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AI is already replacing human workers in some occupations, while providing prescient insights into large datasets too vast for manual human curation. While the benefits are immeasurable, the risks are less subtle. Technology in general and AI specifically is showing how automation frequently exacerbates shortfalls in human cognition, which can cause a decrease in situational awareness and have unforeseen deskilling effects. However, to remain competitive in today's environment, the Marine Corps must pursue AI technologies, while also guarding against cognitive complacency in order to mitigate risks that challenge or potentially compromise fundamental human capabilities in the long-run.

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SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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Executive Summary

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Thesis: To remain competitive in today's environment, the Marine Corps must pursue AI technologies, while also guarding against cognitive complacency in order to mitigate risks that challenge or potentially compromise fundamental human capabilities in the long-run.

Discussion: Technology commentators state that 2016 was the year that Artificial Intelligence (AI) came of age. While difficult to ignore as a fringe technology, let alone keep up with its advances on a daily basis, AI is promising to deliver capabilities only imagined in sci-fi entertainment. From self-driving cars, data mining, computer vision, and language translation, AI is finding its way into everyday life, and most importantly, military technology. While AI is often over-hyped in the media, its true capabilities are typically very narrow in scope and domain specific. Weapon-equipped AI regularly receives the most coverage to the detriment of many other lesser known AI opportunities and risks; this research explores those particulars.

AI is demonstrating significant benefits along with many intractable challenges. AI is already replacing human workers in some occupations, while providing prescient insights into large datasets too vast for manual human curation. While the benefits are innumerable, the risks are less subtle. Technology in general and AI specifically is showing how automation frequently exacerbates shortfalls in human cognition, which can cause a decrease in situational awareness and have deskilling effects. Furthermore, the complexity of statistical algorithms AI employs can draw conclusions from large data sets, which force humans to tacitly trust AI decisions they may not fully understand.

The US military has already been drawn into the AI race, and for good reason. AI can introduce new military realities and provide increasingly sophisticated technologies, while enhancing the warfighters' capabilities. Nevertheless, the military needs to approach AI technologies with a clear-eyed view of the many potential problems they may introduce as well. Opportunity costs and risks lurk in unforeseen places. Therefore, implicit trust in AI and understanding its limitations will become an essential part of decisions to adopt AI in any military domain. Guarding against complacency from emersion into such technology will become a foremost concern for military leaders at all levels.

Conclusion: By embracing the strengths of both AI and the individual Marine, the Marine Corps can increase its warfighting prowess through proper pairing and appropriate training for the most effective combinations.

DISCLAIMER

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 research was prompted by the Commandant of the Marine Corps's question: "How will Artificial Intelligence (AI) impact the Marine Corps? Risk and reward?" While AI has been around in some fashion since the 1940s, it has gone through many ebbs and flows since then with only minor improvements. However, within the last ten years, AI has surged to become a technology that is demanding notice from every sector of society. Arnold Schwarzenegger's *Terminator* movies or the computer named HAL 2000 from *2001: A Space Odyssey* comparisons to contemporary AI often command the most notice in the headlines that speak of the dangers of AI. This research looks to provide an optimistic, yet balanced exploration of AI contrary to the rather sensationalized scenarios periodically portrayed in the media. Drawing from private and public sector AI advances, this research explores how AI opportunities and risks may enhance or impact military capabilities and capacity in the not too distant future. While this research answers many questions, it will most likely raise many more—and that is a good thing.

I am indebted to my Master of Military Studies advisor, Dr. Matthew Flynn for helping me outline and scope my material appropriately. His profound wit and penchant for distilling history down to the most fundamental elements is sublime. I am also grateful to my faculty advisor Lieutenant Colonel Kevin DeWitt (USMC) for his constant mentoring and encouragement. Many thanks to the ladies of the Leadership Communications Skills Center (LCSC) for their keen eye for helping improve this research paper. I would also like to thank Dr. Ying Zhao and Dr. Shelly Gallup from the Naval Postgraduate School for reviewing this work and providing insightful feedback. This research would not have been possible without my lovely wife Teresa and her unfailing support and reassurance. I also want to thank my children Caleb, Noah, and Zoe for being patient and understanding while 'daddy' was working.

THE FUTURE

The year 2030 was quite a year.[1] It was the year the number of autonomous cars surpassed traditional human vehicle operators. In fact, many traditional tasks are now offloaded to technologies that use Artificial Intelligence (AI). AI technologies continue to make progress in areas that have traditionally been the purview of humans. From controlling vehicles, diagnosing diseases and prescribing treatments, to providing human knowledge enhancement, AI was hailed as a savior by many in first world countries that had the resources to invest in building a reliable infrastructure to support the data requirements of AI and its ubiquitous access to almost every area of their lives. Indeed, AI has improved the lives of many people in the world, or at least in the areas that enjoy relative prosperity and peace.

Areas of the world that never seemed to adopt these technologies or make as much progress as the United States made the stark contrasts between these cultures even sharper. Some cultures appeared so savage to the sensibilities of the 2030 American citizen, the US military regularly chooses to use autonomous drones and robots to keep the peace in these areas when required. This would have been unthinkable ten years ago given what the military learned from its wars in Iraq and Afghanistan, which demonstrated that humans need to engage with humans to help 'win hearts and minds.' This, however, changed when fewer US citizens could meet the rigorous standards of military service.

In 2027, the military had to implement its own driving school because many new applicants had never manually driven a vehicle. Additionally, the military services had to implement more in-depth psychological screenings to ensure new service members could properly adjust to the rigorous requirements of military service. Unfortunately, the military could not stem the tide of the fundamental shift in the quality of its service members in both the

officer and enlisted ranks and had to lower standards in some areas. AI was able to make up for some of the losses by no longer requiring certain occupations, thus allowing the Services to shift manpower resources to more critical areas. Likewise, AI made many tasks, which previously required numerous individuals or were deemed 'too dangerous,' no longer reliant on a human component.

