



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

SYSTEMS ENGINEERING CAPSTONE REPORT

ARTIFICIAL INTELLIGENCE AND HUMAN INTERACTION: HOW TO KEEP THE HUMAN IN THE LOOP

by

Ashley N. Gizas, Benjamin R. Hill, Megan Meisner,
Dawn P. Patterson, and Nicole Wilson

September 2022

Advisor:
Co-Advisor:
Second Reader:

Paul T. Beery
Matthew C. Nicholson
Rob Semmens,
West Point Military Academy

Approved for public release. Distribution is unlimited.

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			<i>Form Approved OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC, 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE September 2022		3. REPORT TYPE AND DATES COVERED Systems Engineering Capstone Report
4. TITLE AND SUBTITLE ARTIFICIAL INTELLIGENCE AND HUMAN INTERACTION: HOW TO KEEP THE HUMAN IN THE LOOP			5. FUNDING NUMBERS	
6. AUTHOR(S) Ashley N. Gizas, Benjamin R. Hill, Megan Meisner, Dawn P. Patterson, and Nicole Wilson				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.			12b. DISTRIBUTION CODE A	
13. ABSTRACT (maximum 200 words) Army leaders are looking to procure and implement artificial intelligence (AI) technologies to solve a variety of problems and enhance existing capabilities across multiple portfolios. While there are benefits to implementing new technologies, including AI, there is often a major pitfall: the human factor as a user is consistently underrepresented. This disparity between how AI-enabled systems are being acquired and how they should be acquired is often related to a gap in the development of systems not aligning with Human Systems Integration (HSI) best practices. The design of systems that facilitate human-agent learning requires further guidance. We use data from the System for Award Management (SAM) along with discussions from subject-matter experts both in government and industry to capture how AI-enabled systems are currently being procured by the Army. The combined results of the team's methodology revealed that there are varying understandings across the Army of what an AI requirement is, and there are no obvious processes or specific AI acquisition guidelines that are universally followed when developing an AI requirement. It was also apparent that HSI was not always included in requirements as required by Army regulations. This disparity appeared to have three major root causes: immaturity of DOD Army guidance, shortcomings in AI-related training for acquisition personnel, and a negligence surrounding the incorporation of HSI elements into Army requirements.				
14. SUBJECT TERMS artificial intelligence, machine learning, human systems integration			15. NUMBER OF PAGES 87	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UU	

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release. Distribution is unlimited.

**ARTIFICIAL INTELLIGENCE AND HUMAN INTERACTION:
HOW TO KEEP THE HUMAN IN THE LOOP**

Ashley N. Gizas, Benjamin R. Hill, Megan Meisner,
Dawn P. Patterson, and Nicole Wilson

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS ENGINEERING MANAGEMENT

from the

**NAVAL POSTGRADUATE SCHOOL
September 2022**

Lead Editor: Ashley N. Gizas

Reviewed by:
Paul T. Beery
Advisor

Matthew C. Nicholson
Co-Advisor

Rob Semmens
Second Reader

Accepted by:
Oleg A. Yakimenko
Chair, Department of Systems Engineering

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

Army leaders are looking to procure and implement artificial intelligence (AI) technologies to solve a variety of problems and enhance existing capabilities across multiple portfolios. While there are benefits to implementing new technologies, including AI, there is often a major pitfall: the human factor as a user is consistently underrepresented. This disparity between how AI-enabled systems are being acquired and how they should be acquired is often related to a gap in the development of systems not aligning with Human Systems Integration (HSI) best practices. The design of systems that facilitate human-agent learning requires further guidance. We use data from the System for Award Management (SAM) along with discussions from subject-matter experts both in government and industry to capture how AI-enabled systems are currently being procured by the Army. The combined results of the team's methodology revealed that there are varying understandings across the Army of what an AI requirement is, and there are no obvious processes or specific AI acquisition guidelines that are universally followed when developing an AI requirement. It was also apparent that HSI was not always included in requirements as required by Army regulations. This disparity appeared to have three major root causes: immaturity of DOD Army guidance, shortcomings in AI-related training for acquisition personnel, and a negligence surrounding the incorporation of HSI elements into Army requirements.

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Contents

1	Introduction	1
1.1	Background	1
1.2	Purpose	4
1.3	Research Questions	6
1.4	Organization of Thesis	6
2	Literary Review	7
2.1	Artificial Intelligence: Terms, Definitions, and Examples	7
2.2	Human Systems Integration	13
2.3	Human-AI Teaming	14
3	Method	19
3.1	Methodology	19
3.2	Limitations.	24
4	Results	27
4.1	Results Introduction	27
4.2	Army Solicitation Revelations	27
4.3	What SMEs Had to Say.	33
5	Conclusions and Recommendations	39
5.1	Discussion	39
5.2	Conclusions	42
5.3	Recommendations for Future Research.	44
	Appendices:	47
A	SAM Evaluation Form	49

B Interview Questions	53
C SAM Contract Opportunities Definitions	57
List of References	61
Initial Distribution List	65

List of Figures

Figure 1.1	Timeline of DOD AI Strategy and Policy	1
Figure 1.2	Three Basic Types of AI	2
Figure 2.1	Scale of Human-Machine Automation	11
Figure 3.1	Final SAM Search Parameters	21
Figure 3.2	Key Words and Concepts Shown Here Were Included in the Evaluation Form	22
Figure 3.3	Sample Interview Questions	23
Figure 4.1	Army Opportunities by Category	28
Figure 4.2	Breakdown of Posting with Sufficient Data to Perform an Evaluation of Requirements	29
Figure 4.3	SAM Postings Evaluated to Contain AI by Year	31
Figure 4.4	SAM Postings Containing HSI	31
Figure 4.5	SAM Postings Containing AI Evaluation for HSI Incorporation by Year	32
Figure 4.6	Workforce Roles Mapped to the AI Stack	36

THIS PAGE INTENTIONALLY LEFT BLANK

List of Tables

Table 2.1	HSI Considerations for Human-AI Teams: Traditional and Newilities Needs	15
Table 2.2	Guidelines for AI-enabled Systems that Account for Human Factors	17
Table 4.1	Army Opportunities by Category	27
Table 4.2	Details from the 16 SAM Postings that were Evaluated	29
Table 4.3	Summary of Questions and Answers from SMEs	33

THIS PAGE INTENTIONALLY LEFT BLANK

List of Acronyms and Abbreviations

ACC	Army Contracting Command
AI	Artificial Intelligence
AI2C	Army's Artificial Intelligence Integration Center
ALT	Acquisition, Logistics, and Technology
AR	Army Regulation
BOA	Basic Ordering Agreement
C2	Command and Control
CE	Collaboration Event
CFR	Code of Federal Regulations
CFTs	Cross Functional Teams
COTS	Commercial-Off-the-Shelf
CSO	Commercial Solutions Openings
DA	Department of the Army
DAG	Defense Acquisition Guidebook
DOD	Department of Defense
EDA	Electronic Document Access
FAR	Federal Acquisition Regulation
FPS	Force Protection and Survivability
GPE	Governmentwide Point of Entry

H-A	Human Agent
HFE	Human Factors Engineering
HSI	Human Systems Integration
IA	Intelligent Agent
IDIQ	Indefinite Delivery Indefinite Quantity
JA	Justification and Approval
JAIC	Joint Artificial Intelligence Center
JCF	Joint Common Foundation
KO	Contracting Officer
ML	Machine Learning
MRR	Market Research Report
NASA	National Aeronautics and Space Administration
NASEM	National Academies of Sciences, Engineering, and Medicine
NDAA	National Defense Authorization Act
NPS	Naval Postgraduate School
OTA	Other Transactions Authority
RFI	Request for Information
RFP	Request for Proposal
SE	Systems Engineering
SAM	System for Award Management
SAT	Situation Awareness-based Transparency
SEBok	System Engineering Book of Knowledge

SMEs	Subject Matter Experts
SOH	Safety and Occupational Health
U.S.C	United States Code
USG	United States Government

THIS PAGE INTENTIONALLY LEFT BLANK

Executive Summary

To keep pace with the Department of Defense (DOD) Artificial Intelligence (AI) Strategy, the U.S. Army launched the Artificial Intelligence Integration Center (AI2C) in 2018. Their mission - to communicate with the AI community of companies and universities across the U.S. with the intent to improve and enhance Army capabilities with the integration of AI.

This capstone project analyzed, to the extent possible, the status of current Department of Army (DA) requirements for AI and their inclusion of Human Systems Integration (HSI). The team reviewed AI contract opportunities posted to the System for Award Management (SAM) website and applicable documentation to include Performance Work Statements, Statements of Work, or Statements of Objectives. The first step was to determine if the requirements contained within these contract opportunities met the definition of AI as a computer system having the ability to perform tasks that normally require human intelligence. If the requirement met this definition of AI, then the analysis proceeded and focused on the inclusion of HSI to ensure the human (i.e., operator, soldier, user, etc.) was provisioned for. The research team also interviewed Subject Matter Experts (SMEs) to gain insight into the Army's process to develop and acquire AI requirements.

Of the opportunities posted to SAM between 2003 and 2022, only 16% (40 out of 238) were far enough along in development to be considered for evaluation. Of the 40 considered mature enough in the acquisition development process to move forward, only 16 postings contained relevant documentation to be evaluated against the team's established AI and HSI criteria. From there, only six postings met the definition of AI. Four were liberally judged to include some reference to HSI or human factors. The team's combined evaluations determined that AI guidance in the Army is in its infancy and requires further development and refinement. Evaluations also highlighted that despite DOD and Army guidance to include HSI in all requirements, inclusion of HSI is still lacking.

This capstone project recommends that presented results and conclusions be used to further develop guidance for the procurement of AI requirements with particular focus on the inclusion of HSI. We also recommend that future research incorporate classified requirements as well as requirements managed by other transaction authority efforts via consortiums.

THIS PAGE INTENTIONALLY LEFT BLANK

Acknowledgments

Team DINOMite would like to thank our thesis advisors, Dr. Rob Semmens, Mr. Cody Nicholson, and Dr. Paul Beery, without whose guidance over the last several months we surely would have researched ourselves right off a cliff. Team DINOMite would further wish to thank our family and friends. We are so grateful for your love and support, and most of all your patience, as we spent time away to write our thesis rather than watch movies and go out for Mexican food.

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 1:

Introduction

1.1 Background

1.1.1 Background

The Army is procuring artificial intelligence (AI) technologies to solve a variety of problems and enhance existing capabilities across multiple portfolios to keep pace with competitors (Department of Defense [DOD] 2018). Further, the 2021 National Defense Authorization Act (NDAA) prioritizes AI and requires the National Artificial Intelligence Initiative Office to develop a strategic AI plan complete with goals, priorities, and metrics within two years. The purpose, per the NDAA, of developing this strategic plan is to provide guidance for agencies implementing AI initiatives and to establish evaluation criteria to measure how agencies are approaching the following areas: "AI research and development, long-term funding for interdisciplinary AI research," as well as research on "ethical, legal, environmental, safety, security, bias, and other issues related to AI." Figure 1.1 provides an illustration of the progression of AI doctrine within the DOD. Not pictured is the most recent DOD strategy, the Responsible AI Strategy and Implementation Plan, published in June 2022 in response to the May 2021 memo as shown in Figure 1.1.



Figure 1.1. Timeline of DOD AI Strategy and Policy. Source: DOD (2021).

1.1.2 Artificial Intelligence versus Machine Learning, and Why We Care About the Difference

The New Oxford American Dictionary (2022) defines Artificial Intelligence as a computer system having the ability to execute tasks that typically require human intelligence. The same source defines Machine Learning (ML) as computer systems that can learn and adapt using statistical models and algorithms to evaluate and make decisions based on data patterns. We highlight this distinction because the terms AI and ML are often erroneously used interchangeably. AI is expected to learn to think, almost like a human, with extraordinarily little input. Conversely, ML relies on algorithms to provide the best decision and does not interject any human-like decision making skills. AI can be divided into three categories. Narrow AI, which encompasses ML, refers to responding to preprogrammed algorithms (i.e., voice recognition on Amazon Alexa), and General AI refers to AI that is intended to independently think (i.e., learn and adapt) (Splunk 2020). Super Intelligence takes AI a step further and encompasses a machine that can think better than a human. For this project, our team will focus on Narrow AI as it pertains to the Army. Figure 1.2 illustrates the three basic types of AI (Splunk 2020).

