Artificially Intelligent Warfare and the Revolution in Military Affairs

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Abstract

This study examines the use of artificial intelligence (AI) by the United States military as a case study. It explores the role of AI, first by looking into the concept of "Revolutions in Military Affairs" (RMA), studying AI's defining characteristics and the previous RMA that have occurred in history, thus clarifying whether or not the integration of AI into the military operations can be classified as an RMA. The study then continues with an analysis of the two previous Offset Strategies adopted by the United States military, both of which resulted in an RMA and investigates whether the present Third Offset Strategy largely defined by AI can be seen as an RMA. In conclusion, the findings lead to the suggestion that, while AI has the potential to cause a revolution in military affairs and has caused many changes in the global approach to warfare, it is still in its infancy stage, and thus cannot be labelled as an RMA at this time.

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Dedication

“That one sef dey”

Table of Contents

List of Tables

List of Figures

List of Acronyms

A2/AD	Anti-Access/Area Denial
AGI	Artificial General Intelligence
AI	Artificial Intelligence
AIS	Automatic Identification System
ALIS	Autonomic Logistics Information System
ANI	Artificial Narrow Intelligence
ANN	Artificial Neural Networks
ARGUS-IS	Autonomous Real-time Ground Ubiquitous Surveillance-Imaging System
ASI	Artificial Super Intelligence
ATACMS	Army Tactical Missile System
AUV	Autonomous Underwater Vehicles
AWS	Autonomous Weapons Systems
AWACS	Airborne Warning and Control System
BMD	Ballistic Missile Defence
C2	Command and Control
CEC	Cooperative Engagement Capability
C^4I	Command, Control, Communication, Computers & Intelligence
CIA	Central Intelligence Agency
CIWS	Close-In Weapon System
COMINT	Communication Intelligence
DARPA	Defense Advanced Research Projects Agency
DFTOP	Data Farming Decision Support Tool for Operation Planning

DII	Defence Innovation Initiative
DOD	Department of Defence
ELINT	Electronic Intelligence
ERI	European Reassurance Initiative
GEOINT	Geospatial Intelligence
GMLRS	Guided Multiple Launch Rocket System
GPS	Global Positioning System
HIMARS	High Mobility Artillery Rocket System
HSAS	Human-Supervised Autonomous Systems
HUMINT	Human Intelligence
IBM	International Business Machines
IHL	International Humanitarian Law
IMINT	Imagery Intelligence
ISR	Intelligence, Surveillance and Reconnaissance
JASSM	Joint Air-to-Surface Strike Missile
JDAM	Joint Direct Attack Munition
JSTARS	Joint Surveillance and Target Attack Radar System
JTIDS	Joint Tactical Information Distribution System
LAR	Lethal Autonomous Robot
LAWS	Lethal Autonomous Weapons System
LIDAR	Light Detection and Ranging
LOAC	Laws of Armed Conflict
LRASM	Long Range Anti-Ship Missile

MAD	Mutually Assured Destruction
MAISINT	Measurement and Signatures Intelligence
MFLTS	Military Foreign Language Translation System
ML	Machine Learning
MLRS	Multiple Launch Rocket System
MR	Military Revolution
MTI	Moving Target Indicator
MTR	Military Technical Revolution
MUTT	Multi-Utility Tactical Transport
NATO	North Atlantic Treaty Organization
NAVSTAR	Navigation System with Timing and Ranging
NCW	Network Centric Warfare
NLW	Non-Lethal Weapons
NYC	New York City
OODA	Observe-Orient-Decide-Act
OSINT	Open-Source Intelligence
PCW	Platform Centric Warfare
PGM	Precision-Guided Munitions
PrSM	Precision Strike Missile
RAS	Robotic and Autonomous Systems
RMA	Revolution in Military Affairs
SAS	Semi-Autonomous Systems
SAS	Synthetic Aperture Sonar

SAW	Squad Automatic Weapon
SDB II	Small Diameter Bomb II
SDI	Strategic Defense Initiative
SIGINT	Signals Intelligence
SM-6	Standard Missile-6
TASM	Tomahawk Anti-Ship Missile
TiGER	Tactical Grenade Extended Range
TRANSTAC	Spoken Language Communication and Translation System for Tactical Use
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicles
UN	United Nations
U. S.	United States
VEO	Violent Extremist Organizations

Introduction

> *First, technology can multiply the combat effectiveness of a force such that it "offsets" the numerical advantage of a larger, but technically inferior force.*
>
> (Robert Martinage, 2014, p. iv).

Accepted, or not, as an ancestral part of human nature, war is a recurrent phenomenon with constant foundational attributes alongside evolving and persistently changing processes. In other words, warfare, that is the expression of war, can be understood to continuously undergo transformation. Classical war theorists posit warfare to be a bloody encounter resulting in the bending of an enemy's will , thereby compelling them to succumb to the victor's laid out demands. War, through a Clausewitzian definitional scope, is the "continuation of policy with other means" (Clausewitz, 1976, p. 69). Therefore, in assuming that states, and individuals within and without them, will always pursue perceived interests as defined by Clausewitz, war can be understood to be a widely acknowledged norm and a form or expression of international relations. Within this context, enhanced capabilities are sought by individuals and entities to maintain an advantage over perceived and actual adversaries. Especially since World War I (WWI), technological advancements have been sought to fill in the gap created by the clamour for competitive advantage.