As AI became more and more ubiquitous, people began offloading many tasks to machines powered by AI. It first started with autonomous cars and additive manufacturing in late 2019 when the technology became very good and economical. This allowed mundane tasks such as meal planning, grocery shopping, and operating motor vehicles to become things your parents did, and thus were seen as anachronisms to the new generation. Consequently, this new generation now had more free time to pursue more self-indulgent activities. AI has also been a boon for much of the US manufacturing and services sector as well. For instance, no one has worked at a McDonalds in almost five years once the restaurants became fully autonomous in early 2025. Sadly, unemployment has reached an all-time high within the teenage population and in the population in general because of the confluence of inexpensive AI and the lack of foresight to reskill the workers AI has replaced. Coupled with the advancements in Virtual Reality (VR), many people now spend a great deal of time exploring VR worlds and interacting with friends and artificially intelligent avatars in computer-generated worlds.[2] Unfortunately, many researchers have noted that these trends have contributed to increases in taking prescription drugs to combat the effects of a more sedentary lifestyle and an upward incidence of obesity for the general military age population. Worse, many eligible military age people are practically unable to function without a device connected to the internet. While many other countries in the world are seeing similar trends within their own populations, the US military has

now sounded the alarm for something it should have seen on the horizon ten years ago—an unstable admixture of diminishing human abilities enabled by an over-reliance on technology, but more specifically, the adoption of AI.

TODAY

While the above extrapolation of Stanford University's report, "Artificial Intelligence and Life in 2030," describes a future that may not necessarily happen, the technology described within it is here today and is making significant progress at an accelerating pace.[3] Of all the advancements described above that have the potential to significantly change the lives of many people, AI commands a significant advantage over any other technology because AI will likely underpin many new technologies.[4] To be sure, AI holds many risks and rewards for the organizations that adopt it and make it a fundamental part of their operations. This research will explore such risks and rewards to help understand what AI adoption may signify to the United States military and the United States Marine Corps specifically. Undoubtedly, there are substantial advantages to adopting AI and leveraging its capabilities; however, the dangers of offloading many tasks to AI can have the unforeseen effect of deskilling a traditional workforce and making individuals and organizations subservient to it in ways that may elude the common observer. Therefore, the Marine Corps should approach AI with a clear-eyed view towards how it is used and what tasks it should and should not perform. To remain competitive in today's environment, the Marine Corps must pursue AI technologies, while also guarding against cognitive complacency in order to mitigate risks that challenge or potentially compromise fundamental human capabilities in the long-run. Certainly, while the Marine Corps may embrace the adoption of AI in many areas, implementing new strategies to mitigate its effects, fitting it into an operating concept, and developing a framework for its use will become critical if the Marine Corps is to maintain

individual capabilities for expeditionary environments and austere situations that deny it a technological advantage or decouple the human-to-human aspect necessary to solve problems AI cannot fix.

Current literature on AI-enabled weapons systems receives the most attention within the military establishment; however, other significant impacts of AI in such areas as human cognition and substitution in non-combat arms occupations within military circles receive little attention. Therefore, this research will concentrate on other lesser known benefits and risks of AI that have the potential to affect the military in many significant ways. Overall, this research looks to provide a circumspect outlook on the adoption of AI in order to provide military leadership a clearer view of the many different aspects of this technology beyond the current focus on weapons systems alone.[5]

WHAT IS AI?

The field known as Artificial Intelligence (AI) is quite diverse and does not have one agreed upon definition.[6] Two prominent computer scientists, Stuart Russel and Peter Norvig, assert the field encompasses four general areas:

> (1) systems that think like humans (e.g., cognitive architectures and neural networks); (2) systems that act like humans (e.g., pass the Turing test via natural language processing; knowledge representation, automated reasoning, and learning), (3) systems that think rationally (e.g., logic solvers, inference, and optimization); and (4) systems that act rationally (e.g., intelligent software agents and embodied robots that achieve goals via perception, planning, reasoning, learning, communicating, decision-making, and acting).[7]

In their view, AI will demonstrate uniquely human characteristics, namely cognitive abilities such as rational thinking. Having these characteristics would provide a system that could mimic capabilities that only humans have previously exhibited. AI in their terms would demonstrate the ability to plan or project a future condition from a current state through a list of logical or

reasonable objectives to accomplish that end. Indeed, AI could provide a means to anticipate or predict the future through sophisticated algorithms that have the appearance of representative human reasoning and logical inference.

Nils J. Nilsson, a prominent computer scientist and artificial intelligence researcher, provides another helpful definition by stating, "Artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment."[8] The qualities and characteristics described in the above definitions get to the essence of what AI attempts to achieve: systems or machines that imitate to some degree a type of human-level intelligence. Such an AI-enabled computer would demonstrate human-level intelligence by developing hypotheses, running multiple simulations, taking feedback from sensing mechanisms, and updating its own programming code if necessary to improve or modify future decisions. While far from simplistic, narrowing human intelligence down to easy-to-follow steps would not likely capture all nuances of the dynamic human mind. Nevertheless, AI could provide a way to synthesize large quantities of data at speeds greater than human cognition while ostensibly eliminating common human biases and inaccurate heuristics many individuals use to make decisions.

Broadly, AI can imitate human-level intelligence across three general categories: creative, predictive, and reactive types of intelligence.[9] Creative intelligence consists of AI performing pattern recognition on information and inventing something new to solve a problem.[10] Reactive intelligence requires sensing, then taking action to achieve an end-state.[11] Predictive intelligence processes previously gathered information and produces a prediction or estimation in order to take preemptive actions.[12] Combinations of all three types of intelligence in AI would come the closest to achieving some aspects of human-level intelligence. Thus, the

underlying objective of AI is to imitate or reproduce intelligent actions that only humans are capable of performing.[13] By replicating the intelligence of humans across a variety of domains, AI holds the promise of not only performing human tasks faster, but also doing them better.

The current state of AI encompasses a variety of uses, but has remained typically confined to narrow domains.[14] Search algorithms, email spam filters, travel planners, stock trading, shopping recommendations, and computer games are rudimentary examples of AI applications that have brought conveniences to many users and enhanced economic benefits for companies that have employed them[15] In fact, AI is becoming even more ubiquitous. Businesses and consumers both have the ability to connect a number of devices such as thermostats, refrigerators, and washing machines to the Internet for continuous intelligent-monitoring, now known as the Internet of Things (IoT).[16] IoT is a technology that achieves continuous monitoring and automation by leveraging artificial intelligence to improve such things as energy efficiency or tracking the number of occupants in a building.[17] As a result, many diverse groups are benefiting from AI-enabled devices in a wide variety of domains.

