freedberg Jr. “A New Century Series? Will Roper Takes Air Force Back To The Future.” Apr. 2019 [Online]. Available: https://breakingdefense.sites.breakingmedia.com/2019/04/a-new-century-series-will-roper-takes-air-force-back-to-the-future/

[77] D. Hambling. “Artificial Intelligence Is Now Part Of U.S. Air Force’s ‘Kill Chain’.” Oct. 2021. Section: Aerospace & Defense [Online]. Available: https://www.forbes.com/sites/davidhambling/2021/10/28/ai-now-part-of-us-air-force-kill-chain/

[78] Air Force Life Cycle Management Center, “Kessel Run Delivers Jigsaw to NATO Forces.pdf,” Oct. 2021 [Online]. Available: https://kesselrun.af.mil/news/new-KR-JIGSAW-to-NATO.html

[79] Secretary of the Air Force Public Affairs. “AI Copilot: Air Force achieves first military flight with artificial intelligence.” Dec. 2020 [Online]. Available: https://www.af.mil/News/Article-Display/Article/2448376/ai-copilot-air-force-achieves-first-military-flight-with-artificial-intelligence/https%3A%2F%2Fwww.af.mil%2FNews%2FArticle-Display%2FArticle%2F2448376%2Fai-copilot-air-force-achieves-first-military-flight-with-artificial-intelligence%2F

[80] T. Ward. "The US Air Force is Moving Fast on AI-Piloted Fighter Jets.pdf." Mar. 2023 [Online]. Available: https://www.wired.com/story/us-air-force-skyborg-vista-ai-fighter-jets/

[81] V. Gadepally *et al.*, "AI Enabling Technologies: A Survey," *CoRR*, vol. abs/1905.03592, May 2019 [Online]. Available: https://arxiv.org/abs/1905.03592

[82] General Services Administration. "Understanding and managing the AI lifecycle" [Online]. Available: https://coe.gsa.gov/coe/ai-guide-for-government/understanding-managing-ai-lifecycle/index.html

[83] K. Ishizaki. "AI Model Lifecycle Management: Overview." Nov. 2020 [Online]. Available: https://www.ibm.com/cloud/blog/ai-model-lifecycle-management-overview

[84] Project Maven User, interview and Project Maven Field Service Respresentative, interview, July 2022.

[85] R. D. McCarthy, J. C. McConville, and M. A. Grinston, "The Army People Strategy," Department of the Army, Washington, DC, USA, Rep., Oct. 2019 [Online]. Available: https://www.army.mil/e2/downloads/rv7/the_army_people_strategy_2019_10_11_signed_final.pdf

[86] D. H. Berger, "Talent Management 2030," Department of the Navy, Washington, DC, USA, Rep., Nov. 2021 [Online]. Available: https://www.hqmc.marines.mil/Portals/142/Users/183/35/4535/Talent%20Management%202030_November%202021.pdf

[87] M. A. Michell, email, "Naval AI/ML CoW," Jan. 2023.

[88] Navy Personnel Command, "Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards," Apr. 2023. NEOCS [Online]. Available: https://www.mynavyhr.navy.mil/Portals/55/Reference/NEOCS/Vol1/OCCSTDS%20Manual_94_APR23.pdf?ver=JagSFOktcaFVhaRln1MKkw%3d%3d

[89] Navy Personnel Command, "Manual of Navy Officer Manpower and Personnel Classifications," Apr. 2023. NOOCS [Online]. Available: https://www.mynavyhr.navy.mil/Portals/55/Reference/NOOCS/Vol1/Entire%20Manual_1_83_Apr23.pdf?ver=qQw0Eyulvv7rjHWl6zTnrA%3d%3d

[90] Department of the Air Force. "Career Finder - U.S. Air Force" [Online]. Available: https://www.airforce.com/careers/career-finder

[91] *2022 FY23 USMC Numerical Index of Military Occupational Specialties, NAVMC 1008-A, Headquarters Marine Corps*. U.S. Marine Corps, Apr. 2022 [Online]. Available: https://www.marines.mil/Portals/1/Publications/NAVMC%201008-A%202022%20FY23.pdf?ver=BMzcMa2YVr2CJcmU6QvvDQ%3d%3d

[92] P. Ortiz, "I MEF state of 265X white paper," Oct. 2022.