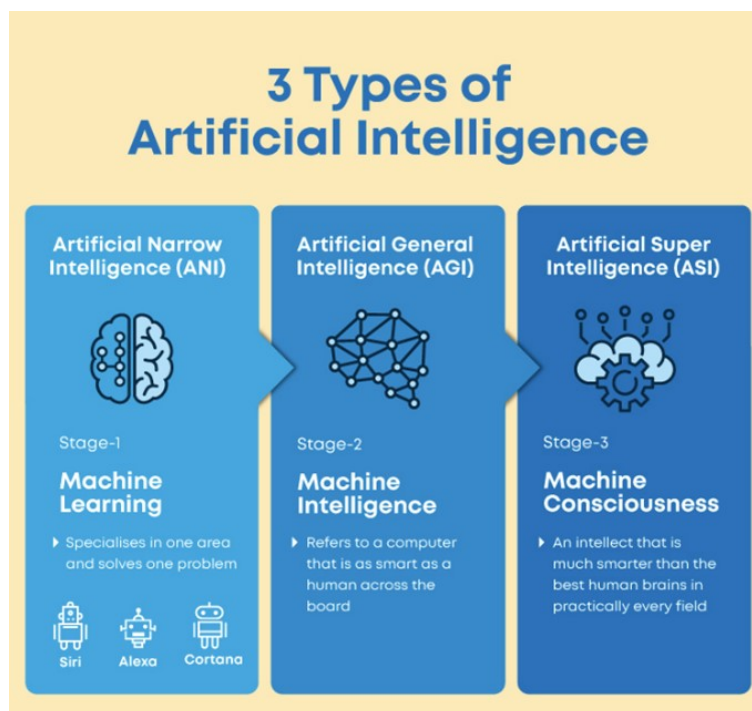


Figure 1.2. Three Basic Types of AI. Source: Splunk (2020).

While there are benefits to implementing AI, there is often a major pitfall: the human factor as a user is consistently underrepresented. The focus, rather, has been on technical elements of emergent systems, relegating human operators to either repetitive or reparative tasks. This view of the human element is insufficient for capitalizing on emergent technologies as it can result in physical or cognitive overloads, a lack of situational awareness, and errors resulting in lowered performance of the system (El Haouzi and Valette 2021). Underrepresenting the human factor is particularly alarming for Army systems, since system deficiencies and errors have greater potential to result in loss of life. Therefore understanding how to best team AI enabled systems with human operators and how these requirements are written into Army acquisition capabilities is essential.

1.1.3 Human Systems Integration

Human Systems Integration (HSI) is an integral element of AI procurement. HSI has long dealt with how humans interface with technology. The Defense Acquisition Guidebook (DAG) states that “HSI is more than human factors, human-computer interaction, or systems engineering. It is a technical and managerial set of processes that involves the consideration and integration of multiple domains” (Schwartz and Hadley 2021, special search “Human Systems Integration”). The Army’s HSI program “has been identified as one of the most promising programs ever developed by the military for providing effective human systems performance” (Booher and Minninger 2003, 663). Despite this, programs struggle to incorporate HSI principles into the program because program managers do not always see the benefit of HSI principles (Booher and Minninger 2003).

According to Higgins, “Military technology, in any form, has at least one major requirement: it has to be usable by Soldiers” (2017, para. 1). This means that the system must be designed with the soldier in mind (i.e., human systems integration). The HSI domains that should be incorporated with the soldier in mind are Human Factors Engineering (HFE), Manpower, Personnel, Training, Safety and Occupational Health (SOH), Habitability, and Force Protection and Survivability (FPS) as identified in DOD Instruction 5000.95 (2022). But how do we design a system with the soldier in mind, when the system is engineered to evolve over time on its own? As technology changes the designer must ensure the skills and capabilities of the soldier are adequate to operate and interface with the system. However, this has traditionally been applied to systems with relatively static capabilities.

As previously mentioned, an AI-enabled system's capabilities are expected to change over time. Therefore, as AI technology advances and is integrated into systems, designers and acquisition stakeholders must consider how the principles of HSI should be written into the requirements for a system that changes.

1.1.4 AI and the Army

A generation brought up on films like War Games, Alien, The Matrix, and iRobot provides a stark view of AI: any integration of AI into military applications is sealing our fate as a doomed and enslaved human race. When asked what misconceptions there were surrounding AI in the Army acquisition community, a subject matter expert (SME) our team spoke with at the Army's Artificial Intelligence Integration Center (AI2C) commented that the general perception is that their organization is, "working on the Terminator." Rather, the AI2C engages universities and companies across the United States through mechanisms such as broad agency announcements (BAAs) to gather information and conduct research on AI capabilities for potential Army programs. BAAs are used in the early planning stages of a potential program for research purposes to provide the government with an understanding of possible future technical challenges (AcqNotes 2022).

The Army's AI2C has taken an in-depth look at how the Army has utilized AI. The center has developed ten AI modernization portfolios that work across Army Futures Command's cross-functional teams (CFTs). These CFTs include Long-Range Precision Fires, Next-Generation Combat Vehicles, Future Vertical Lift, The Network, Air and Missile Defense, and Soldier Lethality. Capabilities-based assessments were recently conducted with all CFTs to identify capability gaps and develop a BAA that is open until 2026. The BAA is intended to attract research and proofs of concept from industry and academia to help the Army solve some of their toughest problems in the following areas: autonomous platforms; AI/ML algorithms; AI-based decision making; human-machine interfaces; data visualization and synthetic environments; assured position, navigation and timing; sensing; communications and networks; internet of things; human performance; and underpinning methodologies (Cruz 2022).

1.2 Purpose

The purpose of this study is to investigate current Army AI acquisition initiatives and determine what considerations for the human role are being written into the requirements. The Federal Acquisition Regulation (FAR) serves as the guiding regulation for all Federal Executive Agencies in acquisition and therefore plays a major role in what extent human considerations are incorporated into requirements. First drafted April 1, 1984, the FAR contains the acquisition laws by which the Administrator of General Services, the Secretary of Defense, and the Administrator for the National Aeronautics and Space Administration (NASA) must abide. Moreover, the FAR provides the policy guidance of the Administrator, Office of Management and Budget (AcqNotes 2021b.)

The FAR dictates to the DOD the appropriate way to disseminate contract opportunities. FAR Part 5, entitled “Publicizing Contract Actions” states that a contracting officer must post opportunities to the Government-wide Point of Entry (GPE) which is the System of Award Management (SAM) which is accessed via the internet at <https://www.sam.gov>.

This paper will analyze AI contract opportunities posted on the SAM website to determine if the requirements are truly for AI, and if so, what human factors have been written into these requirements. This analysis is important because as an AI system’s capabilities learn and evolve, it stands to reason that so must the human counterpart adapt alongside it. If so, then requirements that were suitable in the past may become obsolete in the future if they do not correctly account for the human in that process. This paper will also provide insights from interviews with AI SMEs in Government and Industry about the status and outlook of AI in acquisitions.

Finally, this paper will provide general recommendations for including human factors in AI requirements. In doing so, the research team is aiming to protect the Army’s investment in these technologies and preserve its enduring missions. This research will help establish better support for the warfighter by recommending appropriate writing of HSI requirements into AI initiatives. Identifying existing capability gaps and gathering research on potential AI capabilities to fill those gaps is undoubtedly important to the Army and its future missions. Equally as important to consider however, is the one element that will ensure these capabilities endure: the human.

1.3 Research Questions

To assist the Army in successfully implementing AI capabilities, this thesis will address the following questions:

1. Primary Research Question
 - What human user requirements and/or considerations are being written into Army acquisitions?
2. Secondary Research Questions
 - What training/resources exist today to educate Army stakeholders on how to write requirements for AI capabilities with the human in mind?
 - What recommendations would help the Army properly account for the human in AI acquisitions?

1.4 Organization of Thesis

Chapter I provides the background on the nature of the problem, establishes definitions for core concepts, and outlines the general scope of this study with a high-level overview of methodology. Chapter II contains the literature review. Chapter III will provide the methodology used to gather and analyze the data. Chapter IV will provide the results and highlight key discoveries from that analysis. Chapter V will present the team's conclusions on those findings and provide corresponding recommendations.

CHAPTER 2: Literary Review

The following chapter defines and lists the terms, definitions, and guidelines that apply to AI and Human Systems Integration (HSI) requirements. Defining these terms will allow us to create criteria to evaluate Army Acquisition contracts to determine if the community has adequately considered such requirements. Our primary assumption about any reader of this research centers on their preliminary understanding of AI and practitioner level of understanding of HSI within the context of Systems Engineering and Program Management practices. Therefore, selection of the necessary AI background within this literature review is of greater concern. Once a tailored understanding of AI is complete, this literature review further defines the necessary HSI domains and considerations with respect to the guidelines for a consistent research method.

2.1 Artificial Intelligence: Terms, Definitions, and Examples

AI enables machines to function in a manner that replicates human intelligence by using algorithms to manipulate data, utilize knowledge, and calculate functions to evaluate and provide a solution within an environment (Nagy 2022). AI is substantially different from conventional computer technologies in numerous ways. These differences include making decisions based on context rather than direct input of data and enabling machines to think, learn, and respond on their own (Fossaceca and Young 2018). Conventional computing, meanwhile, utilizes programmed rules and calculations to function in a preordained way, making it unable to contextualize the variability of the real world. Another difference is that while in conventional programming the programmer is informing the computer how to solve the problem, AI utilizes Machine Learning (ML) to teach the computer to figure out how to solve the problem on its own. ML is a technology that allows AI to utilize algorithms to learn and change without human user inputs (Nagy 2022). Algorithms are rules based on user-supplied training data that AI-enabled machines perform. These rules include various tasks like data recognition, object assessment, and numeric forecast to solve problems defined by the human user (Nagy 2022).

The implications of AI solving problems have practical applications within the Department of Defense (DOD) Acquisition System. By integrating AI-enabled systems into DOD Acquisition Systems, response times will be decreased as the human operator's ability is contextualized with the AI algorithms. By organizing, displaying, and adding context for the human operator, a well-designed AI algorithm can reduce their workload. The examples below from proposed and currently fielded systems further highlight the importance and impacts of AI-enabled systems for the future development of weapon systems. However, the evolution of Human System Integration (HSI) requirements with AI-enabled systems remains elusive within the researched literature.

Research into the application of AI-enabled weapons systems, the types of data required for training, and the typical users of these systems provides greater context about present and future applications. AI utilization could apply criteria for faster decision-time response within the Navy's decision kill chain functions (Burns et al. 2021). AI assisted execution of the kill chain functions can be performed in a way that reduces the burdens of operators and prepares the Sailor for future peer-to-peer conflicts (Burns et al. 2021). Given the complexity of modern weapons systems and the necessity for greater data loads, pure human-in-the-loop kill chains may present difficulties by increasing reaction time and possibly producing a human error that has less than positive outcomes (Burns et al. 2021). With the need for faster response time, the human user's interaction within the AI-enabled system remains necessary. This necessity is a common theme throughout the research as the demand for quality data increases.

As systems become capable of receiving increasing rates of input, there is a greater demand for AI systems that are capable of categorizing targets while operating in a hostile threat environment. Within this hostile environment, a human operator requires assistance from AI systems that help with the "aggregation of many data sources and the continuous analysis of contact movement and intent" (Burns et al. 2021, 6). The authors highlight the three "Vs" of any AI system requirements as volume, velocity, and variety (Burns et al. 2021). Where volume describes the magnitude of data available, the definitions of velocity and variety may differ based on the sourcing of the data. These three requirements suggest a means to describe the types of interactions between human users and AI systems. Further, the requirements also hint at a means of scoring AI-enabled system design and prototypes. Finally, the authors suggest that human and AI teaming could lead to a greater synergy of

effort that will increase both situational awareness and decision-making efforts (Burns et al. 2021). The idea of synergy between humans and AI systems suggests a means of teaming that could lead to greater effects when fielding future weapons systems.