To achieve these results, AI incorporates many different technical approaches such as statistical modeling through the application of sophisticated algorithms, rule-based inquiry, and decision tree type concepts. These more rudimentary approaches to AI are generally hardcoded in software and can follow an if-then-else type of logic. They can appear as AI because humans generally understood the context of its use and developed the logic behind the algorithms. The generally predictable nature of the environment and the subsequent results are the benefits of this approach to AI. However, this type of AI is also less adaptable to new situations and typically has a narrow application in use. Such methods and solutions that were at one time considered AI no longer hold such status. For example, techniques to sort and analyze large data sets that

provided novel insights, widely known as “Big Data” analytics, were once termed an AI technology, but are now considered “routine data processing.”[18] Consequently, defining AI becomes more difficult as research in this area advances and makes AI of yesterday appear more prosaic.

Machine Learning is another approach to AI that is more advanced and possesses greater predictive capabilities.[19] Machine Learning broadly encompasses three types of learning: supervised, unsupervised, and reinforcement.[20] Supervised learning uses a statistical method to explore existing data sets to “derive a rule or procedure that explains the data or can predict future data.”[21] Machine Learning requires a body of data divided into training sets, test sets, and a statistical function or model that best represents the parameters of the data.[22] This results in a continuous cycle of training, testing, and adjusting statistical parameters to achieve the best results. Unsupervised learning uses unstructured or unlabeled data to extract meaningful data without a known outcome or goal.[23] This unsupervised method of learning can reveal hidden connections within a cluster of data to provide useful insights.[24] Reinforcement learning is given a reward function that seeks to maximize its outcomes through a continuous trial and error approach and improves its performance as it interacts with an environment.[25] Indeed, continuous research in the fields of Machine Learning are pushing the boundaries of AI and come closer to mimicking how the human brain functions.

Deep Learning and neural networks, both a subset of Machine Learning, attempt to model the human brain in order to develop AI. Deep learning uses a similar approach to Machine Learning to train the system, but receives inputs that commonly pass through hundreds of layers of complex nodes or “neurons” to provide even better results.[26] Machine Learning and Deep Learning both hold great potential for making AI more adaptable to a wider range of

domains. Combinations of different approaches have also brought about methods AI researchers have termed Deep Neural Networks and Convolutional Neural Networks that are more sophisticated. However, due to the high complexity of running various statistical functions over very large training sets of data, comprehending how these types of AI systems produce the conclusions they render makes the process indecipherable.[27]

This inscrutability aspect of AI poses a variety of challenges for researchers and users alike. Machine Learning and Deep Learning use models that often have hundreds or even millions of adjustable parameters that make understanding the decision process difficult.[28] This makes AI explainability inversely proportional to its sophistication and prediction capabilities. In other words, as AI improves, it becomes increasingly difficult to understand how it arrives at a decision. Some have referred to this problem in AI as a "black box" problem.[29] While the inputs and outputs of such systems are usually predictable, the inability to understand the inner-workings of these systems makes their complete safety and efficacy practically unverifiable.[30] This opacity aspect of AI, therefore, raises more serious issues for more advanced AI on the horizon. Consequently, humans may have to trust AI without fully understanding how it came to its conclusions.

The most advanced versions of AI, which currently do not exist, are Artificial General Intelligence (AGI) and Artificial Super Intelligence (ASI). Theoretically, both forms of AI would exhibit intelligence on par with or exceed human intelligence. As such, AGI would exhibit intelligence equal to humans, while ASI would demonstrate an intelligence beyond a human level. Yet, the gap between current AI and AGI or ASI remains significant.[31] In most estimations, AGI and ASI are decades away from becoming a reality.[32] Nevertheless, prominent technologist have voiced serious concerns regarding AI development that has resulted in various

oversight councils taking up a mission to monitor the field and advance policies that would potentially curb AI development.[33] Other technologists, such as the well-known Director of Engineering and futurist at Google Ray Kurzweil, have regarded the development of AGI and ASI as necessary for "man's survival."[34] Kurzweil, best known for his book *The Singularity is Near* and the concept of the "law of accelerating returns" best captures the zeitgeist among AGI proponents by stating,

> What, then, is the Singularity? It's a future period during which the pace of technological change will be so rapid, its impact so deep, that human life will be irreversibly transformed. Although neither utopian or dystopian, this epoch will transform the concepts that we rely on to give meaning to our lives, from our business models to the cycle of human life, including death itself.[35]

Contrary to Kurzweil's position, prominent technology entrepreneur Elon Musk states that AI poses a greater threat than nuclear weapons.[36] Philosopher and neuroscientist, Sam Harris, argues that if intelligence is only a matter of information processing, incremental improvements in AI will ultimately lead to ASI.[37] Whether or not AI evolves to AGI or ASI, and poses an existential threat to human survival, advancements in the field of AI have gained much attention and have raised concerns amongst the private sector as well as the military.

As it currently stands, advanced AI does not seem likely to command any near-term advantages over human tasks that require "social intelligence, creativity and general intelligence."[38] A January 2017 report commissioned by the DoD exploring the risks of AGI echoes this same assessment.[39] Researchers relying on such measures as the Turing test or AI demonstrating general problem-solving capabilities have been the foremost standard for assessing the intelligence level of AI.[40] Stanford Computer scientist, John McCarthy claims the brain and intellect function is still not well understood in the areas of psychology and neuropsychology and therefore difficult to imitate.[41] For now, further examination of AI performing more urbane tasks will push the boundaries of AI possibilities, but current research

such as Stanford's *Artificial Intelligence and Life in 2030* will bring the practical challenges of AI for the forefront.

THE REWARDS OF AI

If AI is already demonstrating important business and personal value in many narrow domains, it stands to reason the US military could potentially benefit from adopting it in a number of practical ways as well. Most importantly, with its promise to simulate simple decision making all the way to near human-level intelligence, it follows that human labor is a prime target for AI substitution. Funding for military personnel is the second largest expenditure within the DoD budget, consuming almost 24 percent.[42] In fact, the 2017 DoD budget request for military personnel alone was $138.8 billion.[43] With such a large expenditure item, it is easy to foresee that even small reductions in personnel can result in millions in cost savings and cost avoidance. While it is doubtful AI could replace many within the DoD workforce, it is not difficult to project that numerous positions are susceptible to replacement and enhancement through AI.

