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14. ABSTRACT

Harnessing artificial intelligence has become a priority for the Department of Defense. The 2018 National Defense Strategy calls for the Department of Defense to gain a competitive military advantage, in part through investment in the application of artificial intelligence. Career fields that rely on predictive capability and are data rich are seen as prime candidates for artificial intelligence solutions. This paper discusses how the Air Force Contracting community is positioned to leverage the current capabilities of artificial intelligence in a way that will augment human decision makers in the execution of their mission. The ability to harness artificial intelligence applications will not only enhance business decisions, but will do so in a way that supports initiatives which will result in quantifiable monetary savings for the Department of the Air Force. In order to take full advantage, the career field will need an overarching strategic vision for artificial intelligence, an artificial intelligence minded workforce, and a consolidated effort across the various Air Force Contracting organizations.

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AUTHOR:

Major Brett O. Barnes, U.S. Air Force

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Mentor Team and Oral Defense Committee Member: Dr. Brandon Valeriano, PhD
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EXECUTIVE SUMMARY

Title: Artificial Intelligence in Air Force Contracting: Harnessing Technology to Modernize Business Processes

Author: Major Brett O. Barnes, United States Air Force

Thesis: Given its access to data from previous contracts, and reliance on analytics to advise mission partners and support business decisions, the Air Force Contracting community should look at expanding its artificial intelligence usage in a way that augments human decision makers across the enterprise.

Discussion: Harnessing artificial intelligence has become a priority for the Department of Defense. The 2018 National Defense Strategy calls for the Department of Defense to gain a competitive military advantage, in part through investment in the application of artificial intelligence. Career fields that rely on predictive capability and are data rich are seen as prime candidates for artificial intelligence solutions.

The Air Force Contracting career field utilizes data to make business decisions that achieve the best value for the government. Artificial intelligence offers a means to leverage that data in a way that augments, and potentially enhances, human decision making. Technology such as machine learning and natural language processing offer the ability to consolidate, analyze, and interpret meaning from existing contract data. While current artificial intelligence efforts have been implemented, there are still many areas where the career field can capitalize on current technology.

Conclusion: The Air Force Contracting community is positioned to leverage the current capabilities of artificial intelligence in a way that will augment human decision makers in the execution of their mission. The ability to harness artificial intelligence applications will not only enhance business decisions, but will do so in a way that supports initiatives which will result in quantifiable monetary savings for the Department of the Air Force. In order to take full advantage, the career field will need an overarching strategic vision for artificial intelligence, an AI minded workforce, and a consolidated effort across the various AF Contracting organizations.

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THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

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PREFACE

This paper discusses the capabilities of artificial intelligence (AI) and the potential expansion of applying those capabilities within the Air Force Contracting community. The research is drawn from literature on AIs capabilities and uses in and out of the contracting/procurement environment, courses taken at the Marine Corps University, and discussions with members of the Contracting career field. My hope is that this effort will encourage readers to deepen their own understanding of AI, and then apply that understanding to advancing their own functional area.

I am profoundly grateful to my wife Mandy and two sons, Blake and John Bradley, for their support and patience as I worked on this paper. Additionally, I would like to thank my Masters of Military Science mentor, Dr. Brandon Valeriano, as well as my second reader Lieutenant Colonel William Muir, United States Air Force, for their guidance and encouragement throughout this process.

INTRODUCTION

"Everyone is responsible to purposefully consider and attempt to include AI in everything we do. Exploration, prototyping, and collaboration are not only encouraged, but critical to our future. AI is a DoD priority, the Air Force will measure itself by demonstrated use of technology in the digital age, we all have a significant role to play."
- 2019 US Air Force Artificial Intelligence Annex to the DoD Artificial Intelligence Strategy[1]

The Summary of the 2018 National Defense Strategy states the Department of Defense (DoD) will seek to gain a competitive military advantage, in part, through investment in the military application of artificial intelligence (AI).[2] The United States has placed an emphasis on the development and implementation of AI. The 2021 Interim National Security Strategic Guidance highlights the promise that comes from emerging technology, such as AI, but also recognizes the fact that other leading powers are racing towards such technologies and the US must "reinvest to retain our scientific advantage."[3]

In late 2020, then acting Director of the Joint Artificial Intelligence Center (JAIC), Mr. Nand Mulchandani, challenged organizations within the DoD to think about the work they do, and what might make it more efficient. He contended, a career field that relies on analytics of predictive capability, and is data rich, may be a prime candidate for AI solutions.[4] The Air Force (AF) Contracting career field requires its professionals make data driven assessments to support their business decisions. The career field also has a significant amount of data from previous contracts which can be used to facilitate the development of AI systems. Despite these conditions, the AF Contracting community is currently only using AI technology in a limited and decentralized fashion. Given its access to data from previous contracts and, its reliance on analytics to advise mission partners and support business decisions, the AF contracting

community should look at expanding its AI usage in a way that augments human decision makers across the enterprise.

