Artificial Intelligence in the Marine Corps Logistics Enterprise

Part 1: It's not pretty: What is artificial intelligence and its components?

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Marine Corps logistics is moving toward artificial intelligence (AI) as an element of our logistics systems. We will address the challenges for the Marine Corps and provide solutions through a three-article series. Article one, "It's Not Pretty: What is artificial intelligence and its components?" sets up the discussion and addresses what AI is and the building blocks associated with it. The article addresses misinformation or misunderstanding of AI that results from its extremely broad application and the varying degrees with which it is developed and implemented. Article two, "It's Not Pretty: How ugly is AI progress in Marine Corps logistics?" will discuss why the Marine Corps logistics enterprise is unable to take advantage of industry technology in timely, relevant, or meaningful ways. The article brings together the magnitude of challenges in implementation for logistics applications. Finally, article three, "It's Not Pretty: How can we start making AI progress 'prettier'?" will discuss an enduring business solution for getting AI

Thesis statement: The Marine Corps logistics enterprise does not have the building blocks in place to use or implement AI in the logistics community. Right now, AI and its application in logistics is a people and skills problem.

implementation right and preventing mistakes early on. It provides tangible and achievable goals to build the capability for execution.

Level-Set Discussion about AI

What is AI? Definitions and capabilities of AI for Marine Corps logistics applications are not uniformly understood, much less agreed upon; furthermore, AI represents broad, dynamic, and evolving technology. There is not a clear understanding among Marine Corps logistics professionals of where the lines between data, information, business analytics, automation, and deep/machine learning are—much less how to formulate and perform these

functions. Adding in AI creates another layer of complication. We will attempt to unify the collective understanding of technology and the path to AI.

Definitions and Building Blocks

In this section, we will provide critical definitions for the essential building blocks of AI. There are several precursors to AI, and it is important to understand how the precursors are linked. AI begins and ends with data. However, the bridge between data and AI is pillared on information, knowledge, analytics, automation, deep learning, and machine learning. Put simply, AI is to data what astrophysics is to arithmetic. There are steps in between that must be refined or, dare say, mastered before diving into a new arena. Ultimately, AI performs human-like analytical tasks based on pattern recognition. Pattern recognition is best accomplished through data manipulation and visualization known as business analytics. Within business analytics, there are critical components of data, information, and knowledge. Below, we provide

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detail for each of these components and the relationship of business analytics with data, information, and knowledge is depicted in Figure 1.

Data is "the basic individual items of numeric or other information, garnered through observation; but in themselves, without context, they are devoid of information."[1]

> **Business analytics is the process of analyzing raw data to draw out meaningful, actionable insights. Effective analytics is the key driver behind data, information, and knowledge. It is embedded within each domain (Figure 1). Without it, we cannot make sense of material to understand the meaning, recognize trends, or arrive at a decision. When looking at a random set of numbers, we can determine it is a phone number. Further analysis can reveal what country it might be from, the state where it was issued, and even to whom it may belong.**

Example: Think about random numbers 5553467864, which have no meaning.

Information is "that which is conveyed, and possibly amenable to analysis and interpretation, through data and the context in which the data [is] assembled."[2]

Example: Give meaning through rational connection. 555-346-7864 is a phone number.

Knowledge is "awareness, understanding, or information that has been obtained by experience or study, and that is either in a person's mind or possessed by people generally."[3]

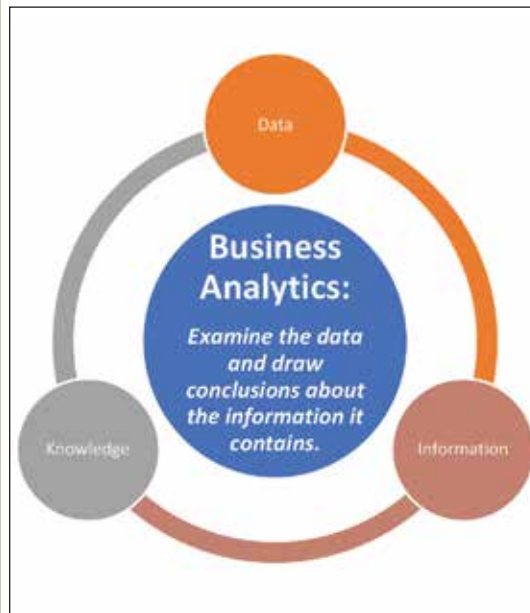*Example: Apply useful meaning to the phone number. 555-346-7864 is Jim's*

Figure 1. *(Figure provided by authors.)*

number; he is the owner of a manufacturing business.