Occupations that have repeatable tasks with clear business rules and little ambiguity are prime candidates for AI substitution or augmentation. In one study by Oxford University, researchers predicted that "around 47 percent of total US employment is in the high-risk category" for replacement by computerization.[44] Many of the positions they cite that are susceptible to automation were in "transportation and logistics occupations, together with the bulk of office and administrative support workers, and labor in production occupations."[45] To kick off 2017, a Japanese insurance firm announced that it would replace thirty-four employees with AI in order to increase productivity by 30 percent and save around $1.2 million in salaries.[46] In a 2013 study on medical outcomes leveraging machine learning, researchers at Indiana

University found that AI based simulations not only reduced medical treatment costs by more than half, but they also improved patient outcomes by nearly 50 percent.[47] In occupations, such as legal, medical, and education, where services are becoming more standardized and systematized, AI is ready to make access to these services for little to no cost.[48] As more information is codified in digital formats and machine learning becomes increasingly able to systematize and synthesize this information, AI is poised to outperform its human analogue across a variety of occupations. Consequently, as data continues to increase in volume and velocity, it becomes increasingly difficult for humans to understand these more complex, data-rich environments and will require augmentation from AI to develop better understanding.[49]

Managing vast volumes of data in complex environments is another advantage AI provides. Monitoring devices and sensors can provide large amounts of information for decision making; however, optimizing the feedback to control parameters within such complex environments could easily overwhelm human decision makers. For instance, Google Data Centers (DC), which are massive computer warehouses that require sophisticated monitoring equipment and sensors to optimize their efficiency, used machine learning to analyze DC power usage and reduce its Power Usage Effectiveness (PUE).[50] Estimated PUE reductions could save hundreds of millions of dollars over several years of operations.[51] Similarly in cybersecurity, machine learning has helped detect security anomalies by sifting through overwhelming volumes of security event data to better identify malicious activity and provide more relevant security alerts to security professionals.[52] With a greater ability to process large volumes of information, AI can provide reductions in certain occupational specialties and cost savings, while simultaneously improving the efficiency and effectiveness of information technology.

If the research holds true, the military could equally stand to save billions of dollars, while improving the efficiency and effectiveness of its IT systems by using AI. AI has the potential to both substitute and augment human capital across many categories. Other non-monetary or intangible benefits may become an even bigger driver for AI adoption. Automated intelligent machines, for example can work around the clock, do not take leave, do not require health care, would not call in sick, would unlikely commit sexual harassment, and would unlikely experience fatigue. Such intangibles, while difficult to measure, should become factors in conducting cost-benefit analysis and estimating any return on investment (ROI) calculations for adoption of AI.

While AI holds the potential to provide savings due to a reduction in human labor costs and system improvements, it also provides a means to augment users with capabilities that can enhance their warfighting prowess. Developments in neural machine translation (NMT) and natural language processing (NLP) have provided significant improvements in translation of languages in recent years.[53] Latest improvements in NLP and NMT have resulted in technologies such as Google Neural Machine Translation (GNMT), which can translate languages without being cued to the language beforehand.[54] This technology could provide all military personnel a means to communicate with numerous coalition partners with a potential reduction in the number of interpreters required for operations. Reducing misunderstanding and providing human intelligence (HUMINT) personnel greater capabilities is a noteworthy goal for such technology, but these capabilities will not end there. Advances in image recognition and medical diagnostics can also provide advantages to warfighters.

Visual recognition and abstract reasoning are no longer limited to humans. In a recent breakthrough, AI scientists, Andrew Lovett and Kenneth Forbus, demonstrated an AI platform

that out-performed an average adult on the Raven Progressive Matrices test (a non-verbal test that measures abstract reasoning through visual pictures).[55] In other experiments, AI has identified tumors better than a human and has provided medical diagnosis from pathology reports.[56] Computer vision and other complementary types of AI capabilities could dramatically improve the speed and accuracy of a military physician's diagnosis, which may result in potential savings from staff reductions. However, having trained personnel that understand how to use AI may become the next high-demand skill that may initially command higher wages if a shortage exists in this burgeoning field.[57]

Most importantly, AI has the potential to increase operational reach. Writing on the AI and robotics revolution, economists and authors of several books on automation, Erik Brynjolfsson and Andrew McAfee, state in *Foreign Affairs*, "Technology expands the potential reach, scale, and monitoring capacity of a decision-maker, increasing the value of a good decision-maker by magnifying the potential consequences of his or her choices."[58] AI could deliver these promises through leveraging machine learning algorithms, modeling, and simulations that help decision makers understand complex and vast amounts of information as long as the decision maker is not overwhelmed with choices. Indeed, AI can amplify leadership choices by parsing through large volumes of data at speeds far greater than human capacity can process. AI could provide recommendations and impact analysis of logistics shortfalls by fusing together weather analysis; air, ground, and sea lines of communication factors; node throughput; transportation availability; maintenance scheduling; and current consumption rates in order to forecast more effectively. With a large network of sensors, forecasting would mimic applications such as Google Maps or Waze, which leverage AI to provide ideal driving directions and alternate routes when necessary.[59] Thus, more information properly combined

through an AI platform can provide more optimal decision-making.

Technology commentators state that 2016 was the year that Artificial Intelligence (AI) came of age.[60] From human-machine augmentation to full human substitution, AI has already given a glimpse to many that it is the future of better productivity and prosperity.[61] However, this productivity and prosperity will not come without a cost. President Obama's National Science and Technology Council state that AI will "reduce demand for certain skills that can be automated while increasing demand for other skills that are complementary to AI."[62] While it is still too early to tell how quickly AI will bring extensive change, significant research remains an ongoing pursuit to understand AI safety and efficacy.

THE RISKS OF AI

On January 21, 2016, Vice Chairman of the Joint Chiefs of Staff, Air Force General Paul Silva, at a Brookings Institute forum on US Department of Defense (DoD) technology and innovation asked, "What happens when that thing can inflict mortal harm and is empowered by artificial intelligence?"[63] General Silva's comments reflect the often futuristic 'Terminator' scenario that is often used to warn the masses on the dangers of runaway AI. While this is in fact an important concern, other risks exist in the adoption of AI that fall far short of apocalyptic ASI scenarios. Indeed, DoD Directive 3000.09 directly addresses autonomy in weapons systems; however, it does not address autonomy in non-weapons systems.[64]

In fact, non-weapons systems can pose dangerous consequences as well. In 2015 there were several non-weaponized AI failures: A robot grabbing for auto parts clutched and killed a man, image tagging software classified black people as gorillas, and adult content filtering software failed to remove inappropriate content.[65] In 2016 alone the most public AI failures included an AI designed to predict recidivism acted racist, game non-playable characters

designed unauthorized superweapons, patrol robot collided with a child, world champion-level Go playing AI lost a game, and a self-driving car had a deadly accident.[66] To be sure, such accidents demonstrate that the military will need to consider safety and ethics issues for non-weapons types of AI as well.