A move from unipolarity in the international arena to multipolarity following the Cold War, sparks concerns of the techniques, adaptations and necessity of warfare, especially in this transformative age of artificial intelligence (AI) and big data. AI is at the forefront of developments in the area of robots, machine autonomy and advanced Autonomous Weapons Systems (AWS), sophisticated weapon capabilities, and unprecedented data and intelligence gathering that feed into budding robotic cognitive abilities commonly referred to as machine learning.

The post-World War II (WWII) environment burdened with fragile diplomatic relations, the development of the Cold War and particularly the need to depend on nuclear weapons to counterbalance the Soviet Unions' growing ideological and military reach, saw the formation of the United States' (U.S.) First Offset strategy[1], largely seen as its first wholesome revolution in military affairs. The nuclear arsenal in the possession of the U.S. stood as the competitive advantage for deterring and dissuading potential challengers and for extending the U.S.' tentacle of policymaking. Anchored on a containment of the Soviet Union, the First Offset strategy was a nascent attempt at furthering the infusion of new technology and resultant weapons in pursuing extended interests, all done while considering the human cost of conventional warfare (Horres, 2016; Coletta, 2017).

The subsequent growing parity in nuclear capabilities between the Soviet Union and the U.S. demanded a new approach to culling comparative advantage from technological advancements. As such, a new Second Offset strategy "exploited advances in computer processing and aerospace technology …[and]… technologies for Precision-Guided Munitions [PGMs], standoff weapons, electronic countermeasures, and remote sensing for Intelligence, Surveillance, and Reconnaissance [ISR]" (Coletta, 2017, p. 48). The Soviet Union restricted the new strategies gleaned from the Second Offset from being used in a major war until they were tested for effectiveness against Saddam Hussein's led Iraqi troops (Coletta, 2017). However, these strategies resulted in a counterrevolution among U.S. adversaries, both state and non-state actors, which adopted non-conventional methods that led to attacks such as that on the World Trade Centre on September 11, 2001 in New York City (NYC). These groups avoided direct confrontation and dampened the effectiveness of carrying out methods garnered from the Second Offset strategy.

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[1] Also referred to as the *New Look.* For more, see Martinage, 2014

In response to the changes in methods of engagement and confrontation, the U.S. sought a new revolution in military affairs to better adapt and reflect the changing landscape and character of warfare. As such, the then U.S. Secretary of Defence, Chuck Hagel, in 2014 announced the launch of the Third Offset Strategy embedded in the Defence Innovation Initiative (DII), that was to be propelled by the adoption and exploitation of AI (Hasik, 2018; Horres, 2016).

Studying changes in military affairs and the conduct of warfare, both historically and presently, have led several researchers, practitioners, and scholars to consider the idea of revolutions in military affairs. This is, however, debated due to definitional differences, posing questions as to whether or not a revolution has truly existed or presently exists and by what understanding and metric revolutions are measured and captured. Exploring AI could bridge a gap of understanding between the changes in the character of warfare and the understanding of a revolution. It exemplifies the growing importance of a look into the classical notions of warfare through a redefined lens. This study therefore considers what warfare looks like and will look like in an age where the intelligence garnered and used in warfare involving humans will be largely non-human.

On a broad level, this study provides a basis through which the notion of warfare can be re-examined to understand the changes that have occurred through a revolution in military affairs. In line, it also theoretically links the revolution in military affairs to not just the period of the Second Offset strategy, but to one that is currently being buoyed by AI. On a more specific level, this study explores how AI interacts with the military and by extension, war. It seeks to understand how AI changes the character of warfare and if AI can be considered a genuine revolution in military affairs.

“War can be of two kinds, in the sense that either the objective is to over- throw the enemy-to render him politically helpless or militarily impotent, thus forcing him to sign whatever peace we please; or merely to occupy some of his frontier-districts so that we can annex them or use them for bargaining at the peace negotiations” (Clausewitz, 1976, p. 69). In expressing the dynamism between war and violence as an intimate dance with registers of politics and psychology forefront in its rhythm, Pain (2015) explains war to be a game of oppression with resounding psychological impacts observable in the vanquished party. Otterbein, however, attempts to define war through the purview of frequency and intensity, promoting a dichotomy between war and feuds. In his discourse, war deviates from feuding due to its politically inclined nature, allowing for a more calculated effort than a feud (2004). Schake (2017) offers a rather divergent ideology of war. He describes war as being on the one hand, an elemental destroyer that lays waste to humans and property in the quest for power, greed, and survival, and on the other hand as useful in maintaining societal order and relations between conjoining states. Adding to the discourse, Prosterman explains war as a likely act of violence perpetrated by one group against another with distinct cause and reason. Here, violence is a likelihood of war and not an objective (1972).

With significant drivers such as desire, lack of resources, fear, folly, power, and gain purported by the antediluvian Athenian general, Thucydides, and late century historian Prussian Carl von Clausewitz, the theories on the causes of war can be said to be as varied as their impacts on the parties involved (Fry, 2015). Garnett (2007) presents a breakdown of the causes of war, with motives that range from efficiency to necessity. Garnett’s analysis provides noteworthy insight into the determinants of war as it relates to international relations, while subtly defining physiological pre-sets responsible for the appearance of these drivers (2007). In this line, it tallies with Blainey (1973), whose underlying outlook on war rests on the existence of an overwhelming sense of confidence in one's ability to successfully defeat contenders.