The goal of this paper is to address the capabilities of AI and outline why AF Contracting should expand its implementation of AI based systems in order to gain efficiency and maximize the AF's buying power. It will begin by looking at current Executive level and DoD guidance on the use of AI. Next, it will briefly look at AI technology, seeking to clarify its different types and capabilities. Furthermore, it will address some of the existing efforts that are utilizing AI in AF Contracting. Finally, it will make recommendations on areas where AI may meet the stated objectives and discuss ways the Air Force Contracting community could move forward with implementing AI solutions.

CURRENT DOD AI Implementation

The call to action on the appropriate utilization of AI within the DoD has been increasing. In a 2019 Executive Order, President Donald Trump identified the use of AI as a means to "drive growth of the United States economy, enhance our economic and national security, and improve our quality of life."[5] The 2021 Interim National Security Strategic Guidance continues to place emphasis on the importance of AI and other emerging technologies. The guidance highlights the need to "provide our workforce with cutting-edge technologies."[6] In his keynote address to the JAIC's 2020 DoD Artificial Intelligence Symposium and Exposition, former Secretary of Defense Mark Esper recognized AI technology as being in a "league of its own, with a potential to transform nearly every aspect of the battlefield…from the back office to the frontlines."[7] At the same symposium, then Secretary of the Air Force for Acquisition, Technology, and

Logistics, Dr. Will Roper, discussed the opportunities for AI to support "missions outside the pointy edge of the spear."[8]

The *Summary of the 2018 Department of Defense Artificial Intelligence Strategy*, outlines the departments commitment to the implementation of AI to "improve support for, and protection of U.S. service members, safeguard our citizens, defend our allies and partners, and improve the affordability and speed of our operations."[9] One of the benefits outlined in the summary is the use of AI to "reduce inefficiencies from manual, laborious, data-centric task…with the objective of simplifying workflows and improving the speed and accuracy of repetitive task."[10] The document goes on to lay out a strategic approach that will focus on key-missions, decentralized-development, cultivation of a leading AI workforce, and enhancing AI partnerships, all while maintaining ethics and AI safety. One key element of the document is the plan to develop training programs for senior leaders to understand the role of AI in defense and how they can "create organizational AI strategies."[11] The strategy goes on to highlight training for mid-level leaders and technical staff to direct and incorporate AI driven solutions. This is all promising for Contracting, as AI based solutions stand to drive reductions in spend and lead-time in support of war fighting requirements.

It is clear DoD senior leaders view AI as a technology that will be instrumental in shaping all facets of the DoD, not just the frontline warfighter. To that end, all functional communities must take active steps in understanding the different types, and realistic capabilities of AI. Doing so will facilitate educated discussions on what core business processes are best suited for an AI augmented solution, and highlight the necessary data and infrastructure needed to implement such capabilities.

The Role of Air Force Contracting

Air Force Contracting professionals are "responsible for the efficient and effective use of taxpayer dollars" to meet the "Air Force national defense mission."[12] To carry out this mission, Contracting professionals must research requirements, formulate business strategies, obtain and analyze data, and provide recommended courses of action to requiring activities.[13] It is essential that Contracting professionals use their best professional business judgment in the course of executing their mission. The obligated dollar amount and number of contract actions executed by AF contracting officers represents a significant portion of the DoD annual budget. According to the publicly accessible version of the Air Force Business Intelligence Tool (AFBIT Lite), AF contracting executed an annual average of $65.3 billion dollars and 117,648 contracting actions between Fiscal Year's 2015 – 2019.[14]

The utilization of existing business data, and the ability to process its meaning, enhances a Contracting professional's ability to achieve the best value for the government. Given the tremendous amount of money obligated, the number of contractual actions executed, and availability of standardized data from previous contracts, Contracting is a career field that is well positioned to take advantage of many of the capabilities AI can provide. While AI would not replace the human Contracting professional, it should be considered as a viable tool to augment decision making in a variety of areas within the career field. Business analytics and spend analysis, support to mission partners on the development of requirements packages, and decision support for contracting officers and buyers are just a few of the ways existing AI technology may prove beneficial to the career field.

LITRATURE REVIEW

Overview of Artificial Intelligence Concepts and Capabilities

Artificial intelligence is certainly not a new idea. The concept of "thinking machines" goes back as far as the 1950s. There has, however, been a renewed interest in AI applications which has been fueled by advancements in computing power or the hardware that supports AI, the availability of massive amounts of digital data to support AI development, and the improvement of the algorithms needed to solve different types of problems.[15] These elements combined have served to make AI a more practical tool that can be implemented to support a variety of different tasks. While developing a deep understanding of AI is beyond the scope of this work, the following is intended to provide high level insight into some types of AI and their capabilities.