AI has also shown to change peoples' behaviors. One research study demonstrated that humans can at times ascribe anthropomorphic characteristics to computers that simulate human behaviors.[67] Dr. Julie Carpenter, a professor at the University of Washington who also studies human-robot interaction (HRI), found that in the explosive ordnance disposal (EOD) community, members displayed interesting behavior towards their robots. For instance, EOD personnel regularly gave names to their robots and displayed a range of emotions when their robots were destroyed during a mission.[68] Such behaviors can become dangerous if humans begin ascribing moral qualities or unnecessary value to robots that are unwarranted, therefore, potentially compromising decision making.

As alluded to in the 2030 introduction scenario above, AI holds the potential to affect the quality of the military's future workforce. Arguably, technology in general and AI specifically are not neutral in their effects on human beings. In his book, *Darwin Among the Machines*, technology historian George Dyson states, "Everything that human beings are doing to make it easier to operate computer networks is at the same time, but for different reasons, making it easier for computer networks to operate human beings."[69] Dyson sees a symbiotic relationship between humans and machines in a corresponding way that the sharing of information globally not only rewards the human, but improves the network itself. As cited by technology writer Kevin Kelly, Theodore Kaczynski, better known as the infamous Unabomber, states emphatically in his manifesto:

> As society and the problems that face it become more and more intelligent, people will let machines make more of their decision[s] for them, simply because machine-made decisions will bring better result[s] than man-made ones. Eventually a stage may be reached at which the decisions necessary to keep the system running will be so complex that human beings will be incapable of making them intelligently.[70]

While still controversial, Kaczynski's provocative predictions seem more prescient in 2016 than it did in 1995 [71] and are in-line with what many technologists see today. In fact, offloading intelligence to machines is becoming more of a concern. In one instance, the information age itself has had the opposite effect by allowing individuals to 'know' more; it in fact allows them to know less because information recall is accomplished easier with online search engines.[72] This results in individuals becoming more reliant on the Internet's ability to provide information and has the potential to make humans more shallow thinkers.[73] Thus, a challenge arises in how much trust AI-enabled technologies command and how users should evaluate results when it becomes the sole source of information gathering for the masses.

The elusive effects of technology go beyond the search engine, of course. The Foundation for Effective Altruism's report titled, "Artificial Intelligence: Opportunities and Risks*,"* cites research that shows automation, pathological gaming, and internet consumption in fact affect social behavior and attention spans in a way that raise significant concerns.[74] Providing rich technological environments can therefore nurture such negative predilections if not properly guarded against. Mica Endsley, a researcher with Situational Awareness Technologies, states that an "automation conundrum" manifests when "more automation is added to a system, and the more reliable and robust that automation is, the less likely that human operators overseeing the automation will be aware of critical information and able to take over manual control when needed."[75] This conundrum produces what Endsley terms as an "Out-of-the-Loop (OOTL) error" making human situational awareness the key issue to improve in

autonomous technology.[76] The question of autonomy is meaningful problem for adopting AI in the military if the aforementioned trends continue in a negative direction. While this phenomenon is not the fault of technology per se or AI particularly, it nevertheless highlights shortfalls in human cognition and awareness in an autonomous environment with conditions that can easily breed the aforesaid apathetic behavior. Ultimately, if AI affects human cognition, an imperative emerges in understanding how it impacts human judgment.

A subtler risk exists in trusting AI for decisions humans may not fully understand themselves or ones that require critical judgment. Because AI-based decisions modeled on machine learning and deep learning become more inscrutable over time, trust becomes inferred; therefore, any "flaws in data or the algorithms can leave professionals susceptible to an especially pernicious form of automation bias."[77] Consequently, users "could become mindlessly bound to the output of AI analyses, even if its user suspects something is amiss."[78] In other words, because of the sheer amount of data it has analyzed to produce a decision, AI decision making could become so complex that "managers could increasingly find themselves playing a subservient role to software and be forced to rubber stamp its recommendations."[79] Compounding the issue further, in a *Statement for the Record on Worldwide Threat Assessment of the US Intelligence Community* to the US Senate Select Committee on Intelligence, the US Director of National Intelligence, James Clapper stated, "AI systems are susceptible to a range of disruptive and deceptive tactics that might be difficult to anticipate or quickly understand."[80] Accordingly, these situations provide a conundrum for organizations that want to implement AI. AI provides a potential way to make better decisions, but at the same time, it does not necessarily provide the 'why' behind the decision because of the inherent limitations of understanding the algorithms and the data sets used for learning.[81]

Another risk worth understanding is selecting an AI technology is choosing which AI to adopt. As more start-up AI companies are purchased by only a few of the largest technology firms like Google, Facebook, Amazon, and Microsoft,[82] the military may have fewer options to choose from in the future. While such a trend can ensure greater support for AI advancement, it also narrows the field of competition, thus limiting available choices. For instance, the military could become beholden to an AI technology provider that could hold a monopoly on system maintenance, sustainment, and improvements. This could result in an unhealthy marriage for the military if the firm that provides AI fails or sells out to a competitor. Such risk with vendor lock-in prove difficult when attempting to switch to another AI system if a vendor no longer supports a system or the technology becomes obsolete. In either case, such a proprietary system may require sustainment past its useful life and result in a similar situation where the US Navy must sustain the use of the outdated Microsoft XP operating system past its end-of-life support date. Consequently, this additional support has cost the Navy approximately $9 million a year.[83] Similarly, such concerns that have always plagued technology acquisitions will for AI as well.