Automation is "the ability of software systems and equipment to perform repetitive, monotonous tasks."[4]

Examples: text notifications on your smart device, assembly lines, and out-of-office replies.

Deep Learning/Machine Learning is "a type of artificial intelligence that uses algorithms (sets of mathematical instructions or rules) based on the way the human brain operates" and "the process of computers changing the way they carry out tasks by learning from new data, without a human being needing to give instructions in the form of a program."[5]

Example: speech and image recognition.

Artificial Intelligence is "the ability of machines to perform tasks that normally require human intelligence—recognizing patterns, learning from experience, drawing conclusions, making predictions, acting, and more—whether digitally or as the smart software behind autonomous physical systems."[6] "AI makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tasks."[7]

Examples: autonomous vehicles, smart assistants like Siri, and grammar predictions.

Like anything else, AI is a building process that requires multiple predecessors to execute correctly (Figure 2 on following page). It is a sequencing of steps from a repertoire of operations, each building from its predecessor so that the goal is better achieved. In business, certain elements must first be refined or created before reaching the desired end state. For example, stakeholders must be identified, roles and responsibilities defined, project scope created, budget formulated, timeline built, milestones established, goals prioritized, and deliverables defined. The Marine Corps is no different. The Marine Corps Planning Process has taught us that there are precursors to the final execution of a well-developed plan. Before we reach the transition step, we must sufficiently tease out a problem-framing course of action (COA) development, COA wargame, COA comparison and decision, and orders development. Moving from problem framing straight to transition does not work—neither does jumping Marine Corps logistics from its current state to AI without enhancing the predecessors.

Business analytics (data, information, and knowledge) can be accomplished without the use of computers, non-digitally. Even though the use of computers and digital systems can enhance analytics, they can still be accomplished (albeit slower and less efficiently) by non-digital systems and processes. Replicating a non-digital process in digital form should not be confused with automation.
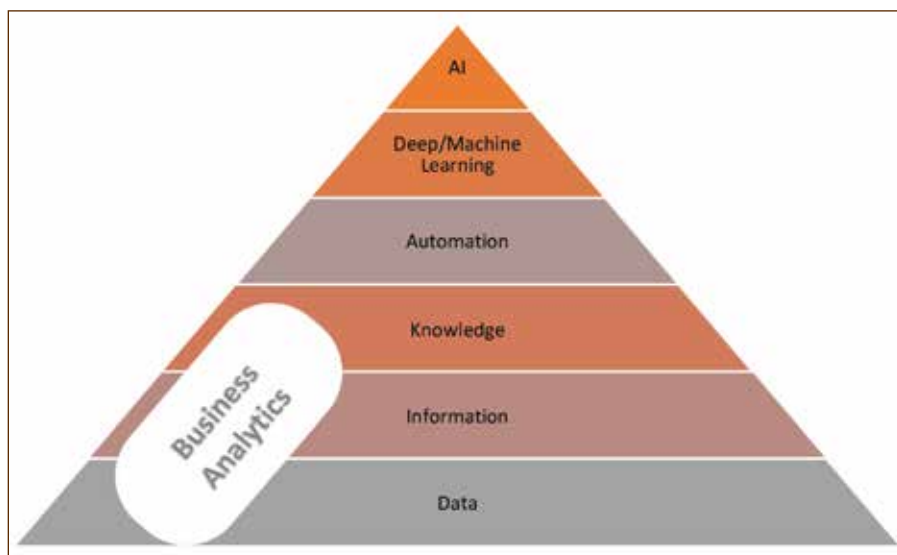
Figure 2. *(Figure provided by authors.)*

Findings From Relevant Literature

Reading the Commandant's *Sustaining the Force in the 21st Century* and *Talent Management 2030, Marine Corps Gazette* articles, and "Stanford University Artificial Intelligence Index Report 2021" provides a great perspective on the direction logistics is headed and the precursors that are necessary before AI exploitation. Military-specific publications establish the status of AI internal to Marine Corps organizations, while academic publications convey a broader perspective and describe the industry overall. Below is a synopsis of those materials to provide readers with a collective understanding and establish common knowledge.