Before seeking to apply AI to real world problems, one first needs to understand what it actually is. Dr. Danielle Shah of MIT's Lincoln Laboratories' offers that AI is when machines are able to "mimic human intelligence through behaviors which are typically associated with cognitive functions such as learning and problem solving" or, "the process by which machines turn environmental stimuli into decisions of how to act."[16] In, *Artificial Intelligence in Practice: How 50 Successful Companies used Artificial Intelligence to Solve Problems,* authors Bernard Marr and Matt Ward describe AI as "the ability of a computer system or machine to display intelligent behavior, that allows them to act and learn autonomously."[17] This, they state, is accomplished when "AI takes data, applies some calculation rules (or algorithm) to the data to make decisions or predict outcomes."[18] The DoD Artificial Intelligence Strategy described AI simply as "the ability of machines to perform task that normally require human intelligence" and

offers examples of pattern recognition, learning from experience, making predictions, or taking actions, as a few of the current AI capabilities.[19]

While the advances in AI have been significant, capabilities are still limited in the types of task they can, or should, be used to accomplish. In *What is Artificial Intelligence*, authors Loukides and Lorica state, over the last 20 years, AI has resulted in some extremely powerful programs such as the Chess playing AI program Deep Blue and IBM's Jeopardy dominating Watson.[20] However, they go on to point out that, while these programs have achieved incredible results in highly specialized task, they are not able to perform other human intelligence-like functions beyond their programing. This type of intelligence is commonly referred to as "narrow AI", which is AI that is only able to solve a specific type of problem.[21] The alternative to narrow AI is general AI, or programs that have the ability to solve a range of problems without requiring extensive programing to do so. According to Lincoln Laboratories' Dr. Shah, it is still a widely held belief that we are far from achieving general AI that can replicate the full range of human cognitive task.[22] *Artificial Intelligence in Practice* authors seem to hold the same opinion that AI, in its current state, is most appropriate for solving problems that have set rules which can be programmed using the appropriate algorithm to accomplish the desired task.[23]

In *The Second Machine Age*, authors Erik Brynjolfsson and Andrew McAfee see the new digital world as one being able to augment human decision making just as the industrial revolution augmented humans' physical strength.[24] This is happening in part because of the creation and adaptation of AI systems. Brynjolfsson and McAfee assert that digital machines, through the use of AI, have been able to "demonstrate broad abilities in pattern recognition, complex communication and other domains that used to be exclusively human."[25] In *The AI Advantage*, Thomas Davenport discusses AI or "Cognitive Technologies" as those technologies

that "employ such capabilities-previously possessed only by humans - as knowledge, insight, and perception to solve narrowly defined tasks."[26] Davenport recognizes the "cognitive" label implies that AI technology is focused on accomplishing task that were "once performed only by humans."[27] He points out there are several types of AI which include technologies such as machine learning, natural language processing, and robotic process automation.

Machine Learning (ML) algorithms are used to combine statistics and mathematical optimization to perform task without having to be programed by a human.[28] ML offers the ability to conduct classification, regression, prediction, similarity, and anomaly detection.[29] To do this, ML models must be trained on data sets that are a representation of the data the ML model will be used to solve.[30] There are three primary ways of training an ML model; supervised learning, unsupervised learning, and reinforcement learning. In supervised learning, models learn from large sets of labeled training data that applies to what the model is supposed to classify. In unsupervised ML, algorithms analyze large quantities of unlabeled data, then seek to classify it without human intervention. There is a combination of these two, which is referred to as semi-supervised learning, that utilizes a smaller set of labeled training data to help guide classification. Finally, reinforcement learning is when an ML model learns through trial and error. Applications for this method include robot navigation, and game AI.[31]

Natural language processing (NLP) is a subset of AI that seeks to use computers to perform tasks involving human language.[32] Applications of NLP include "text analysis, translation, generation, and other goals related to translation."[33] While there are many applications for NLP, the one that may be most advantageous to the AF Contracting community is its ability to acquire insight from large amounts of textual data.[34] Specifically, NLP may offer

the ability to produce concise summaries of similar contracts or statements of work for similar goods or services that can support business decisions or the development of new requirements.

Robotic process automation (RPA) systems are able to perform digital task by relying on workflow, business rules, and integration with information systems to act like semi-intelligent users of a system.[35] More advanced RPA systems are able to observe human employees and then emulate their actions. The advantage of RPA systems is their ability to complete repetitive task which will reduce labor cost and minimize human error.[36] While Contracting's labor cost might not see a decrease from the implementation of RPA, it could apply technology to allow employees to focus on more value-added task. While RPA technologies may not be as advantageous to Contracting as other forms of AI, applications that may be useful include the ability to enter data as well as the ability to pull data from multiple websites.[37] The latter could be used to support market intelligence or the development of category intelligence reports.

The systems using these technologies, according to Davenport, can be used to support three business capabilities:

- Automating structured/repetitive work, often via robotics or robotic process automation

- Gaining insight through extensive analysis of structured data, most often using ML

- Engaging with customers/employees using NLP, chatbots, intelligent agents, and ML[38]

The various applications of these three capabilities can be far reaching. Examples of automating repetitive processes that may be most germane to Contracting are the reading of one or more contractual documents and then using that information to produce a useable summarization of the content. Davenport highlights these projects as being the most common because they are generally the least expensive, easiest to implement, and generate a high return on investment.[39]

Gaining cognitive insight involves the "use of algorithms to detect patterns in vast volumes of structured data and then interpret its meaning."[40] This type of capability is most useful when making predictions based on large quantities of data. For Contracting, this could enhance an analysis of various categories of spend to show where there are large deltas in price paid. Doing so would highlight goods or services that may be most appropriate for strategic purchasing initiatives.