The nature of AI and its potential to become a game-changing technology makes answering questions of suitability more difficult, especially if the system becomes mission critical or if disparate AI systems optimize resources in competition with one another. For instance, an experiment conducted by Google AI researchers demonstrated that multi-agent AIs playing a matrix game social dilemma (e.g. Prisoner's Dilemma, Gathering, and Wolfpack) were uncooperative in some scenarios.[84] Therefore, integration of separate AI technologies will need to account for how these systems cooperate with each other when attempting to optimize parallel resources. For these reasons, purchasing AI from a vendor or developing it in-house comes with

clear trade-offs; however, the complexity within AI design itself will require a thoughtful approach to avoid and lessen its inherent risks.

Certainly, other inherent risks with AI systems are their inherently complex nature. Current AI systems are designed and developed by software engineers and programmers that understand the constructions of these very complex systems.[85] The upkeep of such complex systems may require the military to devote significant resources to sustain the program in order to improve algorithms when necessary, upgrade systems when required, or retain program expertise to maintain AI systems. AI systems may have large data requirements that necessitate having dedicated data center support from a virtual or private cloud.[86] AI methods such as Convolutional and Neural Networks perform better on large arrays of Graphics Processing Units (GPU)[87] rather than the standard Central Processing Units (CPU) found in most data centers today. Arguably, military data centers that desire to deploy certain types of AI would need to ensure the correct hardware is available to operate AI effectively. Therefore, military leaders need to understand total cost of ownership of AI systems and determine an appropriate return on investment for AI as they do for other technologies.

While understanding AI risks and how they will potentially affect the military recruitment population, deskill its workforce in certain areas, and relinquish some decision making, there are also questions of AI ethics. For example, if AI causes injury or harm to a person, current liability laws fail to address who would shoulder the blame, especially if machine learning AI has learned its behavior from various sources.[88] Because machine learning improves with more information, controlling the quality of AI training data might prove very challenging since it is unrealistic to screen vast amounts of data without an AI system in the first place. Since machine and deep learning algorithms are often inscrutable, pinpointing the exact data that

might have caused the trouble becomes an intractable problem. The ethics of AI is a burgeoning field of study, but space limitations here prohibit a complete discussion on the matter and should be addressed in future research separately. Nevertheless, laws, policies, and ethics related to AI systems will likely lag behind the continuous fielding of AI enabled cyber systems and the rapid introduction of related technologies, yet this does not absolve organizations from their responsibility to craft strategies and guidelines for use in their absence.

HOW THE MILITARY CAN RESPOND TO AI

Replicating human intelligence or performing tasks makes replacing or augmenting military personnel one of the foremost benefits of AI. With the potential pool of eligible military recruits already projected to become inadequate due to increasing numbers with criminal records, obesity, and insufficient education,[89] it is unlikely AI will completely solve these problems. Equally an issue, in a July 2015 report titled "Military Officer Quality in the All-Volunteer Force," researchers Matthew F. Cancian and Michael W. Klein cite declining scores for the General Classification Test (GCT) of Marine Officers since 1980 as an indicator of how the entry-level population is changing.[90] AI based technologies will further help and hinder these concerns in several ways. With the adoption of AI society-wide, the military may need to update how it assesses recruits and officer candidates for future occupational specialties and develop new tests to ensure cognition is adequate. If AI performs as well as many project, it will potentially reduce manpower requirements for some occupations and provide "extended intelligence" for others.[91] The adoption of AI may demand the military to also adopt new tests and recruit for specific skills not previously required to operate AI. More to the point, AI may bridge the future gap in inadequate numbers of personnel by replacing some occupations or

making average personnel sufficient to accomplish more complex tasks when augmented with AI.

AI will not only have an impact on personnel within the US military, but it will also change how it operates. For instance, AI could provide new insights on DoD information by indexing and cataloging information across its many disparate data centers. Leveraging Machine Learning or Neural Networks, AI can sort through the vast amounts of unstructured and structured data that resides across the DoD to uncover insights previously undetected. AI monitoring for the Internet of Things (IoT) technology can provide a wide range of smart monitoring of equipment providing increased efficiency, indications and warnings of component failure, and cost savings in the areas of human capital while improving energy usage and efficiency. AI has also shown promising results in the area of cyber security and could provide both offensive and defensive capabilities for the DoD cyber force.[92] The list of possible uses of AI is potentially limitless and provides many potential opportunities for the US military across many domains. Nevertheless, the DoD will need to balance the opportunities AI provides with its many potential downsides as well.

Clearly, AI is poised to change many aspects of the countries that adopt it, resulting in balancing opportunities with its downsides. Because of the undeniable influence of commercial and private sector developments, the US military will undoubtedly face a flurry of AI demonstrations and solicitations for military applications. "U.S. companies are both the world's most prolific producers and the world's most enthusiastic consumers of technology; therefore, many of the effects of this digital revolution will likely be seen first in the United States," writes Andrew McAfee and Erik Brynjolfsson in *Foreign Affairs*.[93] For these reasons, the US military will need to develop the foresight to anticipate and respond to potential rapid changes in the

culture. As an example, if driverless vehicles become a public standard, thus freeing more individuals from the need to earn a personal driver's license or learn to drive, the US military may have to implement a more rigorous driving school to provide instruction from a more rudimentary level. Even if the military does adopt driverless vehicles in some capacity, it is a mistake to assume that such vehicles could operate in austere environments where electronic signatures may become a liability or complex terrain and human factors become insurmountable for AI to handle properly, potentially hampering freedom of action. If AI replaces some military occupational specialties (MOS) in garrison, the military may still require the functions in a deployed environment with limited or no access to the technology, which could lead to excess human capacity if not cross-trained in other functions. Additionally, the military will also need to review its operational security (OPSEC) policies to account for AI. While current OPSEC briefings include the dangers of social media, they will need to also account for the always-on AI technology such as Apple's Siri, Amazon's Alexa, and Google Home's AI-enabled assistants that may inadvertently gather sensitive military information from military families, DoD employees, and defense contractors. To be successful, the US military will require a systematic whole-of-DoD, and government approach to how the Armed Services field and plan for AI systems.