During his time as Commandant, Gen Berger has published several documents that outline his visions for developing a Marine Corps that is relevant and prepared for future conflict environments. A common thread of urgency to address talent and technology shortfalls can be seen throughout the documents:

Sustaining the Force in the 21st Century: Gen Berger states the logistics community must identify the improvements necessary to elevate the MAGTF beyond its current state. He goes on to allude that we must always review, discuss, and debate the capabilities we hope to develop. Finally, he talks about data-driven processes for conversion into actual task-related information.

Talent Management 2030: Gen Berger primarily discusses the retooling of our personnel system to better recruit and retain especially skilled individuals. The former Commandant says, "unless we find a means to quickly infuse expertise into the force—at the right ranks—I am concerned that advances in artificial intelligence and robotics, among other fields where the speed of technological change is exponential, will force us into a reactive posture. We should have an open door for exceptionally talented Americans who wish to join the Marine Corps, allowing them to laterally enter at a rank appropriate to their education, experience, and ability."[8]

Gen Berger is referring to the building blocks that are necessary to advance our logistics operations. He is not expressing a specific direction here but is leading the logistics community to identify vulnerabilities and mitigation strategies that will enable advanced technologies like AI in support of the MAGTF. Likewise, following the Commandant's guidance, our recommendations will enhance our current capabilities to better transition into more technological domains.

A review of *Marine Corps Gazette* articles from the last five years highlights that we have an exceptionally large gap to close from our current logistics practices to what is required in future operating concepts as outlined in key documents like the *National Defense Strategy* (2018), the *Commandant's Planning Guidance* (2019), and *Force Design 2030* (2020). Technology, innovation, and rapid flexibility will be essential for logistics support, yet progress is being slowed by legacy systems and practices:

"21st Century Logistics, Designing and Developing Capabilities": LtGen Dana's (Ret) focuses on hybrid logistics, which optimizes old technologies and blends them with the new, discussing how data will drive our future. He indicates that the Marine Corps must realize the full potential of a user-friendly Global Combat Support System-Marine Corps while anchoring in data-driven predictive analytics. Harnessing a data-based approach will elevate logistics operations to the next level. He then mentions training and education as critical for logistician success. He talks of greater operational understanding among the joint, interagency, international, commercial, and host-nation environments to expose logisticians to new ideas. In article two, we will pick up on this topic and address the analytical skills shortfall that is becoming an ever more abundantly clear impediment to advancements and growth in the technology sphere.

"Future Logistics Challenges": BGen Stewart (Ret) points to logistics information technology shortcomings and our struggles to maintain material readiness for the future we want. He states that we need a user-friendly command and control foundation to advance any future capability or innovative technology. He questions whether the logistics community is invested and taking the right steps to properly educate and train the force for *big data* and advanced technology execution.

"Data Driven Logistics": LtCol Spangenberg et al proposed a year-long experiment that would equip the MLGs with specialized cells focused on data-driven logistics. The cells would consist of six to fifteen Marines with expertise in data engineering, systems engineering, software design, and data analysis. These

teams would "experiment with data (collection, analysis, visualizations, decision support) to tangibly demonstrate capabilities, limitations, and requirements of D2L [data-driven logistics] ... collect, access, and analyze data; produce actionable insights with clear visualizations; and answer questions or solve problems to enable decisions of their host MLG."[9] At its core, the article proposes a solution to conduct formalized business analytics with core competencies in a manner that mimics leading logistics companies and organizations in the private sector.

The key documents discussed above highlight two crucial points. First, we are unquestionably headed into a data-centric world. Second, we do not have the core competencies, skills, or training to maneuver properly within the inescapable advancements in technology and AI development. We argue we are not even close to commercial industry progress.

The "Stanford University Artificial Intelligence Index Report 2021" highlights the trajectory of AI research and publications and accurately tracks the current state of the art for AI. The report compares the trajectory and effort of various industries, economic sectors, superpowers, Fortune 500 companies, etc. The key takeaways are listed below:

Private investment in AI soared: The private investment in AI in 2021 totaled around $93.5 billion—more than double the total private investment from 2020.