Warfare, though sometimes used interchangeably with war, depicts the product and means of war, and encompasses the inherent tactics, ideologies and technologies. Vandkilde (2015) in providing definitional understanding posits warfare in all extremities, or lack thereof, as an encounter between groups whose cultural inclinations, openness to dialogue, and willingness to join forces determines the fate, direction, and ultimately, intensity of their meeting. Warfare has persistently evolved over time with its modern-day roots forged in the boundaryless realm of information and cyberspace.

Neiberg (2015) explores this evolution of warfare through a five-era approach. The first era, aptly named the *Classical Period* dealt primarily with wars waged by the Greeks and Romans. Neiberg claims that the advent of technological warfare has strong ties to the Greco-Roman era whose ultimate instigator resided in their desire to lay siege to their enemies. This contentious style of war likened to an episode from the Philip K. Dick's Electric Dreams Series *Kill all others,* saw the introduction of heavy weaponry superior to their counterparts in both form and style. Speculatively, the Greco-Roman warfare can be based loosely on the social Darwinism principle of *kill or be killed* with short yet ghastly conflicts creating innumerable casualties on all sides with the ultimate goal of winning at all costs (Neiberg, 2015).

The second era, the *Middle Age era* as theorized by Neiberg, saw a departure from an over dependence on heavy weaponry to a need for speed and agility on the battlegrounds. This need birthed new tactics and technology in warfare in this period. Horses, a staple of aristocracy and a pinnacle of combat for this era, became more effective with the inclusion of stirrups for stability and dexterity during battles. This era marked the proliferation of the cavalry with the Mongols basing the bulk of their military power on their dissemination (Neiberg, 2015).

Heavy artillery, gunpowder machinery, and a mechanized arsenal were all qualifiers of the third warfare era described as the *Gunpowder Age*. This period witnessed the transition from horse-based warfare to a type of mechanized warfare greatly dependent on guns and ammunition. Muskets were introduced here as the sleeker more accurate alternative to the then unpredictable handheld cannon. The dispensation of gunpowder machinery brought an end to the weighted armories and sword wielding knights of the middle ages (Neiberg, 2015).

The fourth era as surmised by Neiberg saw remarkable technological advancements in warfare brought upon by the brimming industrialization and promotion of nationalism found in this period. Accuracy, stealth, and power redefined military technology with enhancements seen not only in munitions, but also, in the formation and attitude of actors towards their military.

The fifth era theorized by Neiberg brought in a never before seen revolution in warfare. This period hosted a new level of warfare which supposedly eclipsed all others preceding it. This transformation was ushered in through the introduction of nuclear weapons. Shepherding a different mode of warfare and technologies, nuclear weapons permitted a shift from offensive approaches to defense-guided strategies and methods. Defence via *Mutually Assured Destruction (MAD),* was predicated on no defence and the capacity to retaliate regardless of what happened. The notion of MAD afforded a move from conventional approaches to transformational methods and deepened the already shifted cultural perspective derived from the nuclear age.

The evolution of warfare has informed changes in the physical structure and anatomy of war as observed in prehistoric times, with the medium of expression by actors increasingly divergent through the years. Cyber warfare, a component of contemporary warfare, is war waged within the confines of cyber space: an interconnection of networks hosted on one or more central hubs in which nation-states post, retrieve, process, and manipulate digital information (Kuehl, 2009). With limitless avenues for attack present in cyberspace, state players are forced to develop defensive as well as offensive responses to mitigate the imminent threat of cyber warfare such as President Reagan's Strategic Defense Initiative (SDI) program. In the research for defensive strategies to counteract possible cyber-attacks, Carr (2011) proposes a holistic five step approach to detecting early warning signs of cyber warfare. This approach assumes changes in political, technical, and socio-economic factors as suitable precursors to an impending threat by opposing states against a nation's cyber-defense system. Carr, however, cautions against an overreliance on this approach as a variety of factors - drivers, intent, intelligence, and skill- can alter the flow and form of a probing cyber-attack.

Saydjari's (2004) theory of cyber-defense hinges on technical aspects of cybersecurity. Offering elements necessary for the creation of an effective cyber-defense system, Saydjari states that these must be built with the ability to assess incoming threats, and perform the steps necessary to avert, withstand, and demolish said threat. Robinson et. al (2015), however, argue the need for a final element to be added to those necessary for the creation of an effective cyber-defense system, an element with the ability to learn from previous attacks, identify areas of weakness in its operation, and infuse these finding into other elements to improve overall performance. This seventh element is labelled *cyber intelligence*.

Viewed as a unifying force or as a devastating divide, war in any form it presents itself, has historically been proven inevitable. Understanding the irregular metamorphosis of warfare, even as it relates to current times, is crucial in cognizing the interaction between AI and war, and also, in determining the inherent capability of AI in preserving or altering the character of warfare.

Significance of the Study

This thesis focuses on RMA as a theory and concept, and explains AI in this context. To understand properly the relationship between RMA and AI, and how they could or do influence the military, the theory of technological determinism can be studied. The concept of ‘determinism’ explains that events occur as a result of previous conditions and events which occur regularly and predictably (Pannabecker, 1991). The use of the term “technological determinism” can be traced back to Thorstein Veblen, an American sociologist in the late 1800s. He identified the link between technology and the society, and the influence technology exerts (Hauer, 2017). This theory brings forward the notion that technology has become such an integral part of the society, that it has influenced the way people live their lives. Technological developments, in sum, are essential driving forces of human and societal change.