Developing a well-informed, holistic approach to AI will be difficult, but not impossible. In order to stay ahead of adversaries while also creating efficiencies with the DoD, military leaders will need to explore and experiment with the benefits of AI. Such an approach should seek to partner with the most mature AI organizations in the public and private sector to stay abreast of the latest developments. The DoD will also need to ensure that AI is mature, sustainable, and well-tested before implementation in a production environment. Therefore, the

DoD will need to devise a battery of tests and experiments that AI should accomplish with a special emphasis on safety and how it may affect human cognition and awareness. Human-AI augmentation may still require its participants to perform to a specified set of standards in case the technology were to fail in dangerous circumstances. Providing oversight through approaches such as the Human-autonomy System Oversight (HASO) model, can keep humans cognitively engaged in order to help improve safety and increase situational awareness when AI technologies encounter unforeseen problems.[94] Equally important, DoD should develop clear data and information classification standards for meta-tagging and labeling content in order to help ensure portability to different AI systems. Content curation and an ongoing development of the corpus of knowledge AI has access to will require management by experts versed in AI development.

The DoD cannot afford to ignore the many advances in the field of AI. Predictably, the benefits and potential new military realities of AI may provide advantages for a "third offset" in US capabilities.[95] While not all encompassing, many of the aforementioned recommendations will require significant planning and resources to develop AI within the DoD and should come under the oversight of a diverse council of experts across a broad swath of disciplines to ensure success.

HOW THE MARINE CORPS CAN RESPOND TO AI

AI will have impacts across society far and wide; therefore, the Marine Corps must develop an appropriate response to this truly game-changing technology that can challenge both conventional wisdom and its approach to warfare in the 21st century. As the Marine Operating Concept (MOC) highlights the need to "reap the benefits of technological progress," while inspiring the force to "capture the full potential inherent in automation," the Marine Corps will need to carefully balance these opportunities with both short-term and long-term risks.[96]

AI can provide attractive opportunities for increasing the Marine Corps's warfighting capacity. For instance, a *2016 Index of US Military Strength* conducted by the Heritage Foundation found that the Marine Corps was 'weak' when it came to overall warfighting capacity due to an inability to fight a major regional conflict in two theaters simultaneously.[97] Hence, AI could provide a way to automate or augment some occupations in order to add capacity to selected MOSs. AI has already shown great progress in the domain of some autonomous platforms and will continue to provide the Marine Corps a greater range of options from tactical resupply to target identification with its ability to provide safety stand-off in dangerous circumstances. The real challenge will come when AI and humans both share the battlefield and introduce new risks that will require acknowledgment and potential mitigation.

While the MOC states, "automation can mitigate risk, reducing the exposure of humans to harm, and reduce the workload on personnel,"[98] automation will also introduce potentially unforeseen risks of its own. From the aforementioned examples, such as occupation deskilling, cognitive complacency, over-reliance on technology, and increasing the complexity of the information technology environment, AI has the potential to behave as a sagacious genie that synthesizes large quantities of data, an act that no human could potentially perform.[99] While such a system may become indispensable through self-reinforcing processes, implementation would need to account for having a high degree of protection and a team of specialized personnel to maintain it. Therefore, AI could lend itself to become a friendly center of gravity or a critical vulnerability if it becomes an indispensable warfighting tool.

With all the same challenges that the US military will face with adopting AI, the Marine Corps will also face both new opportunities and risks to how it conducts operations.

The Marine Corps Operating Concept suggests, "As machines advance from performing repetitive tasks to dynamic workloads, it will free people to focus on the things they do uniquely or best."[100] In order to free people from these tasks, AI will require training by the experts that currently perform these tasks. This means Marines would train an AI platform to take over their function, potentially making themselves obsolete at some point, which could generate resentment manifested in ways that attempt to deliberately make AI fail through sabotage or create unnecessary friction during the implementation phase. As the MOC states, "the challenge, as machines become more capable and autonomous, is how to put people and things together in the most effective pairings for the mission at hand."[101] Consequently, the adoption of AI that replaces occupations wholesale will require a clear transition or reskilling program for some of the workforce. Effectively pairing AI with personnel to augment their cognitive capacity will most likely require new skills for functioning with AI to reap the full capabilities of the system. Moreover, AI can also provide a way to better organize the Marine Corps's information management processes. From meta-tagging, file organization, archiving, and document lifecycle management, AI could provide a more standard information environment with greater consistency of process across the Marine Corps therefore, flattening the learning curve while also making on-boarding of new personnel more productive and faster.

Lastly, finding the right fit for AI will become an important challenge. The MOC states that the Marine Corps's ability to successfully carry out "the Concept" will rely on "how to use unmanned systems and automation at all echelons and in every domain – because mastering the man-machine interface offers a revolution in military operations."[102] Arguably, the Marine Corps is already reaping the benefits of man-machine capabilities seen within the last decade of combat operations. KMAX unmanned helicopters that supported resupply missions[103] and the

more than twenty different types of robots used for surveilling a room to Explosive Ordnance Disposal (EOD)[104] provided unmeasurable benefits in the form of improved situational awareness and safety. While AI has some potentially clear benefits to offer the current operational paradigm, the real revolution will come when an adversary uses weaponized-AI without any ethical inhibitions.

Given the current state of AI enabled machines and their capacity to interpret large quantities of information, while out-cycling human cognition through sheer brute-force processing, the limiting factor in future warfare could be humankind. At the very least, if a human is making the binary decision to kill or not to kill, the human may not understand how the AI came to its conclusions. If an adversary can leverage AI to make faster decisions and autonomously prosecute targets with no human-in-the-loop hindering the process, it follows that the Marine Corps might need to reevaluate its stance on conventional AI use.[105] If not, this will ostensibly sacrifice or severely limit the advantage autonomous technologies are supposed to provide in the first place.[106] Other options could allow autonomous AI to engage in limited, non-lethal activities that provide a comparable alternative. Consequently, AI technology will continue to outpace both international and domestic legislation, which will require interim guidance on how the Marine Corps approaches these developments and potential ethical quandaries.

CONCLUSIONS AND RECOMMENDATIONS

AI will have significant impacts on the US military as a whole. Clearly, AI will pose multifaceted challenges with adoption and implementation, which indicates a variety of generally knowable and unknowable trade-offs. Mutual exclusivity, however, will not exist between

benefits and risks because AI substitution for human skills will provide narrow expertise, but little to no versatility in additional uses. Therein lies a spectrum of potential trade-offs that may offer a significant competitive advantage against an adversary and a clear risk in others. Hence, the Marine Corps will need to continue its efforts in developing and increasing human capacity while also pursuing AI in areas that make the most sense.