When considering the fielding of AI-enabled weapon systems, Carlo Munoz (2021a) from Jane's International Defense Review highlights AI "enabled end-user platforms" may be used to "update and enhance" other AI-enabled platforms by collection of battlefield data "in real time" (1). The power of AI is contingent upon the designers' and users' ability to collect verified and validated data to improve the abilities of AI-enabled platforms (Munoz 2021a). The design of such platforms starts by defining the necessary algorithms based on mission parameters and available data. Munoz (2021a) includes one useful example of AI-enabled tools and the associated algorithms as "predictive analysis of collected data to narrow down a list of potential options or outcomes for a combat commander" (1). While this example is vague, the cycle of data recognition, assessment, and forecasting remains constant. Furthermore, the AI is providing a human user, a commander, with a tangible deliverable for consideration within a battlespace. The ability of the AI system to accomplish what the commander needs for rapid decision making begins with training the AI based on a data set.

When training the AI-enabled system, Munoz (2021a) further explains that "one important step in moving algorithm training and development down to the tactical level is the eventual shift from hosting AI technologies on a cloud-based network or an actual physical server, to having those technologies housed within an actual end-user device" (1). The application of such delegation highlights additional requirements on hardware and local networking of AI-enabled systems. By delegating to the lower echelons, the AI-enabled system benefits from data collected at the tactical source. These local collections of relevant, end-user data on these AI-enabled devices allows for local, tactical exploitation if the system is readily understood by the user (Munoz 2021a). Thus, the typical user of an AI-enabled system could range from a theater commander to a tactical soldier. With a more decentralized emphasis of data collection at the tactical level, the challenge for AI-enabled systems will focus on how to process and filter raw data collection (Munoz 2021a). Again, the challenge remains how to verify and validate the data collected in such a manner that allows for greater volume, velocity, and variety. Munoz (2021a) reflects that unfortunately "there is no way for both military and civilian AI technology developers to keep pace with the massive

amounts of data collected and compiled by the Department of Defense and US intelligence agencies” (4). Along with the user, the developer of AI-enabled system also must contend with the challenges of how to process large amounts of data that may vary over time. When considering the human factors and interface touch points, the emphasis remains how the user can conduct data management and arrangements that provides an AI-enabled system with relevant data to train with and eventually exploit for tactical advantage (Munoz 2021a).

Beyond processing large amounts of variable data over time, fielding AI-enabled systems must also provide the necessary command and control (C2). One AI impact for military planners to consider, according to Edwards (2021) in “C4ISR Mission Systems: Air”, is that once the C2 of a given theater is fully AI integrated, the requirement for staffing could “mean one or two staff performing a task that previously took 10” (3). C2 operations require networking of sensors, maneuvering elements, and command in a dynamic manner that takes advantages of the ebbs and flows of modern warfare. With the present constellation of C2 communication nodes, the question remains how to integrate AI modernization efforts with legacy systems. Based on the research to this point, complete and accurate data along with training for the human operator are necessary to incorporate when drafting AI-enabled system requirements.

Munoz’s (2021b) other referenced article titled “JAIC [Joint Artificial Intelligence Center] Looks to Link AI Development Platforms Across Pentagon, Services”, explains the efforts to date in creating a unified system of systems that connects AI with existing platforms. A unified system of systems is the common approach within the DOD to integrate legacy fielded systems with modern AI systems. The impacts of AI as a feature of most future weapons systems remains the focus and mission of the JAIC. JAIC’s emphasis is to create an AI development platform called the Joint Common Foundation (JCF) (Munoz 2021b). The JCF intends to leverage its cloud networks and provide access to the curated training data necessary to develop and test AI-based applications. Delegating data retrieval and utilization by local AI-enabled systems remains an industry goal for the future. This goal suggests a more decentralized approach versus cloud control of data.

Munoz (2021b) explains the JCF intends to rectify one of the largest barriers the Pentagon faces in implementing AI-enabled technologies by addressing the collection, aggregation, and management of data for future requirements. Data management, from the JAIC point

of view, is the next AI requirement to add to the discussion of requirements like the three V's, algorithms, and data training. One such application of data management in weapons development of legacy systems is the Iron Dome air-defense system by Rafael Advanced Defense Systems. The Iron Dome Surface to Air Missile System includes the necessary radar networks, C2 network nodes, and Tamir missile interceptor effectors. Any AI-enabled system would be required to interact with all these subsystems, pulling and relegating data as required. These subsystems are likely to be operated by personnel of varying technical abilities, but all abilities must be accounted for in the design of an AI-enabled system. Figure 2.1 displays the varying levels of human-automation interaction, depicting the use of these elements as a tool through those fields which may use AI-enabled systems in a human-machine partnership capacity (Matthew Nicholson and Michael O'Neil, personal communication, 2022).

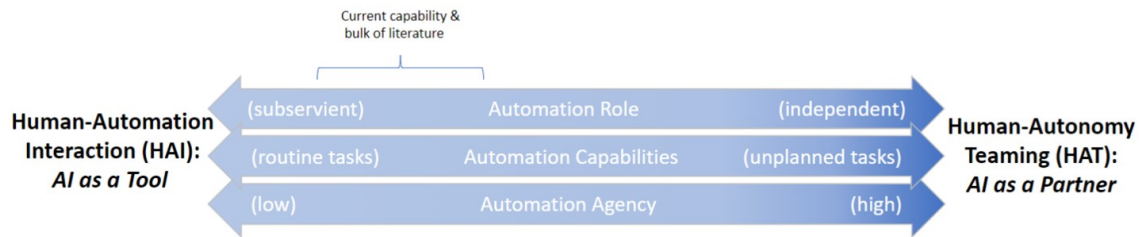


Figure 2.1. Scale of Human-Machine Automation. Source: Nicholson and O'Neil (2022).

According to Lappin (2020), the Iron Dome's AI-enabled C2 battle management system consolidates collected data that allows the AI system to adapt the Tamir intercept algorithms in order "to deal with increasing greater hostile projectile barrages" (1). The AI-enabled system allows the Iron Dome to identify the launch of ground-to-ground threat using networked sensors from across the battlespace and predict the likely impacts sites for the airborne threat (Lappin 2020). The prediction algorithms fuel the sensor fusion of the C2 battle management system and the continual data update of the incoming threat. Testing the AI's prediction ability is critical before any engagement. Therefore, the AI system training centers on historical and simulated data to further hone and refine intercept solutions. The availability of historical battlefield data is one challenge the JCF is meeting to provide AI

developers with the necessary data to train AI systems within a C2 battle management system. With every successful intercept by the Iron Dome, the demand for AI-enabled C2 systems will continue.

Modernization operations with deployed systems will continue to utilize fewer personnel and demand faster response times to counter weapons systems that are ever more capable. Therefore, Lappin (2020) highlights this balance by developing AI systems that prioritize task allocation decisions with fewer human operators. With fewer human operators, the centralization of human decision-making to a single commander could become more common. Therefore, another AI system requirement to consider is how to leverage the benefits of AI when human operators or commanders are becoming task saturated. The AI system could use facial or voice queues from the operator or commander to determine the likelihood of task saturation. With these queues, Lappin (2020) states it is possible for the AI to delegate down the command echelon to update battlefield units in order to maintain adequate theater command and control. The ability of AI systems to delegate C2 and interface with human operators requires machine-operator team communication that involves training the AI and generating awareness for the human operator.

Given the future environments in which AI and human operators will operate, the mission goals set by the operator at any operational echelon must start with communicating in a way that is compatible with AI systems. One challenge Goldfarb and Lindsay (2021) identified for successful communication between AI and humans was identifying verified data with the human providing clear judgement on the validity of the data for military operations. Human-player understanding begins with an understanding of how AI utilizes ML. The widest application of ML stems from its ability to communicate within a given AI-enabled system in order to improve statistical forecasting that allows for greater opportunities for human operator decision making (Goldfarb and Lindsay 2021). Based on the current literature, ML is the means for AI to adapt, operate, and communicate within a defined system. The impact of AI-enabled systems utilizing ML applications allows greater evolution in data forecasting and presentation for the human operator to make decisions. Goldfarb and Lindsay (2021) state the importance of AI utilizing ML shifts the battlefield paradigm from emphasizing “metal on target” to “data and judgement” (9). Furthermore, the authors categorize judgement as “command intentions, rules of engagement, administrative management, and moral leadership” (9). These categories of judgement are non-deterministic attributes

meant to describe possible AI system requirements for future weapon systems. However, Goldfarb and Lindsay (2021) concede on the deterministic nature of ML as too narrow to meet these categories fully. Therefore, AI-enabled systems advancements must also take advantage of other means to adapt, operate, and communicate with human operators.

One aspect of AI systems that utilize ML is the predictability and reproducibility of outcomes based on previously collected data sets; however, human operators utilizing data and environmental queues are anything but predictable and reproducible. Therefore, AI system designers must account for human errors in decision-making. Pita et al. (2010) suggests a means to start the conversation on predicting how AI systems and human operators may interact in a manner that allows AI systems to game with the human user. Games are a means of setting established rules and running simulations until one side wins. One game example used by the authors is the Stackelberg games. Pita et al. (2021) describes the utility of such games as a means for the AI system to account for human operators or adversaries not cooperating or operating in an optimal fashion. The AI algorithm thus assumes the human operator is acting in a fashion that may not be based on discrete rules. Pita et al. (2021) highlight that “human adversaries’ decisions are biased due to their bounded rationality and limited observations” (1). This observation provides a transition point between the logic of AI systems and elements of HSI within the system.

2.2 Human Systems Integration

Army Regulation (AR) 602-2, HSI in the System Acquisition Process, states, “the Army’s HSI Program focuses on the integration of human considerations into the system acquisition process to enhance Soldier-system design, reduce life cycle ownership cost, improve safety and survivability, and optimize total system performance” (Department of the Army [DA] 2022, 1). The Assistant Secretary of the Army (Acquisition, Logistics, and Technology) gives the responsibility to “ensure the application of HSI practices are considered throughout the system design and development processes for acquisition systems” (DA 2022, 1). This involves making sure budgets include HSI funds and HSI-related training throughout the acquisition life cycle. Specifications must describe how the system is to operate for the user in the operational environment, how the human influences performance parameters, and how those requirements will be verified (DAA 2022). Specifications will also “clearly

identify any HSI objectives and thresholds identified in the capability development document" (DA 2022,11). Per DODI 5000.95, HSI in Defense Acquisition, the incorporation of HSI in Army programs is clearly required (Department of Defense 2022).

2.3 Human-AI Teaming

The report titled, Human-AI Teaming: State of the Art and Research Needs, recognizes the idea that the human operator and AI must form a team (National Academies of Sciences, Engineering, and Medicine [NASEM] 2021). This report considers the many facets of interaction between the human operator and the AI system to include teaming methods, processes and effectiveness, interactions, trust levels, and training requirements. Issues and concerns that human operators historically experienced during the advent of automation will continue to be the same issues and concerns as human operators perform their duties alongside AI systems. Operators with little understanding of how their autonomous systems perform often lead to confusion due to erroneous expectations of system behavior. As the system performs most of the effort, human operators may find their attention waning, leading to performance errors. This lack of situational awareness, along with out-of-the-loop performance degradation, can cause delays in the ability of operators to identify system errors. Operators who do not utilize their skill sets may find that their abilities degrade over time. Remedies for these expected problems are only possible by ensuring that AI-enabled systems incorporate the capabilities of human operators (NASEM 2021).

The NASEM (2021) researchers identify the need to incorporate human-machine interaction and teaming arrangements into system requirements. One of the gaps related to HSI and human-AI teams identified was “the development of AI systems often does not follow HSI best practices” (NASEM 2021, 70). This lack of incorporation could be attributed to AI systems being acquired as research and development projects rather than proceeding through the normal acquisition process. In an effort to ensure AI system requirements packages appropriately account for human interfaces, three traditional and two AI-specific “-ilities” were captured. These “-ilities” are identified and defined in Table 2.1.

Table 2.1. HSI Considerations for Human-AI Teams: Traditional and New-
ilities Needs. Adapted from NASEM (2021).

-Ility - Traditional	Adaption Need
Usability	· Transparent AI operational limitations and competency boundaries. · Conduct sensitivity analyses to explore a decision space and limitations. · The user needs to provide routine feedback about usability.
Operational Suitability	· Incorporate process for tracking and documenting issues with concept drift as well as operator disuse, misuse, or abuse of AI. · Implement process that maps operational dependencies created in the implementation of AI systems to determine which negative effects occur downstream if an AI system is degraded or fails.
Sustainability	· Establish process for identifying changes in operations or environmental conditions that affect model outcomes, including when retraining should occur for ML-based AI systems. · Create incident repository and routinely analyze for all AI systems, in which users and supervisors can document erroneous, unusual, and unexpected system behaviors. · Incorporate process for tracking software changes and possible unintended impacts on operations and/or human activity.
-Ility - New	
Auditability	· Periodically audit data and resulting models to uncover issues with suitability, sustainability, and bias. · Humans need automated tools to support auditing of tasks.