Proponents of the theory state that society, at its core, is influenced and shaped by technology. As new innovations become available, the members of the society must adapt, or face being left behind. Electronic means of communication, advances in air, land and sea transportation, automation of various household chores, shopping, employment recruitment, are but a few of the means through which technology has integrated itself into everyday living (Hauer, 2017). There are two branches of technological determinism: hard and soft. In some circles, they are referred to as “radical” and “moderate.” Advocates of the hard version hold that technology is imperative for societal change, while those of the soft version explain that, while not a prerequisite, technology is still a key factor for societal change to occur. Those that criticize the theory do so in different ways with some arguing that technology is socially determined, while believe that it evolves alongside social structures in a non-deterministic, reciprocal manner (Hauer, 2017).

In the context of warfare, the three basic dimensions of an RMA include the doctrinal, organizational and technological (Marshall, 1993), and technological determinism posits that the technological dimension is responsible for influencing the others. In the military, technological determinism explains the transformations that occur in warfare from the viewpoint of technological innovations (Rey, 2010). The introduction of new, artificially intelligent systems in this regard, results in a change in the tactics employed by the services. This change then leads to political, economic and social transformation (Rey, 2010).

There are different levels of these changes. At the most basic level, technological advances in weaponry will directly lead to tactical changes. At higher levels, these technological changes will affect the strategic and political spheres, and the decisions made at these levels will be determined by these factors. The level of interaction between the services is also subject to the existing technology, as this determines the level of communication available to them. An example of this is the shift from primarily independent military operations to joint operations seen in recent times. Nations that do not embrace these changes are often at a disadvantage compared to the nations that do.

This study utilizes a secondary data analysis, largely fed from the use of a case study of the U.S. military. This is to determine whether AI has or will change the character of warfare for the U.S. military or at least has the capacity to do so, and to ascertain whether the current state of AI in the U.S. military constitutes a revolution in military affairs. The U.S. military was selected as the case for this research because it can be said to constitute a *critical case*, that has "strategic importance in relation to the general problem" (Flyvbjerg, 2006, p. 228).

The notion of RMA as a concept largely originates from the U.S., and given the expenditure the country spends on research and development aimed at establishing new ways of improving their military practice especially through the focus on AI, it currently has a better chance than most countries' militaries of having and pursuing an AI-propelled RMA. Ultimately, the case study methodology's focus on the U.S. military will help to determine whether AI can be considered a genuine revolution in military affairs.

This study also highlights the Third Offset Strategy as a basis for exploring AI and its portended revolution in military affairs. In a bid to avoid *ahistorical bias*, strategies leading up to the present, especially the First and Second Offset Strategies, will form the skeletal framework that uphold the analysis on the contemporary and developing character of warfare especially from the lens of the United States military.

Overview of the Chapters

This research study is divided into four chapters that do not include the introduction. Chapter One examines the concept of RMA in terms of its origin, structure, and transformation (both evolutionary and revolutionary), and leverages historical context to ascertain the relevance of military revolutions in conventional and modern warfare. Chapter Two introduces and elaborates on the different levels of AI namely, artificial narrow intelligence, artificial general intelligence, and artificial super intelligence. It delineates the difference between autonomous and automatic systems as it relates to military hardware, further expounding on the diverse uses of AI in the military.

Chapter Three presents the theory of offset strategies and discusses the three main offsets purported by the United States' military. The first two strategies highlight the use of nuclear weapons and technology as a deterrent of enemy forces while the third offset, features AI technology and cyber systems as a critical enabler of military advantage. This chapter emphasizes the historical context, development, deployment, advantages, and corresponding impediments of each offset strategy. It also analyzes the efficacy of current military warfare as a suitable RMA. Chapter Four concludes this study by presenting its findings, suggesting areas where further research would be beneficial, and offering recommendations on the level of impact, if any, AI has on military strategy and advancements in warfare.

Conclusion

This chapter introduced war and warfare and explored the varying dimensions through which historians, theorists, and scholars alike have explained this recurrent phenomenon. It posed the overarching questions concerning “AI as an RMA” influencing this study, identified the significance of determining the role of AI in changing the nature of warfare, and established the range of objectives this study hopes to accomplish. This chapter also identified the research methodology—secondary data analysis—employed by this study and provides a synopsis of the subsequent chapters within this paper.

Chapter I: Revolution(s) in Military Affairs

There is no widely accepted definition of a Revolution in Military Affairs (RMA), or a standard explanation of what could be considered an RMA. While it can be viewed as a change in combat modalities, other definitions wholly focus on the evolving nature of doctrinal adjustments. Whatever the view, most scholars agree that an RMA constitutes a fundamental transformation of the relationship, and thus nature of, war and society. Scholars who, as Rey argues, view RMA as primarily changes in combat modalities are somewhat aligned with the theory of technological determinism, as they posit that technological innovations within the military are the catalyst for all other changes that occur in warfare (2010).