Crafting a force that can both increase its combat effectiveness and grow its capacity is possible with AI, but will come at a cost. AI offers an opportunity for organizations to focus on their core competencies. By smartly reducing and or eliminating occupations that are more suitable for AI, such as many administrative, human resource, intelligence, and logistics positions, the Marine Corps can potentially exchange them for additional combat arms roles. At the same time, the Marine Corps will most likely need to develop, recruit, or contract a number AI experts and autonomous systems engineers to ensure new technology is integrated and appropriately nested within the overall Marine Corps Enterprise Network (MCEN) and the Joint Information Environment (JIE). The complexities of maintaining and integrating such systems will require advanced degrees and experience to properly implement optimally within an ecosystem of many other technologies and competing interests. Thus, eliminating some positions and implementing new ones will provide significant considerations for balancing human resources and talent management when adopting AI technology as a program of record in any domain.

In the mid to short-term, the Marine Corps should pursue a dual strategy where both AI and humans can perform side-by-side until it is clear AI can handle tasks at an acceptable level, while ensuring a degree of safety and efficacy. Tasks that may require a human-in-the-loop will become more complex with contributions of AI. While research in the area of AI decision

making is on-going, the Marine Corps cannot afford to ignore testing AI and human interactions on a small scale. Studies in the area of automation are replete with examples demonstrating inadequate human reactions or responses when automation fails or an unexpected event takes place.[107] As a result, further research in this area needs to explore mitigation strategies to ensure overall organizational effectiveness is not diminished from AI implementation.

Most importantly, the human component underlies the fundamental aspects of AI itself. In fact, it is the human characteristics that are the most valuable features of AI itself, which are often the most complex to represent within a machine. Most importantly, AI cannot fundamentally replace the very thing that created it without dire consequences, nor change the nature of warfare itself. The MOCs' admonition with respect to how technology intersects with the human and the nature of war is worth repeating at length:

> It is critical to emphasize, however, that technology will never override the human dimensions of war. Like conflicts of the past, wars of the future will be characterized by their destruction, bloodshed, and suffering. No level of automation or use of robotics will replace the fact that war will always center on violence directed by humans against other humans. Killing is inherent to fighting, and war's violent essence will never change. Hence, war will continue to be an extreme trial that will test our strength, stamina, and endurance. On the battlefields of tomorrow, our Marines and Sailors will still have to contend with danger, fear, exhaustion, and privation. While new technologies and scientific advancements may grant us advantages, ultimately, it will be our hardened resolve and will to win that will prove decisive in future combat.[108]

Accordingly, even technologies such as AI should not distract the Marine Corps from pursuing activities and research that are foundational to the conduct of warfare. Developing Marines through rigorous training and education to operate independently on mission-type orders, 'off-the-grid' sans technology will become elemental in an environment where technological advantages are fleeting. Nevertheless, AI technologies will expand the boundaries of how and where warfare is conducted across the range of military operations (ROMO). Adversaries not constrained by a more Western ideology or bounded by our fundamental ethical considerations may push to challenge our notions of what we are willing to do. Just as the crossbow, the

machine gun, and the airplane pushed the limits of destruction humans were willing to inflict on an enemy, history may add AI to this list as well.

AI can provide a capability that can potentially morph in importance as the technology can scale quickly. The ease of scalability in AI technology could lead from small scale implementation to such an importance that it becomes 'too big to fail.' To this point, Marine Corps Doctrine Publication 1 (MCDP 1) is instructive: "[t]here are two dangers with respect to equipment: the overreliance on technology and the failure to make the most of technological capabilities."[109] This makes heeding the warning of MCDP 1 problematic if AI is not closely monitored once it crosses a threshold of becoming a mission essential/critical system. As a result, the Marine Corps cannot abandon core tenets of its development of human qualities that have provided the foundation for all its past and current successes.

Finding the optimal combination of AI technology will prove difficult because the push to adopt technology is unrelenting from the commercial and military industries. For this reason, balancing will become the operative word with adoption of AI. By continuously experimenting with AI where it makes practical sense, the Marine Corps can adhere to core principles and gain the most from using AI based technologies. In fact, recent research has confirmed that leveraging the inherent flexible and diverse characteristics of human types of reasoning (inductive, deductive, long-term memory, etc.) with the strengths of domain-specific AI, what some term as a "centaur," have provided the most effective combination for tackling problems.[110]

When the Marine Corps decides to implement AI within any warfighting domain, it should tread carefully and not abandon its primary focus on developing and maintaining the underlying human character that has defined warfare for millennia. Again, MCDP 1 states,

"[t]echnology can enhance the ways and means of war by improving humanity's ability to wage it, but technology cannot and should not attempt to eliminate humanity from the process of waging war." It is doubtful that the next major war will be exclusively fought by robots alone, but will likely be enhanced with many different forms of autonomous technologies enabled by AI. For sure, robots destroying other robots is perhaps a battle after a fashion, but such a spectacle is not a sufficient condition to win a war ultimately rooted in human machinations. War will remain a human endeavor tangentially enhanced by AI technology to help impose violence or the threat of violence to break the will of an adversary. To be sure, the Marine Corps need not eliminate the human from all calculations when adopting AI technology, nor can it. By embracing the strengths of both AI and the individual Marine, the Marine Corps can increase its warfighting prowess through proper pairing and appropriate training for the most effective combinations. In the end, the Marine Corps can embrace this hybrid conception that does not abandon, but enhances the one true incalculable in war: the human will.[111]

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ACRONYMS

AI	Artificial Intelligence
AGI	Artificial General Intelligence
ASI	Artificial Super Intelligence
CPU	Central Processing Unit
DC	Data Center
DoD	Department of Defense
EOD	Explosive Ordnance Disposal
GCT	General Classification Test
GNMT	Google Neural Machine Translation
GPU	Graphics Processing Unit
HASO	Human-autonomy System Oversight
HRI	Human-Robot Interaction
HUMINT	Human Intelligence
IoT	Internet of Things
JIE	Joint Information Environment
MCDP	Marine Corps Doctrine Publication
MCEN	Marine Corps Enterprise Network
MOC	Marine Operating Concept
MOS	Military Occupational Specialty
NLP	Natural Language Processing
NMT	Neural Machine Translation
OPSEC	Operational Security
OOTL	Out-of-the-Loop
PUE	Power Usage Effectiveness
ROI	Return on Investment
ROMO	Range of Military Operations
USMC	United States Marine Corps
VR	Virtual Reality

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