Continuation of Table 4.3	
Passive Vulnerability	· Identify and mitigate adversarial machine-learning vulnerabilities.
End of Table	

Old HSI considerations for traditional weapons systems within the DOD establish a baseline for AI-enabled systems. Within the HSI literature, different terms apply to the elements of an AI system. One primary change in terms is describing AI systems, specifically autonomous robots, as agents. Further, an agent does not necessarily need to be physically shaped like a robot that is able to navigate, proportionate, and deliberate within a physical environment. Leaving the physicality to the human operator, the AI agent teaming requirements highlight further elements to consider. Human-agent teaming with an AI-enabled robot suggests a level of trust that must be emphasized and further discussed based on the advantages and disadvantages of teaming (Chen and Barnes 2014). While the agent may have clearly defined performance requirements, the human operator's variation in performance abilities necessitates further study. Chen and Barnes (2014) focus on human performance factors to include their spatial abilities, attention to detail, and technological experience. A human operator's spatial abilities define notional methods the human may use to interface with the agent team member in a predictable manner. Furthermore, both attention to detail and relevant experience with interacting with technology are important considerations when measuring human performance attributes for teaming. Chen and Barnes (2014) emphasize the necessity of human-agent teaming guidelines to account for human variations in ability, support multitasking in stressful situations, and provide proper interface visualizations that allow for human decision authority. These guidelines are necessary context for requirements that allow for greater operator trust in the agent and the flexibility to remain current in an ever-changing technologic battlespace. Teaming remains the constant theme for requirements.

The design of systems that facilitate human-agent teaming requires further guidance. Guidance for designers of AI systems for adequate human-agent teaming starts with an academically founded and validated formal setup of principles. Amershi et al.(2019) provides a formal set of 18 guidelines for human-AI interactions based on 150 AI-related design recommendations collected from academic and commercial literature. Among the proposed 18 guidelines, there are several with direct application to requirements evaluation of AI

systems with human factors adequately addressed. These specific guidelines are listed in Table 2.2 with the definition of the guideline and associated application in a weapon system.

Table 2.2. Guidelines for AI-enabled Systems That Account for Human Factors. Adapted from Amershi et al (2019).

AI Guideline	HSI Application
Clearly define what the system can do and how that systems accomplishes the task.	The system provides the necessary usability for interaction with a human user
Show relevant data in a timely fashion that reduces user biases.	The system is suitable for the task a human user is required to complete.
· Allow ease of operator use and filter outputs in a manner that is relevant to user intent.	The system is sustainable based on the user's constantly changing environment and scenario.
Learn from user behavior and provide feedback on user consequences.	The user and the AI system can audit behavior based on training data.
Allow user customization and notify the user of capabilities that will be impacted.	Account for the AI systems vulnerability to system threats and mismatch to established system algorithms.
End of Table	

These commercially developed guidelines provide a foundation and basis for the Army's evaluation of human factors requirements for an AI system. The application of these guidelines places emphasis on human centric AI systems early in the design phase of a project. One further utility of these guidelines is measuring the presence, or absence, of human factors in contract proposals. For Chapter III, the methodology of evaluating contract proposals and solicitation starts with understanding how to identify an AI-system, determining if there are any HSI requirements, and evaluating if these HSI requirements are valid and complete.

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 3:

Method

3.1 Methodology

Evaluation of Human Systems Integration (HSI) factors in Army Artificial Intelligence (AI) requirements took two major forms: interviews with knowledgeable personnel in the government and industry and a review of Army contract opportunities posted in the System for Award Management (SAM). SAM is an official U.S. government site which combines eight federal procurement systems into one (AcqNotes 2020). One of these federal procurement systems was Federal Business Opportunities (FedBizOpps) or FBO.gov, now known as Contract Opportunities under SAM. SAM was chosen as the opportunity database to search for and evaluate Army AI requirements because it is required by the Federal Acquisition Regulation (FAR) for contracting officers to publicize contract actions using this government wide point of entry (GPE) (FAR Part 5, 2022).

The interviews informed our understanding of the Army stakeholders, their AI requirements and how they approach AI acquisitions. During the interviews, a particular emphasis was placed on discovering what training, policies, or practices were taking place to incorporate HSI principles. The contract opportunities in SAM provided the data necessary to analyze direct requirements. After analyzing the SAM data, evaluations were completed to determine if HSI principles were considered in the development and procurement of AI.

On 4 June 2022, we accessed the SAM database to ascertain the breadth and scope of AI requirements posted. The initial assessment of the database determined that 4,348,610 active and inactive contract opportunities existed. This initial assessment identified the volume and history of contract opportunities with the oldest contract posting dated May 12, 2000. It also demonstrated the wide variety of opportunities posted, from the need for a Protestant Choir Director, an Inspection of Elevators, to a Machine Learning Collaboration Event (CE) Related Notice that would be more in line with the team's topic of research.

As a wide variety of opportunities are presented in the SAM database, it was important to define the criteria in the search to view only those posting which might hold some relevance to the research.

The first step was to narrow the postings down from the broad range of federal agencies to understand the volume of postings applicable to the DOD. This was accomplished by entering 097 – DEPT OF DEFENSE as the federal organization, which narrowed the postings to 3,072,489. The search was refined further by inputting 2100 – DEPT OF THE ARMY as the federal organization for which 570,348 postings were attributable. Of the 4.35 million opportunities in the database, the DOD accounted for 70.65%. Furthermore, of the 3.07 million posted DOD opportunities, the Army requirements accounted for 18.57%.

The keywords “Artificial Intelligence” were added to the search, and “exact phrase” was selected to further narrow the opportunities based upon our main topic. As explained in Chapter I, AI in its purest form is the focus of the research. Therefore, the keyword search was limited to “artificial intelligence” alone and excluded “machine learning” to ensure that the opportunities extracted for analysis were intent on development of an AI capability that has the potential to replace the human in the loop and exclude, to the extent possible, requirements merely for development of a database and/or algorithm to support machine learning. Exact phrase was selected so that the search was inclusive of the full phrase of artificial intelligence and excluded postings that contained only artificial or intelligence. Both “Active” and “Inactive” were selected to ensure that a history of all related postings were captured, regardless of whether or not requirements materialized from presolicitation efforts. Actions are inactivated based on a time-frame designated by the Contracting Officer (KO) in accordance with applicable, existing policy guidance. The remaining drop-down criteria (such as place of performance or set aside) were not designated as they were not required to capture the scope of posted requirements. A screenshot of the search parameters can be found in Figure 3.1. The search resulted in 981 total postings. From these results, 679 were DOD, and 238 belonged to the Army. Out of the initial 4.35 million SAM postings, we were able to determine that 0.02% of posted opportunities contain the phrase “Artificial Intelligence.” The DOD accounts for 69.22% of the AI postings and 35.05% belong specifically to the Army.

The screenshot displays the 'Select Domain Contract Opportunities' search interface. It includes a 'Filter By' section with a 'Keyword Search' area. Under 'Keyword Search', there are three radio button options: 'Any Words', 'All Words', and 'Exact Phrase' (which is selected). Below these is a text input field containing 'e.g. W51QVH-17-R-008' and a tag labeled 'artificial intelligence'. The 'Federal Organizations' section has a dropdown menu showing '2106 - DEPT OF THE ARMY'. The 'Dates' section includes 'Response/Date Offers Due' and 'Updated Date', both set to 'Anytime'. Below these are several expandable filter categories: 'Notice Type', 'Product or Service Information', 'Set Aside', 'Place of Performance', 'Contract Awarded', and 'Status'. At the bottom, there are checkboxes for 'Active' and 'Inactive' status, and a 'Reset' button.

Figure 3.1. Final SAM Search Parameters

To review Army requirements in the form of a contractual document, Performance Work Statement, Statement of Work (or Statement of Objective), Award Notice, Solicitation, Combined Synopsis, and Justification and Approval (JA) opportunity types were accessed in SAM and all available documents downloaded for each posting. Definitions of these opportunity postings may be found in Appendix C. Awarded contracts, posted in SAM as ‘Award Notices’, and associated attachments were downloaded from the Electronic Document Access (EDA) web portal if not available in SAM. EDA is an online tool that allows authorized DOD users access to contracts and any existing contract modifications (AcqNotes, 2021a). To streamline and standardize the analysis of the contract opportunities, an evaluation form was developed (see Appendix A). This form captured items like the

contract/solicitation identification number and date the contract/solicitation was initiated. It also provided the definition of AI as well as references to HSI domains and human factors as shown in Figure 3.2. These references, while broad, were intended to cast a wide net as the team performed their evaluations to ensure all possible HSI principles were captured.

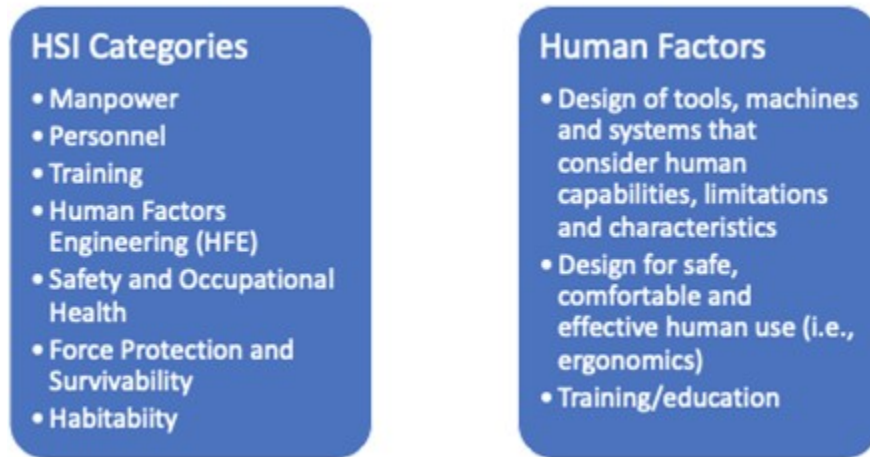


Figure 3.2. Key words and concepts shown here were included in the evaluation form

The form first asked the evaluator to identify if the opportunity was applicable to this project. If the answer was yes, the evaluator was then asked to identify if the opportunity referenced “human.” Human references could include words like manned, user, soldier, warfighter, operator, and other similar human descriptors. If the evaluator observed any reference of “human,” the associated human factors and/or HSI categories had to be described. This form served as a control method during the team’s individual opportunity evaluations. Team members were assigned specific opportunities to review and were required to use the form to record observations. The form ensured that each evaluation considered the same terms and definitions for AI and HSI requirements. Team members discussed the evaluation results to ensure there was agreement on how each opportunity was classified. Each evaluation was categorized to determine if it did or did not include AI requirements (yes or no), and then further observation was conducted to determine if HSI elements were captured in the written requirements package (yes or no). HSI requirements discovered during this process were not sorted into specific domains.

To better understand the current climate of Army AI acquisition, interview candidates were identified using findings from the literature review and personal connections within the research team.

The team was able to engage with three SMEs in Army AI acquisition for interviews. The first is a contracting officer at Army Contracting Command Rock Island (ACC RI) with eight years of experience in contracting and the last two years in AI acquisitions supporting the DOD's Joint Artificial Intelligence Center (JAIC) and the Army's Artificial Intelligence Integration Center (AI2C). The second SME is a government business director at AI2C who has been with the organization since its inception in 2018. This SME also has a law degree specializing in contracts and acquisition. The final SME is a software engineer with 12 years of experience in government contracting, as well as a master's degree from Georgia Tech in Computer Science with a specialization in Interactive Intelligence.

Questions were developed by the research team prior to each interview and took into consideration the background and expertise of each candidate. These questions were then reviewed by Naval Postgraduate School (NPS) personnel to ensure they were within the scope of the project, structured to help reveal critical insights and did not lead or bias responses as much as possible. Additionally, NPS personnel guided the team to ensure that the proposed interview questions encapsulated the project goals. Figure 3.3 provides examples of the interview questions. The complete list of interview questions may be found in Appendix B.