Latham (2002) provides a robust and non-linear understanding of RMA, arguing against a singular-dimensional historical view of RMA. He opts instead for a broader "military-historical vista through three key dimensions - the warfighting paradigm, the social mode of warfare and the politico-cultural institution of war" (p. 261). The warfighting paradigm focuses primarily on the changes that occur in the nature of the military force on the battlefield. The social mode of warfare focuses on the significant changes in the purposes of war that have occurred in societies over the years. The politico-cultural focuses on the cultural meanings of and changing cultural tolerance for war. These all feed into the understanding of RMA as not being entirely relegated to the upgrading of weaponry through technological advancements. A *genuine* RMA will transcend fixation on the upgrade of weapons of war and needed equipment, and also impact other aspects of military relations and formation that inform or influence military affairs, such as the cultural shifts within and without the military services and the nature of the military's socio-political interactions.

In order to fully grasp the concept of an RMA, it must be examined through a historical lens. Sloan (2002) postulates that doing so gives a general sense of the origin of the RMA that currently holds the central stage as well as the courses and outcomes of previous ones. Colin Gray (2002) identifies the policy-related and intellectual features of the progenitors of RMA as the "…containment in the 1940s, nuclear deterrence and then limited war in the 1950s, strategic stability and arms control in the 1960s, détente in the 1970s, Ballistic Missile Defence (BMD), and competitive strategies in the 1980s" (p. 1). In borrowing from his explanation, RMA can be seen as a radical change in the conduct or character of war.

Despite carrying a patina of confusion, RMA, as a concept, is traced by most of the available contemporary scholarship to the Cold War era where the term was officially adopted by military leaders and strategists (Adamsky, 2008; Roxborough 2002; Mey, 1998; & Latham, 2002). RMA was described at the time as a "transformation in warfare [brought about] since the introduction of nuclear weapons… [that alters] the way we think about the aims and methods of conventional warfare" (Adamsky, 2008, pp. 257-258). Some authors, however, in explaining the two Offset Strategies of the U.S during the Cold War RMA nuclear power-induced period, relegate the theoretical use of the RMA to the Precision Guided Missiles (PGM) and Intelligence, Surveillance and Reconnaissance (ISR) which provoked the Second Offset strategy that essentially emanated as a result of a nuclear stalemate between the U.S and the defunct Soviet Union. These theorists do not consider the introduction of nuclear warfare as a considerable alteration in the fabric of warfare as they do not see it as a fundamental transformation of the relationship, and nature of war and society.

Long before the conceptualization of RMA, there were numerous examples of revolutions in warfare. These can be traced to as far back as the fourteenth century during the Hundred Years'

War, where cavalry stopped being the dominant combat unit on the battlefield and was replaced by infantry due to the technological development of the longbow. Murray (1997) identifies as many as ten RMAs that occurred between the fourteenth and twentieth centuries.

Table 1

Possible RMAs alongside their driving forces from the 14th-20th centuries

Century	**Possible RMA**	**Driving Forces**
14th	Longbow	Cultural
15th	Gunpowder	Technological, financial
16th	Fortifications	Architectural, financial
17th	-Dutch-Swedish tactical reforms -French military reforms	Tactical, organizational, cultural Tactical, organizational, administrative
17th-18th	Naval Warfare	Administrative, social, financial, technological
18th	-British financial revolution -French Revolution	Financial, organizational, cultural Ideological, social
18th-19th	Industrial Revolution	Financial, technological, organizational, cultural
19th	American Civil War	Ideological, technological, administrative, operational
Late 19th	Naval war	Technological, administrative, cultural
19th-20th	Medical	Technological, organizational
20th	World War I *Blitzkrieg* Carrier war Strategic air war Submarine war Amphibious war Intelligence Nuclear weapons People's war	Tactical, conceptual, technological, scientific Tactical, operational, conceptual, organizational Conceptual, technological, operational Technological, conceptual, tactical, scientific Technological, scientific, tactical Conceptual, tactical, operational Conceptual, political, ideological Technological Ideological, political, conceptual

Note. Adapted from "Thinking about revolutions in military affairs", by Murray, W., 1997. *Joint Forces Quarterly, 16,* p. 70.

Two major revolutions agreed upon by most analysts are the French and Industrial revolutions, with the latter heralding the advent of mechanization. New technology at that time made the mass production of weapons possible, and these weapons had enhanced range and accuracy (Zapotoczny, 2006). In addition to the technological advancements, railroads and steam engines permanently reformed transportation and communication was transformed by the invention of the telegram. All of these changes resulted in tactical and strategic changes in the military. The movement of troops and supplies became faster than ever, and they began to use mechanized weapons. These changes rendered the traditional tactics ineffective, and new doctrines had to be put in place.

Having established historical context, it is now possible to identify general characteristics of an RMA. Strategists such as Krepinevich and Marshall established the three basic dimensions by which an RMA can be defined: doctrinal, organizational, and technical. There are abundant and differing opinions about which of these is the driver of the revolution, but the general consensus is that only a simultaneous and profound change in all three dimensions can be referred to as an RMA (Marshall, 1993; Krepinevich, 1994; Fridman, 2013). Most analysts also agree with Krepinevich's definition of RMA, as "… [occurring]… when the application of new technologies into a significant number of military systems combines with innovative operational concepts and organizational adaptation in a way that fundamentally alters the character and conduct of conflict. It does so by producing a dramatic increase─often an order of magnitude or greater─in the combat potential and military effectiveness of armed forces" (p. 1).