[93] "Extended solicitation of nominations for the Fiscal Year 2023 Intelligence Data Engineer training pipeline," official memorandum, Headquarters United States Marine Corps, Washington, DC, USA, Apr. 2023 [Online]. Available: https://www.marines.mil/News/Messages/Messages-Display/Article/3364976/extended-solicitation-of-nominations-for-the-fiscal-year-2023-intelligence-data/https%3A%2F%2Fwww.marines.mil%2FNews%2FMessages%2FMessages-Display%2FArticle%2F3364976%2Fextended-solicitation-of-nominations-for-the-fiscal-year-2023-intelligence-data%2F

[94] *Signals Intelligence Training and Readiness Manual, NAVMC 3500.105C w Ch 1,*, Washington, DC, USA, Sep. 2019 [Online]. Available: https://www.marines.mil/Portals/1/Publications/NAVMC%203500.105C%20w%20Ch%201.pdf?ver=lTlY1-iI2v6WzhoLlirhGg%3d%3d

[95] C. Bahk, J. Avetette, J. McLinn, and P. Sherlund, "Announcement of the Marine Corps Software Factory," official memorandum, Deputy Commandant for Information, Washington, DC, USA, Mar. 2023 [Online]. Available: https://www.marines.mil/DesktopModules/ArticleCS/Print.aspx?PortalId=1&ModuleId=542&Article=3325426

[96] K. Landtroop, "Zero to one in DoD," Naval Postgraduate School, Oct. 2022.

[97] R. Ryan. "Here's What's Happening To Remote Work In 2023." Jan. 2023. Section: Careers [Online]. Available: https://www.forbes.com/sites/robinryan/2023/01/10/heres-whats-happening-to-remote-work-in-2023/

[98] B. Aczel, M. Kovacs, T. van der Lippe, and B. Szaszi, "Researchers working from home: Benefits and challenges," *PLOS ONE*, vol. 16, no. 3, pp. 1–13, Mar. 2021. Publisher: Public Library of Science [Online]. Available: https://doi.org/10.1371/journal.pone.0249127

[99] M. Porter, "Clusters and the New Economics of Competition," *Harvard Business Review*, vol. November-December 1998, p. 16, Nov. 1998.

[100] E. Gholz and H. M. Sapolsky, "The defense innovation machine: Why the U.S. will remain on the cutting edge," *Journal of Strategic Studies*, vol. 44, no. 6, pp.

854–872, Sep. 2021 [Online]. Available: https://doi.org/10.1080/01402390.2021.1917392

[101] S. Blank, "As Silicon Valley Tries to Enlist, the Pentagon Strangles Innovation," *War on the Rocks*, Apr. 2022 [Online]. Available: https://warontherocks.com/2022/04/as-silicon-valley-tries-to-enlist-the-pentagon-strangles-innovation/

[102] High-Level Expert Group on AI, "Ethics Guidelines for Trustworthy AI," Eurporean Commission, B-1049 Brussels, Rep., Apr. 2019 [Online]. Available: https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai

[103] R. Mena-Werth. "Artificial Intelligence Summit at NPS Accelerates Critical Capabilities." Jan. 2023 [Online]. Available: https://www.navy.mil/Press-Office/News-Stories/Article/3272831/artificial-intelligence-summit-at-nps-accelerates-critical-capabilities/https%3A%2F%2Fwww.navy.mil%2FPress-Office%2FNews-Stories%2FArticle%2F3272831%2Fartificial-intelligence-summit-at-nps-accelerates-critical-capabilities%2F

[104] Defense Acquisition University, *Defense Acquisition Guidebook*. Washington, DC, USA: Defense Acquisition University, Sep. 2013 [Online]. Available: https://www.dote.osd.mil/Portals/97/docs/TEMPGuide/DefenseAcquisitionGuidebook.pdf

[105] D. H. Berger, "Talent Management 2030," Washington, DC, USA, Rep., Mar. 2023 [Online]. Available: https://www.marines.mil/Portals/1/Docs/Talent%20Management%202030%20Update%20-%20March%202023.pdf

[106] *Military Occupational Specialties Manual, NAVMC 1200.1H, Headquarters Marine Corps*, Washington, DC, USA, Sep. 2022 [Online]. Available: https://www.marines.mil/Portals/1/Publications/NAVMC%201200.1H.pdf?ver=FSEja2jd4eCtb1U6H3wO3w%3d%3d

[107] "Marine Corps Intelligence Surveillance and Reconnaissance Enterprise Geospatial Intelligence Information Management Policy," official memorandum, Headquarters United States Marine Corps, Washington, DC, USA, 2022.

[108] *Intelligence and Ground Sensors Training and Readiness Manual, NAVMC 3500.100C, Headquarters Marine Corps*, Washington, DC, USA, June 2019 [Online]. Available: https://www.marines.mil/Portals/1/Publications/NAVMC%203500.100C%20Intelligence%20and%20Ground%20Sensors%20T-R%20Manual.pdf?ver=2019-09-26-092731-097

[109] Chief Digital and AI Office. "Tradewind | Discover AI Opportunities within the DoD" [Online]. Available: https://tradewindai.com/

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