Finally, cognitive engagement involves using AI to "engage employees and customers providing them with rich language or image-based personalized services."[41] This type of capability is generally used for answering questions or making recommendations. Examples include intelligent agents that offer customer service and systems that recommend medical treatment options. The AF Contracting community could look to such technology to augment workers by having a platform that can offer automated advice to mission partners who may be developing a requirement that will need a contract solution. It was noted that such technology can lead to dissatisfaction when those using chatbot technology are required to restate their issues to a human agent.[42]

Throughout this paper there will be instances where these three different capabilities have been, or can be, applied to augment task normally accomplished by humans.

Practical Applications of AI

While the capabilities of AI are broad, and can encompass elements of autonomous vehicles and robotics, the more applicable applications for Contracting seem to be those happening in the business and medical fields through the use of machine learning and natural language processing. The following cases offer insight into where the implementation of AI has been successful in augmenting human workers in two distinctly different fields.

The first application is Vanguard's "Personal Advisor Services" or PAS system, which is a robo-adviser that "combines automated investment advice with guidance from human advisors."[43] Robo-advisers are AI supported systems that may be used to "provide decisions that are ethical and compliant with regulation" and offer decisions that are "likely to be more accurate than those made by human intuition."[44] Launched in 2015, the Vanguard PAS platform provides clients with a mix of human and algorithmic investment advice based on a series of questions related to their individual investment situation such as financial objectives, risk tolerance, and wealth characteristics.[45] The PAS system considers each investor's responses, then provides a hybrid of human/machine advice to generate a proposed portfolio strategy that best meets the individual's investment goals.[46] While each investor using the PAS platform must speak with a human financial advisor, algorithms perform the bulk of the analysis and recommendations.[47] In 2019, Vanguard expanded its robo-adviser offerings to include it Digital Advisor (DA) option. DA considers many of the same types of questions as the PAS systems however, unlike PAS, DA offers users a completely digital experience. Based on the user's risk attitude, the DA system will provide guidance and recommendations to meet the individual's investment goals.[48]

The ability of these systems to utilize algorithms to provide personalized financial recommendations can augment the advice of human financial advisors or help individuals, especially those with a lower understanding of investing strategy, make more informed decisions without having to pay for a human adviser. There may also be advantages in having a robo-adviser as opposed to a human making recommendations. One is the varying level of skill, education, or particular investing bias that comes with having just a human financial manager. A 2019 article from Business Insider points out that a "robo-adviser may not perform significantly

better than a great financial adviser, but not all financial advisers are great."[49] Another advantage of financial robo-advisers is that they generally charge clients lower fees than those that rely on humans. In this way, AI adds value to both the institution and the client. The institution is able to utilize its human financial advisers in a way that is most advantageous, and the client enjoys sound advice while paying a lower fee.

The medical community is also looking towards AI to support various aspects of patient care, including AI making a diagnosis that might otherwise be missed by a human. One recent application is the DoD's Rapid Analysis of Threat Exposure (RATE) system, which has the potential to help the medical community identify cases of COVID-19 up to 48 hours before a patient becomes symptomatic.[50] The RATE system utilizes ML algorithms to "explore large sets of data for patterns in how the human body changes when it acquires an infection."[51] Dr. Christian Whitchurch, the Director of Human Systems at the Defense Innovation Unit, explains how the RATE model was trained on data collected from "293,109 participants, including 256,320 controls and 36,782 with known hospital acquired infections and correlated to these common attributes: temperature, pulse oximeter and cardiac measures."[52] To make its predictions, the RATE system can analyze changes in an individual through data collected via commercial technology, such as smart watches. Being able to accurately predict when someone has been infected offers the ability to minimize the spread of COVID-19 by enabling military personnel to initiate self-quarantine, thereby preventing further spread of the disease.[53] These types of predictions are invaluable in early identification and mitigation of infectious diseases and would almost certainly be missed without AI supported technology identifying subtle changes in an individual's health. Future applications of RATE may be realized by its ability to better prepare military members against biological warfare.[54]

These cases offer insight into how AI is being used to create efficiencies and augment humans in two distinct sectors. A deeper discussion of how these, and other AI applications can be applied to Contracting will take place later in this paper.

Applications of AI in Contracting/Procurement

While the literature on AI principles and applications is vast, this review found a much smaller body of scholarly work relating to current AI applications in the Contracting and Procurement fields. A 2020 Naval Postgraduate School thesis by Kory Krebs begins to explore the utility of applying AI to the Contracting career field. He specifically discusses spend analytics, which is an area that would seem to be ripe for AI solutions. As the Federal government spends billions each year on services, commodities, weapon systems and construction, there will be an abundance of data to evaluate. Krebs also provides a basic concept for how an organization should approach AI implementation, such as prioritizing which task can be helped through technology, acquiring data, using agile development, gaining small wins, and collaboration with other agencies conducting similar work.[55] Additionally, through the use of interviews, he looks at what some organizations are already doing to institute AI into their processes. There are still opportunities to expand on what level of savings may be achieved, how data will be gathered, how AI could enhance decisions on contract type, and how to best train the workforce for identifying and implementing future AI solutions.