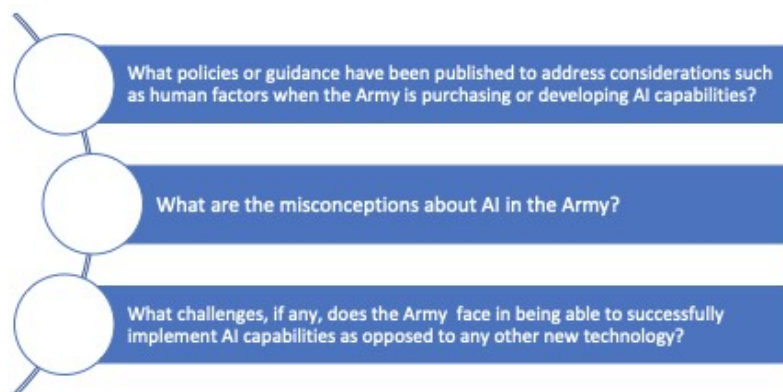


Figure 3.3. Sample Interview Questions

Interviewees were provided with the questions a minimum of five business days prior to their scheduled interview to ensure sufficient time was available to prepare complete answers since all interviewees had busy work schedules. Interviews were conducted with at least one NPS staff member present, along with as many team members available to attend. Each team member took notes during the meeting, which were subsequently compared for completeness. Furthermore, interviews were recorded in order to ensure accuracy. Copies of pertinent sections from Chapter IV were forwarded to interviewees in order to ensure that their statements were not misrepresented by the research team.

3.2 Limitations

Several limitations were identified throughout the course of the research project. Not all SAM postings contained relevant documentation in EDA, rendering these postings unavailable for complete review. While the team was able to review the base contract, any possible existing attachments were not posted to EDA by the Contracting Officer and therefore, were unable to be evaluated for HSI inclusion. Typically, a base contract includes administrative items such as FAR clauses, funding data, and Contract Line Item Numbers which provide a breakdown of the commodities being procured (labor hours for services, funding for travel, product quantities). Contract attachments are where one would find things like detailed written requirements such as Statements of Work (SOWs) or Performance Work Statements (PWSs). Not having access to detailed attachments rendered our evaluation of HSI requirements impossible.

The team further did not have access to review requirements packages for classified AI related projects. At least one of the Awarded contracts in the SAM database was for a classified project which would prevent the attachments from being loaded to the system by the Contracting Officer into EDA. These projects may or may not have included HSI requirements.

Lastly, some contract numbers were incorrectly entered into the SAM database. These contracts did not have the correct 12 digit number to align with a standard Government contract number. While the contract number posted to SAM was obviously incorrect, it was not possible to discern either what the extra digit was or what the missing digit might be. Further, some of these contracts which were incorrectly entered into SAM contained the

correct number of digits, but one or more of the digits input by the Contracting Officer were incorrect, making the contract unavailable for search in EDA. As such, neither these contracts nor their associated attachments were available for review.

The team further had a limited amount of time with each interviewee. Because of this, the team was not always able to elicit a response to every question. These time constraints challenged the depth at which information in interviews could be provided.

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 4: Results

4.1 Results Introduction

The primary research question for this project is to determine if the Army is addressing the “human factor” in written requirements when procuring and developing AI capabilities. Analysis of SAM opportunities revealed the following:

- Not all AI opportunities posted in SAM were truly considered AI by the definition established by this research team. For example, one SAM posting title was advertised as an AI requirement, while the detailed requirements documentation described a need for a commercial off the shelf (COTS) software capability.
- 57% of AI postings that met the definition of AI established by this research team included vague HSI references in written requirements.

Interviews with SMEs in AI contracting, program management, and industry show congruency with the team’s SAM opportunity analysis. The interviewees revealed disparities between how AI is understood, the way requirements are defined, and how acquisitions are approached.

4.2 Army Solicitation Revelations

Table 4.1 and Figure 4.1 provide a breakdown, by opportunity type, of the 238 Army postings remaining after the “artificial intelligence” filter was applied to the SAM search.

Table 4.1. Army Opportunities by Category

Posting Type	Quantity
Award Notice	16
Combined Synopsis/Solicitations	14
Fair Opportunity/Limited Sources Justification	1

Continuation of Table 4.3	
Justification	2
Presolicitation	24
Solicitation	8
Sources Sought	68
Special Notice	105
Total Postings	238
End of Table	

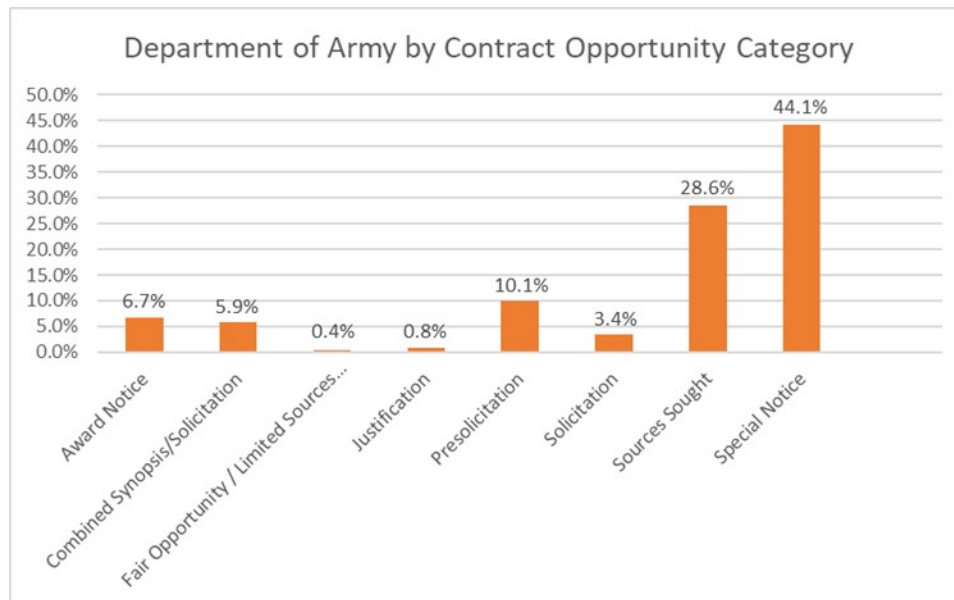


Figure 4.1. Army Opportunities by Category

Of the eight opportunity types, award notices, solicitations, combined synopsis, and justifications are more likely to include SOW, PWS, and Statements of Objectives within SAM. Because of time constraints and the lack of detailed data, special notices, sources sought, pre-solicitations, and fair opportunity/limited sources justification were not considered for further evaluation. Only 40% of the postings within the awards, solicitations, combined synopsis, and justifications contained the detailed documents necessary to conduct the in-depth review using the evaluation form. Figure 4.2 shows the breakdown of data that was available.

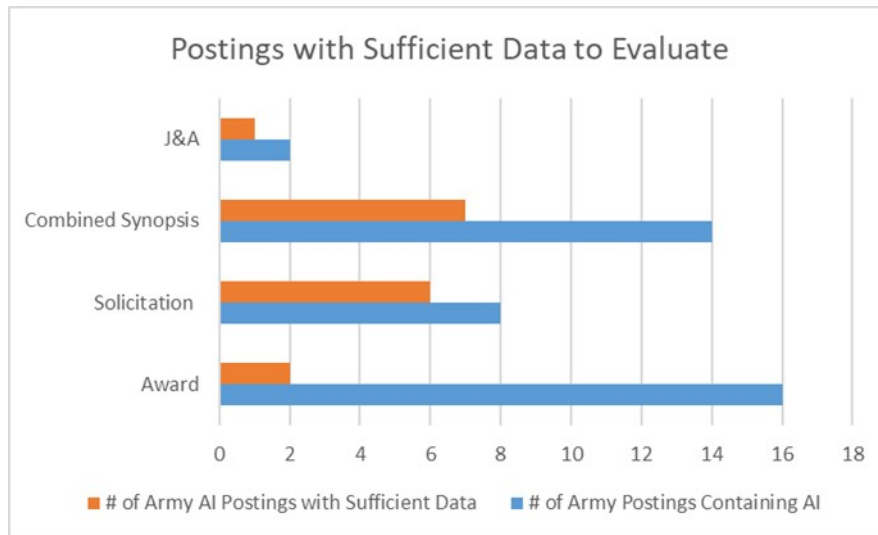


Figure 4.2. Breakdown of Posting with Sufficient Data to Perform an Evaluation of Requirements

From the selected opportunity types—award, solicitation, combined synopsis, and JA—only sixteen contained enough data to evaluate. The team evaluated these sixteen postings utilizing the evaluation form, included in Appendix A, to determine if the postings truly contained artificial intelligence requirements according to the definition previously defined by the team. Of the sixteen postings evaluated, two award notices, three solicitations, and two combined synopsis contained AI requirements that met the definition established by the research team. Table 4.2 shows a breakdown of the evaluated postings from the selected opportunity categories.

Table 4.2. Details From the 16 SAM Postings That Were Evaluated

Contract/Solicitation Number	Type of Solicitation	Apply to Project?	Reference Human?	Include Human Factor?
W911QX20F0106	Award	Yes	Yes	Yes
W911QX-21-F-0132	Award	Yes	Yes	Yes
W15QKN-20-R-08J1	Solicitation	Yes	No	No
W52P1J-21-S-CJKE	Solicitation	Yes	No	No

Continuation of Table 4.3				
W52P1J21Roo30	Solicitation	No	N/A	N/A
W52P1J-21-R-029	Solicitation	Yes	Yes	Yes
W56KGY-22-R-0004	Solicitation	No	N/A	N/A
W56KGY-22-R-0005	Solicitation	No	N/A	N/A
DAAH0103PR076	Combined Synopsis	No	N/A	N/A
W9124D11TSTAR	Combined Synopsis	No	N/A	N/A
W912HZ16R0030	Combined Synopsis	No	N/A	N/A
W911NF-19-D-0012	Combined Synopsis	No	N/A	N/A
W81K00-20-Q-0177	Combined Synopsis	Yes	Yes	Yes
W911SD21R0139	Combined Synopsis	Yes	No	No
WS0NH921Q0007	Combined Synopsis	No	N/A	N/A
W52P1J-19-R-0106	JA	No	N/A	N/A
End of Table				

From the small sampling of data the team evaluated, less than half of the opportunities contained AI according to the team's definition. AI contracting personnel we spoke with also indicated that AI requirements are not being satisfactorily or consistently defined by the Army. Furthermore, this discrepancy appears to artificially inflate the number of true AI requirements being advertised by the Army. The dates for these opportunities ranged from 2003-2022. The Army AI opportunities that meet the definition of AI increased beginning in 2020 seen in Figure 4.3. Prior to 2020, the summary of the five opportunities contained the phrase AI, but when the details of the projects were reviewed, it revealed the projects were not really asking for the development/design of an AI system. As time has passed, the understanding of AI is improving, and the number of true AI opportunities are increasing. The data was pulled from SAM in June 2022; therefore, the number of AI projects in 2022 is not finalized.



Figure 4.3. SAM Postings Evaluated to Contain AI by Year

Of the six SAM postings containing requirements that met the definition of AI, four included some reference to HSI or human factors. The terminology found in these four postings included human-machine teaming, human intervention, training, and system usability. The details for each of the four postings containing AI can be seen in Figure 4.4.

Opportunity ID	Contract/Solicitation Number	Type of Solicitation	HSI Terminology
A1	W911QX-20-F-0106	Award	human-machine teaming, human computer interaction, human augmentation, human analytical bandwidth, human intervention
A2	W911QX-21-F-0132	Award	Human Machine Teaming with Autonomous Sensors and Systems
S4	W52P1J-21-R-0029	Solicitation	Human augmented by machines (human machine interface), tools onsite and hearing human interfaces.
CS5	W81K00-20-Q-0177	Combined Synopsis	Human as the user of the training material. The training platform must use AI to determine how much the user knows and tailor the material to the user.

Figure 4.4. SAM Postings Containing HSI

The data that was available to review was limited and did not detail specifications for the projects. As shown, the team was very liberal in giving credit for HSI requirements. This breakout of postings containing HSI by year can be seen in Figure 4.5.