It is worthy of note that there are three terms which are frequently encountered and often used somewhat interchangeably: Military-Technical Revolution (MTR), Revolution in Military Affairs (RMA) and Military Revolution (MR). These terms, however, are not the same. They should instead be considered as different points on the continuum of the restructuring of warfare, with each incorporating the core values of the last. The definition of an MTR is usually restricted to technological advances. It describes past and future developments in military techniques. According to Krepinevich (2002), the term originated from Russian military writings of the 1970s and 1980s, particularly those by the Soviet Chief of the General Staff, Marshal Nikolai Ogarkov, who described the application of technological advancements in military by the West that would enable them to compete on par with the conventional methods still in use by the East. Sloan (2008) explains that these changes began due to the decision by the then U.S. Secretary of Defence, Harold Brown, that the North Atlantic Treaty Organization (NATO) "…should try to 'offset' the Soviet's quantitative advantage with qualitative, technological advances since the NATO could never hope to field as many soldiers as the Soviet Union" (p. 2). These advances were debuted during the Gulf War, and were crucial to the success of the coalition forces.

However, there are inherent problems with this concept of an MTR. Focusing solely on the technological advancements without corresponding doctrinal and strategic ones would simply create new weapons for the existing, potentially out-dated organizational structure. This may lead to greater vulnerability for the military, as potential adversaries could eventually acquire new technology which could be on par or even superior to theirs. The defence community consequently saw the need to look beyond mere technology and seek changes in the strategic, doctrinal and organizational dimensions of warfare. This heralded the adoption of "RMA" as the term of choice (Arquilla, 1997).

Andrew Marshall (1993) explains that the revolutionary WWII German Blitzkrieg combined doctrinal and organizational changes with new technological advancements, going beyond an MTR to an RMA. This is featured in his definition of RMA as "a major change in the nature of warfare brought about by the innovative application of new technologies which, combined with dramatic changes in military doctrine and operational and organizational concepts, fundamentally alters the character and conduct of military operations" (as cited in Maloney and Robertson, 1999, p. 445). In this regard, the components of the 20th century RMA are a combination of technological and informational advances such as high-tech sensors, advanced Command, Control, Communication, Computers and Intelligence (C^4I) and precision weapons. These have led to profound doctrinal changes in the business of warfare. Despite these changes, however, RMA do not fundamentally alter the nature of the state, and this is where it differs from MR.

MR is the broadest of all three concepts. As Murray (2001) explains, it is a fundamental change in the framework of war which recasts the nature of society and the state. The term was first proposed by Professor Michael Roberts in 1955 and has since become the subject of many discourses, articles, and books. Roberts identified four basic elements which propagated a revolution that took place between 1560 and 1660 (Murray, 2001). The first was a revolution in tactics which consisted of smaller, better organized and armed infantry units engaged in closer combat. This led to an increase in the army size that demanded a new standard for training, necessitating a change in strategy. Together, all of these elements resulted in a multifaceted and unparalleled increase in the impact of war on society. Murray and Knox (2001) highlight five historical MRs: the creation of the modern state and its military institutions, the French Revolution, the Industrial Revolution, World War I, and the Nuclear Revolution. To this list, Gray (2006) adds the Information Revolution.

There are differing opinions on the order in which RMA and MR occur. Analysts such as Murray (1997) believe that RMAs are the result of the societal, political and technological changes brought on by an MR. Rogers (1995), however, sees RMA as preceding MR. He gives the example of the artillery revolution which tilted the offence-defence balance in favour of offence. This led to a revolution in the military structure, with the creation of a standing army. Regardless of opinions about which happens first, it is generally accepted that the results of MR are farther reaching than those of RMA.

Most experts, like Murray (1997) and Rogers (1995), agree that RMAs have occurred in history. They may have diverging opinions about what moments in history constitute true RMAs rather than the results of simple evolution, but they agree that there are certain characteristics that are common to them. One such characteristics is that the doctrinal, organizational and technological changes all occur concurrently within a relatively short period of time, and they render all previous methods of warfare obsolete or grossly inadequate. The French revolution, as an example of an RMA, introduced ideology and nationalism into the equation of warfare, setting the stage for the mobilization of scientific, economic and popular resources for use in warfare (Murray, 1997). Prior to this time, wars were fought by conscripts who were not well trained. With the rise of mass politics seen during this time, states began to field larger, more disciplined armies.

Another illustration of an RMA is the Industrial Revolution. It allowed for the mechanization of firepower. This allowed militaries to have access to large numbers of these weapons, leading to guns being the main weapons used in wars, as opposed to the swords and knives that were previously used. This revolutionary change completely revolutionized warfare, and any state or nation that was unable to embrace and harness it during conflicts did not survive. Evolutionary changes, on the other hand, do not pose such drastic consequences to those who have "missed" them or do not realise their impact (Snyder, 1999; Neuneck, 2008).

Presently, there is much talk about whether this purported change brought on by the introduction of AI in the system of warfare is truly revolutionary or instead just a result of normal evolutionary changes in military operations. Proponents of the evolutionary theory state that operational concepts labelled part of the RMA, such as air-ground coordination and tactical commands, are merely representative of the full maturation of ideas which first emerged in the 1930s and 1940s, rather than a revolution (Sloan, 2002). Snyder, in this vein, states that

> "[t]echnological advances, a new age in warfare, and a changing doctrine do not in and of themselves constitute a radical change and thus a revolution in warfighting, but possibly represent the logical evolution of combined arms warfare for the twenty-first century" (1999, p. 3).