In a 2019 paper titled *Emerging Procurement Technology: Data Analytics and Cognitive Analytics,* authors look at the current and future state of procurement analytics, and what changes will need to take place to enable the integration of analytical solutions.[56] They see procurement analytics as data-driven approaches to solving issues such as management of spending, cost reduction, supplier management, category market intelligence, and stakeholder value

improvement.[57] They break analytics into two categories, data analytics and cognitive analytics.

They see data analytics as a "systematic approach that provides data-based explanatory and

predictive modeling to provide insight into business problems,"[58] Cognitive analytics, according

to the authors, is a more sophisticated approach that implements ML and AI technologies to

analyze both structured and unstructured data.[59] They point out how cognitive analytics has the

ability to understand language, understand underlying ideas and concepts, and deduce outcomes

of identified relationships between different variables.[60] Moving forward, authors believe data

governance will be required to achieve the benefits of analytic technologies and that learning

algorithms will replace humans, resulting in the recognition of data errors.[61] They also see

analytics in spend management as being able to provide "solution-oriented insights…based on

predictive analytics and scenario analysis."[62] To move forward with cognitive analytics, they

offer a roadmap for developing a procurement analytics culture that includes: 1) developing a

data management and governance discipline, 2) identifying target areas for analytics, 3)

exploring the application of alternative analytics approaches, and 4) establishing a technology

roadmap for the adoption of new procurement technologies.[63]

In a 2019 Forbes article, *AI in Procurement: Where We're Headed*, author Michael

Higgins lays out his concept for what procurement functions may benefit from AI. He sees AI

supported risk assessment as one area that may add value in the procurement process. Ideally,

this would be done by an AI driven assessment based on "reliability, stability, and other

predictable factors."[64] He also points to spend optimization and reduction as an area that may

see benefit. His belief is AI will be able to classify and organize spend faster and more

accurately than a human.[65] Doing so will allow for an assessment and decision on how to secure

better rates, terms and conditions that maximize value.[66] Higgins sees talent development,

digitization, and forward-thinking strategy as the starting block for organizations looking to move towards AI supported procurement solutions.[67]

Implementation

One of the most valuable lessons from this review is the insight one gains from understanding how to begin implementing AI solutions into business practices. In T*he AI Advantage,* author Thomas Davenport offers a concise process for leaders and companies considering AI solutions. Intuitively, this begins with leaders "understanding cognitive technologies and how they work".[68] He posits, organizations should look to build on current analytical strengths, ideally headed by a preexisting data science or analytics group.[69] He goes on to advocate for three types of assessment: the domain assessment, use assessment, and technology assessment. In this process, organizations will explore which domains may benefit the most from cognitive applications, where AI use can generate the most value or business success, and if the organization is truly up to the task of bringing in AI solutions.[70] In A*rtificial Intelligence in Practice*, Marr and Ward also address this topic, and their beliefs seem to align with Davenport's. They assert a sound way to begin the process is by looking at task that can be automated now, or in the near future, as well as identifying those which should not be considered for an AI solution, and expand this by pointing to tasks that involve empathy, social communication, critical and strategic thinking, and high dexterity as being best suited for humans.[71]

Should an organization decide to move towards an AI solutions, having a strategic roadmap will be beneficial in guiding a team through in their execution of the project. In the Lincoln Laboratory's *Survey of AI* course, Mr. David Martinez offers 10 guidelines to the successful deployment of an AI system. The steps he lays out are as follows:

1. Develop a clear vision and project roadmap for the AI system
2. Understand the customer needs
3. Strengthen AI team by fostering internal and external relationships
4. Build a multidisciplinary and diverse team with complementary skills
5. Provide Measurable objectives while mentoring AI talent
6. Continue to expand AI team skills as future work evolves
7. Demonstrate an initial AI capability then iterate
8. Verify individual subcomponents and validate end-to-end AI system
9. Secure AI systems both physically and against cyber threats
10. Attend to ethics in AI.[72]

While there are some ongoing AI efforts taking place within the career field, literature did not reveal what exact efforts are being made to ensure implementation is following a strategic plan. The aforementioned guidelines may not be the only strategic model that offers utility when developing an AI system, however, it does outline critical elements that warrant consideration. Suggestions on how implementation may be pursued will be explored in a later section of this work.

Noted Challenges

While AI does offer potential utility when applied correctly, there are also significant challenges that may come with implementing AI solutions. Foremost, is the notion that the current hype is still far ahead of AI capabilities. In the article *Myths of automation and their implications for military procurement*, authors do not specifically address automation or AI as it relates to Contracting but, do point out issues with autonomous systems on a larger scale. The main contention is autonomous systems, which are designed to enhance capacity, may lead to a more task saturated workforce. This, the authors contend, is because humans can become the systems "caretaker", leaving them unable to focus on other tasks.[73] They also point to an overreliance on automated systems, which can lead to humans trusting systems more than they should.[74] As AI systems become more prevalent, users may look to them as infallible but, in so doing, lose the requisite skills needed to know if the outputs are actually correct.