AI capabilities and technology shifts: The AI algorithms are more capable than ever and continue to make drastic improvements (language and image recognition). Robotics are less expensive and more accessible than ever before (42 percent price decreases).

The United States and China dominate cross-country collaborations on AI: Despite rising geopolitical tensions, the United States and China had the greatest number of cross-country collaborations in AI publications from 2010 to 2021, increasing five times

since 2010. The collaboration between the two countries produced 2.7 times more publications than that between the United Kingdom and China—the second-highest collaboration on the list.

Increased investment: Data management, processing, and cloud received the greatest amount of private AI investment in 2021—2.6 times the investment from 2020—followed by medical and healthcare.

Technical experts flocking to industry—not government: In 2020, one in every five computer science students who graduated with PhD degrees spe-

Figure 3. *(Figure provided by authors.)*

cialized in AI/machine learning, the most popular specialty in the past decade. From 2010 to 2020, most of the AI PhDs in the United States headed to industry while a small fraction took government jobs.

The chart above (Figure 3), which depict the number of publications written on AI, correlate with the sense of urgency for AI progress in the Marine Corps and industry. The chart on the left depicts the number of articles written in the *Marine Corps Gazette*, and the chart on the right shows the number of articles written in the industry. Publication and research efforts are driving

the private sector's development of AI. At first look, the rapid increase in the number of *Marine Corps Gazette* articles and journal publications around the 2018 timeframe are parallel—this is a positive. However, it is important to note that these are publications that only mention AI and are not necessarily related to logistics.

A closer look at the *Marine Corps Gazette* articles reveals that of the 47 articles written since 2017, three of them were related to logistics, but they only make cursory mention of AI and address little about what is needed t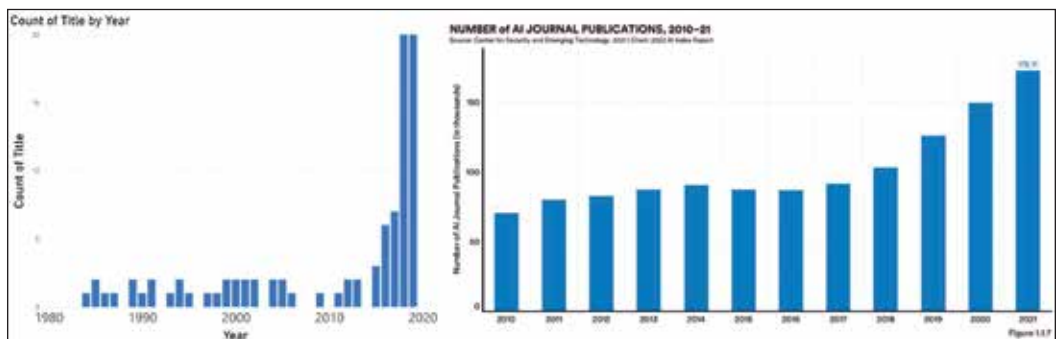o get to an AI end state. Is three a high or low number of articles? The answer depends on whether the information in the articles was acted upon. Were the results of their implementation assessed, refined, and redeveloped? The sparsity of articles should make

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the corresponding suggestions easy to track, and if they are not being implemented, then they are the wrong ideas, and not enough ideas are being presented. Since, as a logistics community, we are not collectively discussing how to implement AI, what the requirements are, and what structural problems might exist, the three articles written in the *Gazette* have not served

as benchmarks for traction and implementation across the Marine Corps logistics enterprise

Understanding AI

A better understanding of what it can do, some examples of its use, and how it works may increase the priority it is given within the Marine Corps logistics enterprise.