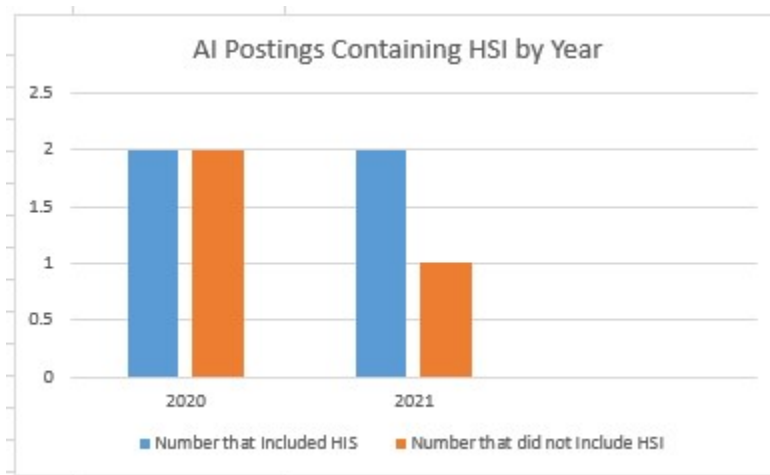


Figure 4.5. SAM Postings Containing AI Evaluation for HSI Incorporation by Year

The two award notices evaluated (A1 and A2) were issued as task orders from a Research and Development Indefinite Delivery Indefinite Quantity (IDIQ) contract, W911QX-20-D-0008, awarded to Carnegie Mellon University. This IDIQ was awarded for the purpose of leveraging autonomy and AI to augment Soldiers by minimizing time spent on low-impact and high-time activities. Both notices were determined to apply to the project according to the definition set forth for AI by the team. In addition, both task orders included references to human-machine teaming, human computer interaction, human augmentation, or human intervention. Although specific HSI requirements were not available in detail, some aspects of human factors are being considered (e.g., human interaction). This was a common occurrence among the evaluated postings.

Of the six solicitation opportunities, three were considered to contain AI, and only one of those containing AI (S4) was considered as containing HSI. The summary of the project was the “acquisition of commercial AI tools and services into environments, the operation and support of AI tools and services, integration of those tools, and the use of AI testing on AI models and software applications” (SAM, June 4, 2022). The PWS required human-machine interfaces; therefore, it was classified as containing HSI requirements. In stark contrast to the award data associated with contract S4, as an example, the solicitation posting for S5 was lacking any tangible information. While the posting contained the phrase “Artificial Intelligence” in the opportunity summary, evaluation of the statement of work (SOW) and

other documents attached to the posting indicated the requirement is to procure commercial software and support services to meet the intelligence systems and analytics requirements. Artificial intelligence is not mentioned in the SOW, nor is machine learning.

Of the seven combined synopsis opportunities, two were considered to contain AI, and one (CS5) of those included HSI requirements. The opportunity summary required the contractor’s solution to “demonstrate the ability to use artificial intelligence in order to deliver a personalized curriculum to the learner based on the individual learner’s strengths and weaknesses. The contractor’s learning platform shall use artificial intelligence to alter the individualized learning experience, based on the learner’s current knowledge base” (SAM June 4, 2022). The PWS required the system to consider the user and tailor the training material according to the user’s knowledge of the coursework; therefore, it was considered to include some form of HSI.

4.3 What SMEs Had to Say

A complete list of questions used to guide the interviews may be found in Appendix B and a summary of the responses are in Table 4.3 below.

Table 4.3. Summary of Questions and Answers from SMEs

Questions:	Responses:
Policies or guidance for AI to address HSI?	· None so far · Planned implementation by 2024
Misconceptions about AI?	· Public fears how far AI will go · Army wants to put AI in everything · Only as good as the data you have
· Roadblocks to developing policy/ guidance to clarify AI integration in acquisitions?	· Air Force has central repository, Army does not · Disjointed information and projects · Staff and command power struggle
Recent AI capabilities?	· Automated Threat Recognition
Response to BAA?	· Over 200 submissions

Continuation of Table 4.3	
	· Covered Technology Readiness Level 1-5 · Research must be deliberate and purposeful
Funding for BAA?	· Available · 12–14M per year for basic research · 50–60M per year for advanced research
Challenges to implementing AI compared to other technologies?	· Faster than normal development cycle
Training initiative involvement?	· Faster than normal development cycle
End of Table	

Established in early 2020, the Artificial Intelligence Integration Center (AI2C), is the main requiring activity for Army AI initiatives. The AI2C utilizes Broad Agency Announcements (BAAs) and Commercial Solutions Openings (CSOs) to present identified capability gaps and challenges facing the Army rather than detailed requirements. BAAs and CSOs are used by the Government to connect with businesses and institutions that do not traditionally do business with the Government but that specialize in innovative technologies and services. This is an innovative way to approach contracting for AI capabilities because it removes the traditional bureaucratic barriers implemented by traditional FAR-based acquisitions. According to Mr. Ruben Cruz, posting identified capability gaps and challenges allows more flexibility for the Government to engage with academic institutions and industry about their proposed AI solution (Ruben Cruz, interview, May 12, 2022). In other words, the Army is not defining the AI requirement, but rather the requirement is being defined by what the respondents deem technically possible. These BAAs and CSOs also allow for a variety of contracting options (i.e., other transaction authorities (OTAs), cooperative agreements, cost-share, etc.) with very quick turnaround times for contract award (i.e., 90 days).

AI2C's mission is to develop Army AI capabilities and ensure these capabilities may be used in programs being developed in Assistant Secretary of the Army (Acquisition, Logistics, and Technology) (ASA(ALT)). Rather than developing technology with no future use, the intent of this venture is to ensure upfront that AI projects will be suitable to transition to

either existing programs of record or future programs of record. According to the Business Director, AI2C recognizes the human factors pertaining to AI have not been fully considered in the workforce education programs which are currently offered. In an attempt to remedy this, AI2C has been working with the University of Southern California to develop a master's level program that will be available to Army soldiers with specific focuses on the human aspects and societal impacts of AI (Ruben Cruz, interview, May 12, 2022).

AI2C is working to educate the workforce and develop policies that are applicable to AI and its uses by implementing the Artificial Intelligence Integration Center Workforce Development Framework. AI2C acknowledges the gap in HSI requirements within AI projects and plans to join efforts with the Army Research Lab and leverage work done in the area of human machine teaming (Ruben Cruz, interview, May 12, 2022). New roles for the AI workforce, such as data engineer, data analyst, autonomous systems engineer, applied machine learning engineer, analytics manager/data science leader, and ethicist, have been developed and are being implemented through workforce development education programs. (AI2 WFD Overview Briefing, 2022)

The Army Futures Command developed an Artificial Intelligence Integration Center Workforce Development Framework that defines AI workforce roles and training paths. The human/AI interaction category has the potential to integrate HSI as seen in the AI Stack in Figure 4.6. This effort is an attempt to ensure AI projects follow a holistic approach (AI2 WFD Overview Briefing, 2022). Currently, there is training for contracting personnel in areas including data rights, copyrights, and patents that are heavily required in AI projects, but the training is not tailored specifically towards AI (Mark Martinez, interview, June 30, 2022). It is important to note; however, that at the time of this writing, specific training in the AI field is optional.

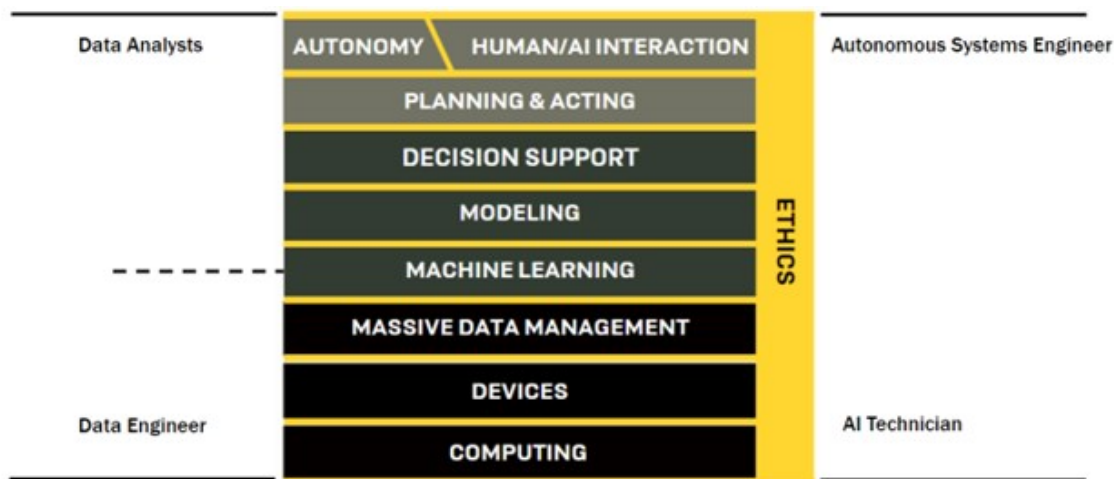


Figure 4.6. Workforce roles mapped to the AI stack

Another perspective comes from an Army Contracting Command Rock Island (ACC RI) Contracting Officer (KO) whose primary responsibility is to award AI requirements. According to this source, KOs rely heavily on the requiring activity to both adequately define the AI effort and evaluate technical elements of the received proposal responses accordingly. A major challenge identified with procuring and implementing AI capabilities is not knowing the pitfalls associated with technically complex AI-related efforts. Instead, best practices are a learned effort over time (Mark Martinez, interview, June 30, 2022). Mr. Martinez noted he has learned through experience that posting AI requirements to SAM generally doesn't result in receiving relevant responses. This is identified as a significant deficiency to the acquisition process for advertising contract opportunities per the FAR. Initially, a Basic Ordering Agreement (BOA) was used for the solicitation of AI-enabled projects because there was not an established pool of industry contractors. This led to receiving over two hundred responses to the BOA, many of which were not valid or applicable. This BOA requested responses to challenges and capability gaps identified by Army Futures Command's (AFC) Cross-Functional Teams (CFTs) in the areas of Long Range Precision Fires, Next Generation Combat Vehicles, Future Vertical Lift, Army Network, Air and Missile Defense and Soldier Lethality. A wide range of proposals were received, many not meeting the intentions of the solicitation.

An industry contractor the research team spoke with provided useful insight into his process for reviewing posted AI solicitations in SAM. The requests for information or proposals (RFI/RFP) are often vague and the requirement titles may not match the detailed description contained within the supporting documentation. For example, the RFI/P title may say something about Natural Language Processing (NLP), but the requirements documentation may not describe any requirement for the underlying infrastructure needed to perform that work (databases, datasets, and hardware requirements). This makes it exceedingly difficult for companies to accurately respond to Government solicitations. This SME suggested that the vague and incongruent descriptions are likely due to a lack of basic AI knowledge on the part of those writing the solicitations. Therefore, his company must establish a baseline knowledge for the audience of their response. This can include establishing definitions such as the difference between AI and ML or giving foundational knowledge for understanding the technical factors for the technology. Once this baseline is established for the audience, the proposal can then get into the details. Establishing this baseline can be risky because it could diminish the space required to describe the underlying necessities of the system being proposed. (Dion Gizas, interview, June 6, 2022). In summary, of the sixteen postings reviewed by the team, six contained AI requirements that met the defined criteria for AI. Of those six containing AI, four contained some type of HSI requirements. DODD 5000.01 requires Army systems to include HSI in early planning in order to optimize total system performance and total ownership costs all while meeting the system mission requirements (DODD 5000.01). According to the Army personnel the team interviewed, there is no policy or guidance that currently exists on how to include HSI in Army AI projects. Likewise, there is currently no general guidance or best practices published within the Army regarding how to classify, define, or write any AI acquisition requirements at large. Although HSI requirements are required by DODD 5000.01 and DODI 5000.02 to be incorporated in Army acquisitions, they are not consistently being incorporated as common requirements for AI systems. However, there is concurrence across all aforesaid SMEs that an understanding of how an AI capability will impact the Soldier is crucial. From the industry perspective, HSI is important because system users need to be able to trust that the system is doing its job correctly (Dion Gizas, interview, June 6, 2022).

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 5:

Conclusions and Recommendations

The research team sought to identify what human systems integration requirements and considerations were being written into Army AI acquisitions. The process of identifying these requirements included researching existing policy and regulations involving AI and HSI at the DOD and Army levels, reviewing AI contract opportunities posted in SAM (with associated contract award documentation found in EDA), and conducting interviews with Army personnel assigned to AI efforts as well as SMEs on the industry side.

The combined results of the team's methodology revealed that there are varying understandings across the Army of what an AI requirement is and there are no obvious processes or specific AI acquisition guidelines that are universally followed when developing an AI requirement. It was also apparent that HSI was not always included in requirements as required by Army regulations.