In the Air Force's 2019 *Autonomous Horizons*, one recommendation is that systems "should be designed to ensure trust when operated or teamed with human counterparts" and that "tenants of trust include cognitive congruence and/or transparency of decision making."[75] A major factor in implementing any system will be the government's ability to understand why the AI system made the decision it did. In *Shaping the Future of the Fourth Industrial Revolution*, Schwab discusses this issue, stating "many of today's AI systems act as Black Boxes…We don't understand fully how some of the most popular machine-learning algorithms…arrive at their conclusion."[76] He goes on to explain that even if the decision were understood, the "AI will likely modify its approach for the next decision."[77] This uncertainty about how machines make decisions does appear to be in conflict with the Air Force's recommendations about transparency and may create issues as the service looks to implement capable AI systems.

There are also the ethical concerns that come with implementing an AI system. Schwab specifically discusses this as a high priority as "AI is capable of having an impact everywhere from labor markets to vehicle navigation to decisions about creditworthiness."[78] In Contracting, ethics in the contract award process are expected, and interested parties wishing to call a decision into question may look to protest a government decision. The *Federal Acquisition Regulation* states that a protest by an interested party may be filed for: a solicitation…for a contract for the procurement of property or services; the cancellation of the solicitation; an award or proposed award of a contract, or; a contract termination.[79] In such a case, it will be incumbent on the government to show how a decision was made. If AI becomes involved in the decision-making process, defending Government decisions may prove exceedingly difficult if the rationale cannot be explained/defended. To meet this challenge, Contracting would need to develop what Wilson

and Daughtry refer to as "explainers", which are professionals trained to explain AI decisions to non-expert users.[80]

METHODOLOGY

This study assesses the current state of AI capabilities, looks at its use in and out of AF Contracting, and offers suggestions for potential future applications and AI implementation strategies. The information contained in this research is based on a study of existing literature regarding AI and its uses both in and out of the Contracting and Procurement career fields. Additionally, it looks at various government documents to establish a sense of current AI mandates and initiatives. It also draws on lessons from the Massachusetts Institute of Technology (MIT) Lincoln Laboratories' Survey of Artificial Intelligence course. Furthermore, it gathers data from online sources such as the Air Force Business Intelligence Tool Lite (AFBIT Lite) and the Product Service Code (PCS) Selector Tool. Finally, discussions with AF employees were used to understand current AI efforts taking place that may enhance capabilities in the AF Contracting career field.

Utilizing this methodology allowed for a qualitative analysis and consolidation of scholarly information, government literature, academic coursework, and functional knowledge related to AI. This approach addresses the question of AIs potential utility in Contracting by presenting real-world AI applications and challenges, then aligning those with potential applications for Contracting that are similar in nature.

CURRENT AF CONTRACTING AI INITIATIVES

The Air Force Contracting Community has already begun to look at, and in some cases implement, AI technology as a way of supporting processes. A series of phone calls, coupled

with additional research, revealed there are currently some AI supported applications being used to streamline processes and free up human resources for other efforts. The following will discuss a few of these ongoing efforts, their intent, and if known, their impact.

The first effort is the Product Service Code (PSC) Tool that was developed through a collaborative effort between the Naval Postgraduate School (NPS) and the Air Force Installation Contracting Center (AFICC). A PSC is the federal Governments method of classifying the various types of services and commodities being procured. Using 4-digit coding, the PSC system is able to categorize over 2,000 different products or services that are procured by the federal government.[81] As the AF Contracting community continues to look at AI enhanced solutions, accurate data will be paramount in achieving reliable, accurate outputs. The PSC Tool helps to ensure the most accurate PCS is assigned, which supports accurate business intelligence and will ensure higher quality data for future AI initiatives. At the same time, the ability to accurately identify potential PSCs in a matter of seconds will reduce unnecessary time contract managers spend searching for the appropriate code.

The PSC selector "performs hierarchical classification through the use of artificial neural networks, specifically character-level convolution neural networks".[82] These networks "mimic certain biological processes to process information and perform task, such as prediction and classification."[83] The PSC Tool provides users a simple and intuitive interface that resembles a traditional search engine. After inputting a description of the product or service being procured, users will be provided with a series of PSCs that potentially align with the good or service being procured. The system is also able to provide a percentage for the quality of match corresponding to each PSC that is recommended.

Another ongoing effort being conducted at the AFICC is the utilization of ML to streamline and standardize Performance Work Statements (PWS). A PWS is a document used to describe a government requirement in terms of the required results rather than how it should be accomplished.[84] During a phone interview, an Operations Research Analyst at AFICC detailed an effort to scrape existing PWSs in order to facilitate the development of a PWS for a new requirement that involved similar work. The effort was in response to a yearlong effort on the part of the requiring activity to review existing PWSs to support their own requirement. Based on available time and resources, it was a prohibitively lengthy process to have individuals working to evaluate and consolidate previous requirements into a new PWS. To support this effort, AFICC was able to successfully utilize ML to evaluate all similar PWSs, then cluster the results based on the specific task. The results thus far have been impressive, with AFICC being able to generate a 90% solution to requirement owners in about a week.[85]

The ability to support requirement owners in the development of requirement documents has significant implications on the amount of time it will take to place a service on contract. The cost savings are equally, if not more significant. If an ML algorithm is able to produce a 90% solution in a week for a task that would otherwise consume one or more individual's time for months, then it is certainly a capability that should be prioritized by both Contracting and the requiring activities. An enhanced feature that is worth consideration is an ML based capability that can provide granularity on the extent to which certain elements or task in a PWS may be driving cost for a requirement. This type of information will serve decision makers as they seek to better understand how a specific task may influence the overall cost, thereby allowing them to prioritize accordingly.