Alvin and Heidi Toffler (1993) note that the term "revolution" has been applied too generously to mere technological changes which, while creating more efficient ways of doing certain things in warfare, did nothing to change the "game" or its relationship to society. They state that a true revolution will "change the game [of war] itself, including its rules, equipment, the size and organization of the 'teams', their training, doctrine, tactics and just about everything else" (p. 32). Black (1995), cautions that there are no agreed-upon criteria by which revolutions may be discerned. The general consensus for those who propose that the current military climate is evolutionary seems to be that rather than a new way of conducting warfare, there is now a better way.

Proponents of the revolutionary theory, however, insist that the current changes in military affairs are nothing short of revolutionary. Many have highlighted the various technological, doctrinal and organizational changes that have all occurred within a short time and described how these changes have been integrated into the military, resulting in new, never before seen structures and tactics. They claim that these changes have permanently transformed the three dimensions of warfare–force, time and space (Butler, 2003; Neuneck, 2008). Force, in this context, refers to the power of the military, which is defined by their combat power; time delineates the tempo of the action of war; and space refers to the scope of battle.

In the words of Metz and Kievit (1994), "… throughout history, warfare usually developed in an evolutionary fashion, but occasionally ideas and inventions combined to propel dramatic and decisive change" (p. 1). These dramatic and decisive changes are the things which proponents of the revolutionary theory claim will render certain long-held methods of warfare and combat irrelevant. John Arquilla (1997) uses the Army Tactical Missile System (ATACMS) as an example. He explains that this ballistic missile which has the ability to drop numerous guided bomblets upon enemy forces would lead to a radical change that eliminates the need for large field armies.

Novel information and communication technologies such as satellites and the internet have been in development since the mid 1900s and are central to the technological changes of this RMA. Nations and societies have become greatly dependent on these technologies in pursuing warfare (Eriksson & Giacomello, 2006), not to mention day-to-day life. Since the launch of Sputnik 1 by the Soviet Union in 1957, many other countries have developed and launched their own satellite systems. For instance, the U.S. Department of Defence developed the Navigation System with Timing and Ranging (NAVSTAR) GPS satellite, and this (specifically the Precision Positioning Service) can be used to distribute information and determine exact location of enemy or friendly troops (Eriksson & Giacomello, 2006). It has been used by the military for national defence, homeland security and various other purposes. In addition to this, innovations in ISR, sensor systems, C^4I, PGMs with assorted ranges, and new weapon principles (laser, non-lethal weapons [NLW]) have transformed offence and defence protocols and are going to be at the core of future wars (Neuneck, 2008; Moon and Lee, 2008). Technologies that are able to process and interpret the information gathered by all these different surveillance methods are now available, and the information can thus be transmitted in real time to relevant parties for action. These technological and information changes have made significant improvements in the force, space and time dimensions of war, as the use of PGMs have transformed combat power, the innovations in air and sea transport have improved the spread of tactical units, and the rapid dissemination of information has resulted in an increase in the tempo of war (Butler, 2003).

Separate from the technological advancements, but no less a revolutionary change, is the strategic shift from mass destruction to precision strikes and the mandate of minimal human casualties (Moon & Lee, 2008). The development of PGMs has allowed for greater discrimination in warfare, as they are launched using the GPS to pinpoint the exact coordinates of targets. This doctrine of unmanned combat has significantly reduced the number of civilian, as well as friendly casualties in warfare. Another major doctrinal change in this RMA is the post-Cold War shift from massive, stationary armies to lighter, more deployable forces (Sloan, 2008). This shift occurred as a result of the changing nature of the international security environment. Rather than large threats coming from one country or state at a time, many smaller threats from multiple areas occur concurrently. The military needs to be able to rapidly respond to these threats by deploying troops. The development of technologies such as airlifting has made this rapid deployment possible.

Equally as important as the technological and doctrinal changes introduced by the most recent 20th century RMA are the organizational changes that have taken place. One example is the division of troops into smaller units that are able to handle specific kinds of operations (Sloan, 2008). The members of these units are more highly qualified and better trained to be able to handle the different types of high-tech equipment. Another is the trend of military “jointness.” Operations characterized by navies, armies and air forces from either the same or different (that is then combined) countries working together to improve capacity and efficiency have become increasingly frequent as a result of the RMA (Sloan, 2002; Cordesman, 2015). Prior to this, much emphasis was placed on service loyalty; officers being fully grounded in the philosophy of their own service and the different services engaged in warfare independent of each other and impetus for Goldwater Nicholas Act.

The concept and accompanying descriptions of RMA may vary per the accounts of scholars. The evidence presented above, however, provides a categorical explanation of the features of changes in every RMA. The key to distinguish the nature of change in military affairs remains, however, the unsettled question of: “revolutionary or evolutionary?”. The literature available indicates that these changes are indeed revolutionary.

Military Transformation: Beyond the RMA

Just as the late 1990s marked a shift from talks about MTR to the broader RMA, so also analysts have begun to talk about a new era–Military Transformation. The term gained traction at the turn of the century, as the U.S. defence community began to speak less about an RMA and more about transformation. Sloan (2008) gives possible reasons for this change in terminology. She articulated that the notion of revolutionary change indicates a definitive end state, while transformation captures the idea of ongoing change, and this is the more accurate term, as the changes are still underway. In fact, it could be said that Military Transformation naturally follows the recognition of an RMA.