The PBS special, *In the Age of AI*, provides several real-world examples of recent advances in AI. One of the most powerful lines in the video is: "China is the best place for AI implementation today, because the vast amount of data that is available in China. China has a lot more users than any other country—three to four times more than the U.S." The host goes on to further explain, "We're talking about ten times more data than the U.S., and AI is operating on data and fueled by data. The more data, the better the AI works—more importantly than how brilliant the researcher is working on the problem. So, in the age of AI, where data is the new oil, China is the new Saudi Arabia."[10]

In his TED Talk, "The Incredible Inventions of Intuitive AI," Maurice Conti walks through the progression of human ages and argues that we are at the dawn of a new age. Human society has progressed through hunter-gatherer, agricultural, and industrial societies and is currently in the Information Age. Conti argues that the next age is the Augmented Age, in which natural human abilities will be enhanced by computers, robotics, and digital nervous systems. While the previous ages have been defined by passive tools, the augmented age will be defined by generative and intuitive tools based on the abilities of humans, robots, and AI systems to work in harmony and solve complex problems. Conti makes a clear argument that within a human lifetime (64 years), computers started off playing tic-tac-toe (1952), then advanced to beating the best humans at chess (1997), then beating humans at Jeopardy (2011), and finally beating humans at Go (2016). Computers started off playing kids' games and are now able to outperform human thought in our most complex games of strategy.

The video "But What is a Neural Network" contains a clear explanation and demonstration of how a neural network is fundamentally built. The demonstration is based on illustrating how the human ability to recognize a set of handwritten numbers from zero to ten is a very simple task. For example, the number three is extremely easy to recognize even when written sloppily and in several different ways. However, writing a program to recognize digitally written numbers becomes extraordinarily complex. Though the video focuses on neural networks, the host explains that neural networks are the foundation of machine learning. Understanding the mechanics and a specific and narrow application of a neural network and understanding where a neural network is in the progression from data to AI are valuable insights.

The Problem

AI is extremely technical, heavily reliant on technology and extensive/free-flowing data, and requires technical experts that can manage complex systems. The Marine Corps logistics apparatus is deep. Not only does the logistics domain include the six functions of logistics but embedded within each of them is a consortium of diverse functions including ship loading, transportation distribution, cargo throughput, mortuary affairs, acquisition, arming and refueling, and warehousing, to name only a few. AI is extremely specific in its algorithm application. Data and information are vast and predictive analytics is brought to life by specifically designed algorithms. Data manipulation has a human element; without understanding the data at a fundamental level, we are guessing about what to tell computers to do.

Conclusion

In our minds, understanding the building blocks for any innovation is critical. The breadth and scope of AI are a significant challenge for any industry, and the Marine Corps is not exempt from this challenge. The three primary concerns are: we have fallen behind industry standards; we have significant challenges adopting state of art for logistics applications; and our pacing-threat competitors are leaning in heavily to develop and apply AI. To win in this domain, Marine Corps logistics must have the goals, talent, and infrastructure to smartly advance it further. In our next article, we will identify the ugly, inconvenient details that currently exist within Marine Corps logistics and must be addressed prior to any deep movement into the AI landscape.

Notes

1. Max Boisot and Agustí Canals, "Data, Information, and Knowledge: Have We Got It Right?" *Journal of Evolutionary Economics* 14 (2004).

2. Ibid.

3. Cambridge Dictionary, "Knowledge," *Cambridge Online Dictionary*, n.d., https://dictionary.cambridge.org/us/dictionary/english/knowledge.

4. Harry Dreany, "LP Studies Artificial Intelligence (AI) Research Proposal," November 23, 2021.

5. Cambridge Dictionary, "Machine Learning," Cambridge Online Dictionary, n.d. https://dictionary.cambridge.org/us/dictionary/english/machine-learning; and Cambridge Dictionary, "Machine Learning," *Cambridge Online Dictionary*, n.d.. https://dictionary.cambridge.org/us/dictionary/english/machine-learning.

6. Department of Defense, *Summary of the 2018 Department of Defense Artificial Intelligence Strategy*, (Washington DC: 2018), https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.PDF.

7. "LP Studies Artificial Intelligence (AI) Research Proposal."

8. Gen David H. Berger, *Talent Management 2030*, (Washington, DC: 2021).

9. Kirk M. Spangenberg, Gregory Lucas, Stan Bednar, Jason Fincher, Leo Spaeder, and Miguel Beltre, "Data-Driven Logistics," *Marine Corps Gazette* 103, No. 3 (2019).

10. FRONTLINE PBS, Official, "In the Age of AI (Full Documentary)," *YouTube*, https://www.youtube.com/watch?v=5dZ_lvDgevk.