5.1 Discussion

Most of the relevant DOD and Army AI doctrine have been published within the last two years and are comprised of strategies and directives to establish teams and implementation plans (see Figure 1.1). Official Army guidance or policy regarding how to classify, define, or write any AI acquisition requirements does not appear to exist. Furthermore, the research team was unable to locate an official source on what elements should be considered when procuring an AI-enabled system.

Moreover, we were unable to discern a method to determine that what is being procured as AI actually meets the definition of AI. This may encourage a wide interpretation among the Army procurement workforce about what can be procured under the guise of AI. As the team evaluated Army contract opportunities, it became clear SAM postings used very broad definitions for AI. The broad use of AI in postings artificially inflates the number of opportunities appearing to include AI. As an example, one posting that was flagged in SAM as containing AI was for a requirement to procure commercial software with support services for the intelligence systems and analytics requirements. While it is possible that

this acquisition is for a rudimentary software package that will evolve to contain AI-enabled applications in the future, at the time of posting, it is impossible to formulate assumptions on the projected future scope of the project. This is just one example of why the total number of Army AI projects is likely not actually as high as it first appears when looking at the SAM data. Of the sixteen reviewed postings in SAM containing the phrase “Artificial Intelligence,” less than half contained requirements that actually met the team’s definition of AI. In line with the team’s aforementioned findings, AI requirements are vaguely defined up front, or in some cases not at all.

AI training opportunities for operators and acquisition personnel appear to be unrealized. Although the 2020 DOD AI Education Strategy discusses training members of the workforce who are primarily aligned with AI efforts, the KO the team spoke with confirmed he had no specific AI training in order to perform his duties. Rather, he gleaned most of his AI knowledge from a colleague who directly supports the Joint Artificial Intelligence Center (JAIC). This research team could find no training related to AI that was designed for acquisition personnel.

For the operator, training on system operability must be included in the contract requirements. Operators must understand what the system boundaries are (i.e., what the system is both capable and not capable of doing). This can be difficult as many AI systems’ underlying components and computing frameworks are highly complex. Moreover, many AI-enabled systems contain such an enormity of data that it becomes nearly impossible for the operator to comprehend what the system is actually observing and/or calculating (Gizas). Not all operators will have a background in AI, mathematics, or statistics, so the question then becomes, “how can we make the system effective for the users?” System training, technical education (such as a basic course in AI), and user-centered design play an important role in building trust between these systems and their intended users.

Per FAR 15.404-1, KOs are, “responsible for evaluating the reasonableness of the offered prices.” From the experience of team members who work in the contracting field, courses are typically offered to acquisition personnel regarding the hardware and technology they might be procuring. The aim of these courses is to ensure that Contract Specialists and KOs have a rudimentary knowledge of the technical details of the assets which they are procuring. This is done with the understanding that a technical knowledge of the assets will make him

or her more able to contractually meet the needs of the Soldier while securing a fair and reasonable price for the taxpayer. While AI-enabled systems are emergent technologies that may not have reached the point at which a high-level technical acquisitions course may be easy to produce, KOs still require enough training to determine if a proposal is or is not reasonable.

Although HSI requirements are required to be part of the system acquisition process per DA PAM 602-2, it appears the Army's wide spectrum of AI understanding has created an unintended consequence of requirement activities overlooking the human user as a major factor to enable an AI capability. HSI is not explicitly defined or required in four of the six opportunities that contained actual AI requirements that the team reviewed. According to the Army personnel interviewed for this project, there is no policy or guidance that currently exists instructing how to include HSI in Army AI projects.

All of the SMEs who participated in discussions with the research team indicated that they believed an understanding of how an AI capability will impact the Soldier was crucial for mission success. This indicates that there is at least the desire to address HSI requirements in Army acquisitions; however, these desires are not currently directly correlated to the implantation of firm, contractual requirements in the majority of acquisition items reviewed during this research project.

DODD 5000.01 requires Army systems to include HSI in early planning in order to optimize total system performance and total ownership costs all while meeting the system mission requirements. While this guidance may be in place to instruct acquisition officials to include and consider HSI requirements, the guidance is not currently being followed. While HSI considerations are important for all Army acquisitions, they will be especially important for emergent, AI-enabled systems that may be more technically complex than previous generations of systems. Not having an official method to verify that HSI requirements are being met relies instead on the opinions and whims of KOs who may not have a technical understanding of what HSI entails.

5.2 Conclusions

As this research team reviewed the available data and held discussions with SMEs, it was increasingly evident that there was a disparity between what Army acquisition of AI-enabled technologies should look like and what reflected reality. This disparity appeared to have three major roots causes: weak DOD Army guidance, shortcomings in AI-related training for acquisitions personnel, and a negligence surrounding the incorporation of HSI elements into Army requirements packages.

1. Weak DOD and Army AI guidance

The lack of official sources and methodologies regarding the procurement of AI-enabled systems may indicate that there currently exists a lack of understanding of what AI is. This was a recurring theme throughout the interviews. Both Mr. Martinez and Mr. Gizas indicated that there seems to be a lack of understanding about what AI actually is. Mr. Cruz had remarked of the public perception of their work that, “they think we are doing The Terminator.” Mr. Gizas remarked that Government RFIs related to AI were very vague, giving him the impression that the writer lacked a basic understanding of the subjects included in the postings.

Without firm guidance on what constitutes AI, along with what elements or features should be included in the acquisition, important factors (including HSI efforts) are likely to be overlooked. Through this research, it appears those in the acquisition process have a poor understanding of what the requirement should entail. This lack of understanding will continue to generate substandard postings for AI unless it is addressed at the Agency level.

Although it is important to write requirements considering the human user when developing and purchasing an AI capability, it is imperative that those writing requirements within the Army have a collective understanding of what AI is at a more basic level. Without the Army having this basic understanding, it’s impractical to assess whether the Army is properly accounting for the human user in these requirements.

While AI is an emergent technology and best practices on procuring it may not be known, it would be best for the Army to have an anticipatory rather than reactive response to its procurement. The Army should develop stronger guidance regarding the requirements and best practices in procuring AI-enabled systems. This guidance should explicitly define both

what AI is and what it is not in order to remedy the shortcomings in posted the posted SAM requirements that we found in our research.

2. Shortcomings in Training for Acquisitions Personnel

The research team recommends establishing an Army AI center of excellence where acquisition personnel may access lessons learned and best practices as they form their AI development and acquisition strategies. This could be housed within an ACC division (i.e., software engineering, cyber and/or IT) or co-led between ACC and the AI2C. Additionally, this may be an endeavor that could be taken on by the Army Acquisition Center of Excellence. There should be a focus on educating contract authorities about the state of AI technology and diverse nomenclature of terms that pervade the community. Further refinement of Human-AI teaming requirements must also start with a comprehensive understanding of how the AI-enabled system will interact with the operator. Defining the operator up front is critical. The assumption must not be that the user will inevitably be “the warfighter.”

3. Negligent HSI Requirements

Currently, Army Contract Command (ACC) maintains standard templates for acquisition requirement packages to include things like Market Research Reports (MRRs), which is a tool that has been developed to verify that proper market research efforts did occur, and that potential contractor sources were not unlawfully or unnecessarily limited. The MRR contains mandatory sections in which the requiring activity must detail the market research techniques and sources utilized, commercial marketplace business practices for acquisitions of similar types, a discussion of results from any Sources Sought or RFI responses, as well as consideration for how the acquisition may impact small business opportunities.

The research team proposes something similar be created in the form of a checklist to verify that AI-enabled requirements are both true AI requirements and that HSI elements are being adequately addressed. For example, the “Sources” section of an MRR lists a variety of acceptable sources with the option to select “Yes” or “No” to the question of whether that type of source was utilized with a follow-on column to explain why the source was chosen. A similar checklist for the purposes of an AI-enabled system may contain the definition of AI with applicable space to explain how the proposed requirement does or does not meet

this definition. The checklist may then go on to address elements that must be included in the procurement, including HSI training requirements (Yes or No) with a third column to detail how the procurement intends to meet that element.

This checklist would require the following policies be reviewed to ensure appropriate definitions and requirements are understood and incorporated during the pre-solicitation phase of the acquisition:

- i. DOD AI Strategy, 2018
- ii. DOD Ethical Principles for AI Memo, February 2020
- iii. DOD Responsible AI Strategy and Implementation Pathway, June 2022
- iv. DOD 5000.95, Human Systems Integration in Defense Acquisition
- v. Army Regulation (AR) 602-2, Human Systems Integration in the System Acquisition Process

5.3 Recommendations for Future Research

The team only utilized the term “Artificial Intelligence” as an exact match in the SAM database. This was done to reduce the number of contracts for the team to review to a manageable level. Should further research be done in this field in the future, researchers might select “Contains” rather than “Exact Match.” Furthermore, additional terms such as “Machine Learning” might be utilized to evaluate a separate but related set of Government requirements. It is possible that relevant results were overlooked due to the parameters used in SAM to define the examined set of requirements.

The evaluation of SAM data focused solely on Army requirements. Should future researchers want to consider HSI requirements of AI-enabled systems, they may wish to evaluate either the requirements of another branch of the DOD or they may wish to compare HSI requirements of AI-enabled systems of all DOD branches. Evaluation performed on a different branch of the DOD may yield different results than evaluation of Army requirements alone.

Future research may also focus on the use of consortiums in the acquisition of AI-enabled

systems. Consortia are currently preferred by AI2C for AI-enabled acquisitions and are allowable IAW FAR 35 for research and development purposes (Mark Martinez, interview, June 30, 2022). Future research may want to consider if consortia are a more effective means for procuring AI-enabled systems, as well as how these acquisitions compare to a more traditional procurement process.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDICES

A	SAM Evaluation Form.	49
B	Interview Questions.	53
C	SAM Contract Opportunities Defintions	57

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A: SAM Evaluation Form

Evaluation of AI Solicitations

Date of Evaluation:

Contract/Solicitation Number:

Type of Solicitation:

Date Solicitation Initiated:

Summary of Solicitation:

Artificial Intelligence Definition: Artificial Intelligence is defined as computer systems having the ability to perform tasks that normally require human intelligence (Knowles 2005). While some use AI and Machine Learning (ML) as synonyms, there is an important distinction between the two. AI is expected to learn to think, almost like a human, with extraordinarily little input. It uses algorithms to form its decision matrix and implement the decision. Conversely, ML, relies on algorithms to provide the best decision and does not interject any human-like decision making skills.

1. Is the solicitation applicable to the project?
2. If not, why was it determined not to be applicable?
3. Does this requirement reference “human”?
 (“Human” references can include “manned”, “user”, “soldier”, “warfighter” etc...)
4. If yes, in what context is “human” related to? (Team member must describe the “human” reference - I.e., human-machine interaction/engineering, etc.)
5. Does this requirement include “human factor” and/or “human systems integration (HSI)” considerations?
6. If yes, what “human factors” and/or “human systems integration (HSI)” considerations were observed? (See human factor/HSI category lists above and record all that apply)

7. Additional Comments:

References:

HSI CATEGORIES:

manpower, personnel, training, human factors engineering, safety and occupational health, force protection and survivability, and habitability

HUMAN FACTORS:

Design of tools, machines, and systems that consider human capabilities, limitations, and characteristics. Design for safe, comfortable, and effective human use. Training/education.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B:

Interview Questions

Questions for Mr. Ruben Cruz (AFC AI Integration Center Point of Contact)

1. What policies or guidance have been published (or are in draft) to address considerations such as human factors when the Army is purchasing or developing AI capabilities?
 - a. Are there misconceptions about AI from your vantage point?
 - b. Are there current roadblocks to developing additional policy/guidance that could clarify AI integration within Acquisitions?
2. What are some of the most recent AI capabilities being implemented for Army missions that your office has input to or oversight of?
3. We understand a BAA was posted for the purposes of receiving information from academia and industry as to how to address certain challenges across the named cross-functional-teams (CFTs) could be solved using AI.
 - a. Have you received any input to date?
 - b. With this BAA being open through 2026, how are updates to the BAA being addressed?
 - c. What are the next steps once the BAA closes?
 - d. Is funding set aside for this effort?
4. What challenges, if any, do you anticipate for the Army being able to successfully implement AI capabilities as opposed to any other new technology?
 - a. Are there any plans for AI integration within legacy army systems?
 - b. Do you recommend any additional points of contact that may help us further understand Army AI technological gaps?
5. Is your group connected to the training initiatives across the Army (i.e., several educational

opportunities are being offered for AI degrees, workforce training efforts for the DOD, etc.)?