MOVING AHEAD WITH AI

Potential AI Applications

The DoD, through its guidance and establishment of the JAIC, has shown it is committed

to integrating AI in areas where it can generate efficiencies. The PSC Selector tool and the

AFICC initiatives in document examination and clustering show that AI can add value and

generate saving for both Contracting and its mission partners. The latter ability to reduce the

time required for developing a PWS by 90% has the ability to significantly reallocate time for

employees. Further evidence of savings can be found in the Deloitte article titled *The AI*

Opportunity in Sourcing and Procurement. It points out where their 2019 Global Chief

Procurement Officer Survey, which receive 500 responses, showed that 25% have, or are

developing an AI based solution.[86] For the companies that have implemented AI solutions, 93%

are satisfied and are seeing benefits from their AI investment.[87]   One specific benefit highlighted

is the ability of AI systems to classify spend data with a 97% accuracy rate.[88] Should

Contracting look to expand its use of AI, each opportunity will need to be evaluated by a multi-

functional team on viability, cost, potential savings, and long term sustainability, however, the

ability to use AI to reduce cost and generate efficiencies offer significant opportunities if

harnessed correctly.

There may be many areas or processes that can benefit from AI solutions. The following

will offer a few potential areas where the community may be able to improve on its current

processes. Table 1 below offers a brief overview of the potential AI applications which are each

then described in greater detail.

Table 1: Potential AI Applications for AF Contracting

Area	Potential AI Applications
Spend Analysis	Apply NLP/ML capabilities to enhance granularity of spend analysis of existing contract spend data.
Requirement Owner Support	Utilize AI capability to Contracting support to requirement owners developing executable requirement packages.
Category Intelligence Reports	Harness AI technology to augment Contracting Professionals in the development of Category Intelligence Reports.
Contracting Officer / Administrator Support	Augment employees by applying AI capabilities to offer suggestions based off previously executed contracts.

One area to be considered is the use of NLP and ML to enhance how the career field analyzes spend data. Today, the AFBIT tool offers the career field the ability to understand spend at the PSC level however, there are at least three issues that arise from this level of analysis. The first is that it is prone to human error in assigning the correct code, or an error made when entering the data. The second issue is that a contract may have multiple items or service, but the PSC assigned may only capture one of these, causing a misallocation of spend in future analysis. Finally, the level of granularity at the PSC level may not be sufficient to understand exactly what was purchased.[89] To fully understand what was procured would require a human to look through the item description and decide what was actually relevant. This is time consuming and would still not account for goods or services that might be missed based on errors in PSC data input. Looking at ways to apply NLP to extract information at the contract line-item description will provide an analysis that is a better depiction than simply looking at spend at the PSC level.[90] This may also offer the opportunity to correct previous data entry that will support future analysis.

Another opportunity to be considered is a system that is similar in nature to the Vanguard PAS platform. While the PAS system does not entirely mirror the AF's procurement process, there are certain similarities that may improve upon the current approach. The most beneficial

similarity is the way such a system could advise requirements owners through the development of their new requirements packages. An AI based system that could provide recommendations, based on previous Air Force acquisitions, and supported by a human Contracting professional would have the potential to reduce Contracting lead time, as well as reduce cost by exposing the requiring activity to alternative solutions used by other organizations.[91] Drawing on data from existing contracts, such a system could provide a requirement owner with an understanding of what has been procured in the past that is similar to their existing need. It should also provide utility in the development and consolidation of all necessary requirements documents. The ability of a Contracting professional to execute may be delayed if the requiring activity omits a necessary piece of information or adds overly restrictive criteria for the item or service required. Identifying these issues prior to the requirements package being sent to Contracting has the potential to reduce rework that will almost certainly prolong the time required to place an item on contract. There may also be savings realized if such a system offers requirement owners insight into alternative solutions that may not have been considered in their market research.

A third opportunity is using NLP and ML to support the Air Force in its category management efforts. In *The Second Machine Age,* authors Brynjolfsson and McAfee discuss how Forbes is successfully using AI to produce their corporate earnings previews for their website. The results, according to the article, have been "virtually indistinguishable" from work done by humans in the past.[92] Applications of this nature may be advantageous in how the AF Contracting community produces category intelligence reports to support strategic sourcing initiatives that can leverage buying power, minimize lead time, or result in more favorable terms for the government. Air Force Category Intelligence Reports are "informative, detailed, painstakingly assembled…reports" that provide decision makers with a "concise recommended

course of action; and practical execution plan."[93] By harnessing technology similar to that being used by Forbes, the Air Force may realize the ability to generate these reports in a manner that is significantly less "painstaking" than the existing approach.