Questions for Mr. Mark Martinez (ACC RI KO Supporting AFC)

1. What policies or guidance have been published (or are in draft) to address considerations such as human factors when the Army is purchasing or developing AI capabilities?

a. Are there misconceptions about AI from your vantage point?

b. Are there current roadblocks to developing additional policy/guidance that could clarify AI integration within Acquisitions?

2. What are some of the most recent AI capabilities being implemented for Army missions that your office has supported?

3. What challenges, if any, do you anticipate for the Army being able to successfully implement AI capabilities as opposed to any other new technology?

a. Are there any plans for AI integration within legacy army systems?

4. Have you (your group) participated in any of the AI training initiatives across the Army (i.e., several educational opportunities are being offered for AI degrees, workforce training efforts for the DOD, etc.)?

a. What qualifications, if any, were required for you to be able to support AI procurement?

5. What procurement strategies are typically used for Army AI efforts (i.e., FAR-based, OTA, etc.)?

6. Do you recommend any additional points of contact that may help us further understand Army AI technological gaps?

Questions for Mr. Dion Gizas (Industry Point of Contact)

1. How important does private industry view human systems integration (HSI, how people and systems work together) requirements in potential AI projects?

2. In reviewing Government AI-related RFIs, what are you looking for to determine if it may be a project worth pursuing?

3. What pitfalls do you see in Government AI-related RFIs?

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C:

SAM Contract Opportunities Definitions

The opportunity types found in SAM are as follows:

Award Notice

"When a federal agency awards a contract in response to a solicitation, they may choose to upload a notice of the award to allow the interested vendors to view the vendor receiving the awarded contract, and amount agreed upon. However, requirement guidelines for posting the award notice vary based upon the agency and the solicitation" (Jimmerson, 2020).

Combined Synopsis / Solicitation

"Most opportunities classified this way are open for bids from eligible vendors. These opportunities include specifications for the product or service requested and a due date for the proposal. The notice will specify bidding procedures in the details of the solicitation" (Jimmerson 2020).

Fair Opportunity / Limited Sources Justification

"Circumstances justifying limiting the source for a proposed order or BPA [blanket purchase agreement] with an estimated value exceeding a certain dollar threshold or established in accordance with other procedures. Regulatory references: FAR subpart 8.4 and FAR subpart 16.5" (Jimmerson 2020).

Justification

"This type of notice is required to justify and obtain approval to award a contract without posting a solicitation as required by the FAR. 41 U.S.C. 253(c) and 10 U.S.C. 2304(c) authorize, under certain conditions, contracting without providing for full and open competition. The Department of Defense, Coast Guard, and National Aeronautics and Space Administration are subject to 10 U.S.C. 2304(c). Other executive agencies are subject to 41 U.S.C. 253(c). Contracting without providing for full and open competition or full and open competition after exclusion of sources is a violation of statute, unless permitted by one of

the exceptions in FAR 6.302" (Jimmerson 2020).

Presolicitation

"The pre-solicitation notice makes vendors aware that a solicitation may follow. Vendors may add themselves to the Interested Vendors List, if the posting agency has enabled this feature. This helps government agencies determine if there are qualified vendors to perform the work scope and allows the contracting office to gather information on the interested vendors. The pre-solicitation notice also helps the government determine if the requirement can be set-aside for a small business if capable small businesses respond" (Jimmerson 2020).

Solicitation

"A document that clearly defines government requirements so businesses can submit competitive bids. A "Request for Proposal" (RFP) is one type of solicitation used by federal agencies" (Jimmerson 2020).

Sources Sought

"The Sources Sought notice is a synopsis posted by a government agency seeking possible sources for a project. It is not a solicitation for work or a request for proposal. For more information, see FAR 7.3" (Jimmerson 2020).

Special Notice

"Agencies use Special Notices to announce events like business fairs, long-range procurement estimates, pre-award (pre-bid/pre-proposal) conferences, meetings. This category also encompasses opportunities such as: request for information (RFI), or draft solicitations and draft specifications for review" (Jimmerson 2020).

Based on the descriptions above, opportunity postings in support of requirements development may start with a Special Notice for a business fair to bring together potential vendors to discuss the level of research or technology available on a broad set of topics. Application of the data collected at the business fair to narrow the scope of the requirement might result in a Sources Sought posting inviting vendors to provide a capability statement detailing the supplies and/or services the vendor offers in support of one or more of the better-defined

topics. As the Army's requirements are further defined based on information received from the Sources Sought posting, the Presolicitation Notice may be appropriate to inform vendors of an upcoming solicitation and determine availability for receipt of multiple proposals or justification to solicit a single source. The Solicitation will follow as the requirement is fully defined and receives funds appropriation. After receipt and evaluation of proposals, if a winner is selected and a contract awarded, the Award Notice would be the final requirements announcement posted to SAM.

THIS PAGE INTENTIONALLY LEFT BLANK

List of References

- AcqNotes. 2020. "System for Award Management (SAM)." Accessed June 22, 2022.
<https://acqnotes.com/acqnote/careerfields/system-for-award-management-sam>.
- AcqNotes. 2021a. "Electronic Document Access (EDA)." Accessed July 6, 2022.
<https://acqnotes.com/acqnote/careerfields/electronic-document-access-eda>.
- AcqNotes. 2021b. "Federal Acquisition Regulations (FAR)." Accessed July 6, 2022.
<https://acqnotes.com/acqnote/careerfields/federal-acquisition-regulation>.
- AcqNotes. 2022. "Broad Agency Announcement (BAA)." Accessed June 22, 2022.
<https://acqnotes.com/acqnote/careerfields/broad-agency-announcements>.
- Amershi, Saleema, Dan Weld, Mihaela Vorvoreanu, Adam Fourney, Besmira Nushi, Penny Collisson, Jina Suh et al. 2019. "Guidelines for Human-AI Interaction." In Boohar, Harold R., and James Minninger. 2003. "Human Systems Integration in Army Systems Integration." In *Handbook of Human Systems Integration*, edited by Harold R. Boohar, 663-698. New Jersey: Wiley.
- Burns, Gregory R., Ryan T. Collier, Richard J. Cornish, Kyle J. Curley, Allan Freeman, and Jared Spears. 2021. "Evaluating Artificial Intelligence Methods for Use in Kill Chain Functions." Master's capstone, Naval Postgraduate School.
<https://calhoun.nps.edu/handle/10945/68801>.
- Chen, Jessie Y.C., and Michael J. Barnes. 2014. "Human-Agent Teaming for Multirobot Control: A Review of Human Factors Issues." *IEEE Transactions on Human-Machine Systems* 44 (1) (February): 13-29.
<https://doi.org/10.1109/THMS.2013.2293535>.
- Cruz, Ruben, 2022. "AI2C WFD Overview Briefing." Briefing at Army Artificial Intelligence Integration Center (AI2C), Pittsburgh, PA.
- Department of Army. 2022. *Human Systems Integration in the System Acquisition Process*. AR 602-2. Washington, DC: Department of the Army.
https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN30750-AR_602-2-000-WEB-1.pdf.

Department of Defense. 2018. “2018 DoD Artificial Intelligence Strategy: Harnessing AI to Advance Our Security and Prosperity.”
<https://media.defense.gov/2019/Feb/12/2002088964/-1/-1/1/DOD-AI-STRATEGY-FACT-SHEET.PDF>.

Department of Defense. 2020a. *The Defense Acquisition System*. DoD Directive 5000.01. Washington, DC: Department of Defense.
<https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/500001p.pdf>.

Department of Defense. 2020b. “2020 Department of Defense Artificial Intelligence Education Strategy.”
https://www.ai.mil/docs/2020_DoD_AI_Training_and_Education_Strategy_and_Infographic_10_27_20.pdf#:~:text=Fiscal%20Year%202020%20National%20Defense%20Authorization%20Act%20Section,relevant%20occupational%20fields%E2%80%9D%20a%20basic%20knowledge%20of%20AI.

Department of Defense. 2021. *U.S. Department of Defense Responsible Artificial Intelligence Strategy and Implementation Pathway*. Washington, DC: Department of Defense.
https://www.ai.mil/docs/RAI_Strategy_and_Implementation_Pathway_6-21-22.pdf.

Department of Defense. 2022. *Human Systems Integration in Defense Acquisition*. DoD Instruction 5000.95. Washington, DC: Department of Defense.

El Haouzi, Hind B., and Etienne Valette. 2021. “Human System Integration as a Key Approach to Design Manufacturing Control System for Industry 4.0: Challenges, Barriers, and Opportunities.” Paper presented at the 17th IFAC Symposium on Information Control Problems in Manufacturing, INCOM 2021. Budapest, Hungary.

Federal Acquisition Regulation. 2022. “Part 5 – Publicizing Contract Actions.” *Federal Acquisition Regulation*. <https://www.acquisition.gov/far/part-5>

Fossaceca, John M., and Stuart H. Young. 2018. “Artificial Intelligence and Machine Learning for Future Army Applications.” In *Ground/Air Multisensor Interoperability, Integration, and Networking for Persistent ISR IX*, edited by Michael A. Kolodny, Dietrich M. Wiegmann, and Tien Pham, 1-19. Orlando, FL. <https://doi.org/10.1117/12.2307753>.

Goldfarb, Avi, and Jon R. Lindsay. 2022. “Prediction and Judgment: Why Artificial Intelligence Increases the Importance of Humans in War.” *International Security* 46 (3) (Winter): 7-50. https://doi.org/10.1162/isec_a_00425.

- Higgins, John. 2017. "Human Systems Integration Uses Soldier Input, Design, Engineering to Improve Critical Military Systems." April 28, 2017. <https://www.dvidshub.net/news/231909/human-systems-integration-uses-soldier-input-design-engineering-improve-critical-military-systems>.
- Jimmerson, Lilla. 2020. "What are the Notice Types for Contract Opportunities in SAM.gov?" System for Award Management. Last modified February 15, 2022. https://www.fsd.gov/gsafsd_sp?id=kb_article_view&sysparm_article=KB0020252&sys_kb_id=aa364c8c1b710d106397ec21f54bcb61&spa=1
- Lappin, Yaakov. 2020. "Rafael Accelerates AI Integration into Weapon Systems." October 19, 2020.
- Munoz, Carlo. 2021a. "AI Development, Training at the Tactical Edge Inches Toward Reality." March 17, 2021.
- Munoz, Carlo. 2021b. "JAIC Looks to Link AI Development Platforms Across Pentagon, Services." April 7, 2021.
- Nagy, Bruce. 2022. *Level of Rigor for Artificial Intelligence Development*. Report Number: NAWCWD TP 8864. China Lake, CA: Naval Air Warfare Center Weapons Division. <https://apps.dtic.mil/sti/citations/AD1173626>.
- National Academies of Sciences, Engineering, and Medicine: Division of Behavioral and Social Sciences and. Education, Board on Human-Systems Integration, and Committee on Human-System Integration Research Topics for the 711th Human Performance Wing of the Air Force Research Laboratory. 2022. *Human-AI Teaming : State-Of-the-Art and Research Needs*. Washington, D.C: National Academies Press.
- New Oxford American Dictionary*. 2022. S.v. "Artificial Intelligence." Accessed July 6, 2022. <https://www.oxfordlearnersdictionaries.com/definition/english/ai>
- Pita, James, Manish Jain, Milind Tambe, Fernando Ordóñez, and Sarit Kraus. 2010. "Robust Solutions to Stackelberg Games: Addressing Bounded Rationality and Limited Observations in Human Cognition." *Artificial Intelligence* 174 (15) (October): 1142-1171. <https://doi.org/10.1016/j.artint.2010.07.002>.
- Schwartz, Ben, Holly Handley. 2022. "Human Systems Integration." *Guide to the Systems Engineering Body of Knowledge (SEBoK)*. May 20, 2022. https://www.sebokwiki.org/wiki/Human_Systems_Integration.

Splunk. n.d. "5 Big Myths of AI and Machine Learning Debunked." Accessed April 13, 2022. <https://www.splunk.com/pdfs/ebooks/5-big-myths-of-ai-and-machine-learning-debunked.pdf>.

Initial Distribution List

1. Defense Technical Information Center
Ft. Belvoir, Virginia
2. Dudley Knox Library
Naval Postgraduate School
Monterey, California