Finally, there may be opportunities to apply AI in a manner that supports less experienced buyers and contracting officers. One way to accomplish this is to look at how AI is being used to support diagnosis in the medical career field.[94] While there are stark differences between the procurement and medical fields, there are similarities in the varying experience levels among procurement professionals and doctors. Just as doctors need years of experience to develop, so do Contracting professionals. Such a system would look at the relevant information for a requirement, such as the good or service being procured and its estimated dollar value, and then make recommendations that could support the selection of solicitation method, contract type and appropriate clauses.[95] If developed to do so, it could also provide insight on previous contracts of a similar nature or potential existing contract vehicles that might be able to support in a faster, more cost-effective manner. Doing so has the ability to reduce cost, minimize lead times, and prioritize actions based on the nature of the good or service being required.

Organizing for Change

Should the career field choose to expand its emphasis on AI technology as a means of augmenting humans in executing their mission, the ten-step process highlighted in the Implementation portion of this work's literature review offer's insight for how to potentially move ahead. The first step in the process is the development of a strategic roadmap. The DoD and AF have both developed strategic guidance on AI use. The career field may benefit from developing its own strategic guidance as a way to inform the career field of the overarching intent and goals for AI. This should support teams with enhanced focus as the look towards

developing their own AI solutions. While this strategic guidance may cover many facets of AI implementation, one critical area will be the assessment of data requirements. How data is collected, managed, and used will be instrumental in the success of AI programs. A sound data strategy will potentially support the entire enterprise in its advancement of AI as users will know what is available, what is needed, and what cannot be accessed.

The second through fourth steps, "understanding customer needs, strengthening AI team by fostering internal and external relationships, and building a multidisciplinary team with complementary skills" respectively, all go hand in hand. Should the career field look towards implementing AI solutions, it will require a team of subject matter experts that would ideally include contracting professionals, AI experts, data scientist and, for projects that reach beyond Contracting, the appropriate external stakeholders. Bringing together this type of group will help identify potential tasks that are well suited for AI solutions. Additionally, this group would be able to determine what data would be required, and whether such a capability can/should be developed in-house or if a contracted solution is more appropriate. While there may be many resources available to support AI efforts, one potential external resource is the USAF-MIT AI Accelerator program. The AI Accelerator program is a cooperative agreement that "conducts fundamental research to enable rapid prototyping, scaling, and the ethical application of AI algorithms and systems to advance the Department of the AF and society in general."[96] The AI Accelerator program offers Airmen and Space Professionals a means to propose "Challenges" that may be solved by AI. While it does not appear that all challenges will be taken on by the program, it does offer a means to potentially leverage the expertise of academia, industry, and the public to support identified problems.[97]

Talent development, addressed in step six, is another area where the career field may realize additional benefit. Based on this research, it seems there are already individuals within the career field that have some understanding of AI capabilities. Leveraging these individuals, when possible, will support future efforts by managing expectations of AI systems, working through potential task that may warrant an AI based solution, and developing less seasoned individuals that may be involved in AI projects of working groups. There are also a host of resources available to aid in the development of AI talent. The MIT Survey of Artificial Intelligence course which was referenced in this research may benefit members looking to develop a deeper understanding of the full spectrum of AI capability.

One potential recommendation is the career field establish an AI Initiative focal point as a means of monitoring AI initiatives and fostering collaboration across the various Contracting squadrons, branches, divisions, and centers. Doing so would help members of the career field identify other offices that may be looking towards, or implementing, AI based solutions. It may also shed light on AI talent that can help facilitate the advancement of AI within the career field. This will support the sixth and seventh step of expanding AI team skills and demonstrating an initial capability. The effects will be broader acceptance and use of AI systems and, hopefully, more executable AI projects that can aid in the most effective and efficient execution of the Contracting mission.

Finally, any potential project will require teams to consider the ethical use of the system as well as a plan for how it will be maintained. As referenced earlier, there may be instances where understanding of how an AI recommendation was made is difficult, if not impossible, to understand. This will require teams to understand the potential impacts of what this level of uncertainty will mean for their intended application. Systems will also demand users maintain

and update them as necessary. Developing a plan for how systems will be maintained throughout their lifecycle will be a necessary step when teams are considering AI based solutions.

CONCLUSION

Given the emphasis being placed on AI, the seemingly favorable access to data, and the ability to produce quantifiable savings in both dollars and manhours, AF Contracting is a career field that appears well positioned for AI solutions. The current capabilities of AI align well with many of the primary Contracting functions. Existing efforts, such as the PSC Selector Tool and AFICCs work with extraction of natural language from PWSs show that AI can provide utility for the career field. Tasks, such as spend analysis and category management, are just two areas that may see benefit from expanding the use of AI. Organic development has proven to be a possibility, but there are also civilian companies working to provide AI solutions to contracting and procurement problems which may be able to support future endeavors. The Contracting career field has an opportunity to show the benefits of AI in a way that produces real savings for the DoD. It is also a chance to develop AI systems that can benefit users with potentially lower risk to mission accomplishment and less ethically questionable than some alternative AI applications. It may be rare for a technology to come along that can fundamentally alter how Contracting professionals analyze information to support business decisions. AI looks to be a technology that can do just that. While harnessing AI capabilities will require a strategic direction and a dedicated team of experts working together, the potential to augment humans with AI based systems has the potential to transform the current Contracting environment.

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