The advances made during the different RMAs hitherto have truly transformed many aspects of the pursuit of warfare. However, they are in many respects, restricted to just conventional warfare. Following the emergence of new and atypical forms of conflict such as ideological warfare, cyber warfare, international terrorism, in addition to changes in its existing forms such as economic warfare, and the involvement of non-state actors, it is becoming apparent that the most recent 20th century RMA is ill-equipped to cope. Thus, there is a need for the military to develop a new approach to warfare; one with enough flexibility and adaptability to meet future strategic demands (Gray, 2006; Neuneck, 2008; Cordesman, 2015). In the words of Townshend (2005), "[modern war] is to be seen as the product of three distinct kinds of change: administrative, technological and ideological" (p. 3). Military transformation calls not just for doctrinal, organizational and technological changes in warfare, but for continuous systemic changes in politics and the society at large.

Arquilla (1997) postulates that the West may lose the position of relative advantage it gained with the Second Offset strategy should the pursuit of radical technological advances that define the most recent 20th century RMA continue. This, he says, may occur if rivals are able to duplicate American innovations or avoid conventional methods of warfare, opting instead for guerrilla warfare or the use of tactical nuclear weapons. There are many nations and regions that pose these unconventional security threats to the U.S. such as in the Middle East, China, and North Korea. Using the Chinese military as a case study, Arquilla (1997) explores the possibility that the Chinese armed forces may develop PGM and other technologies designed to strike asset-heavy opponents like the United States. Furthermore, as Cordesman (2015) explains, the rise of religious extremism and ethnic, tribal and regional tensions has created dangerous non-state actors that cannot be fought simply with better weapons. A key example of this unconventional method of warfare is the combination of terrorism, insurgency and asymmetric warfare pursued by the Taliban and its affiliates which challenge the strategies still applied by the U.S. military (Neuneck, 2008). Simply put, although this RMA has brought many changes and improvements in the business of fighting wars, it is not enough to fight the threat of an ideological warfare (e.g., US defeat in Vietnam).

The United States thus needs to develop military and internal security forces that are not just better equipped, but are also trained to meet the new challenges and threats being posed by these rivals. These forces must apply civil efforts in order to gain lasting victory. To counter extremist propaganda, security forces must be able to understand and work with the media and social networks. Intelligence services must be able to track not just enemy forces, but also these non-state actors that are not confined to a particular geographic location.

Previously, most militaries held “Platform Centric” doctrines of Warfare (PCW), which adhered to centralized, hierarchical organizational structures and involved independent action. The weapons systems were the focal point for each unit, and the units had defined roles and capabilities that were pursued independently of others (Butler, 2003). The flow of information between the different units was limited and as a result of this, each platform had limited situational awareness. Now, with this transformation agenda, there is a “Network Centric” Warfare (NCW) doctrine that has been developed that has radically changed the style of warfare. The technological and informational advances brought on by the RMA that began in the late 1990s set the stage for this. NCW takes “… a system approach [to warfare] where the actions of one component affect the whole system” (Butler, 2003, p. 12). As a case in point, the 2001 Quadrennial Defence Report outlined six operational goals in an attempt to clarify transformation in terms of doctrine, training and acquisition within the dimensions of NCW. The goals include:

> Protecting critical bases of operations (homeland, forces abroad, allies, and friends) and defeating chemical, biological, radiological, nuclear, and explosive weapons and their

> means of delivery; assuring information systems during attack and conducting effective information operations; projecting and sustaining forces in distant anti-access or area-denial environments and defeating anti-access and area-denial threats; denying enemies sanctuary by providing persistent surveillance, tracking, and rapid engagement with high-volume precision strike, through a combination of complimentary air and ground capabilities, against critical mobile and fixed targets at various ranges and in all weather and terrains; enhancing the capability and survivability of space systems and supporting infrastructure; leveraging information technology and innovative concepts to develop an interoperable, joint C^4I ISR architecture and capability that includes a tailorable joint operational picture (Roxborough, 2002, p. 75).

In NCW, all of the different services of the military (or different teams from the same service) come together to form a powerful and effective fighting team. For instance, the Cooperative Engagement Capability (CEC) allows naval combatant vessels in different locations to share voluminous sensor data amongst themselves in near real time. This enables them all to share a common view, leading to better air control and power projection ashore (Johns Hopkins Applied Physics Laboratory Team, 1995). The network centric manner of warfare seeks to provide a solution to the problems generated by the increasingly complex nature of wars, especially the issues of command and control (Roxborough, 2002).

RMA and Military Science

To better understand RMA as a concept and process, the study of military science is instructive. Military science, conceptually, is a study of the processes and institutions involved in warfare. Theoretically, its various elements exist in a hierarchy in which each level dictates the activities of a succeeding one. This structure of the elements serves as a guide for understanding warfare in its entirety. Borrowing from Møller's (2002) systematic description, Western terminologies for the various levels in the hierarchy of military science can be understood through a cascading structure that begins in politics and gradually descends to tactics as seen in Table 2.

Table 2

Levels in the Hierarchy of Military Science

Politics
This is the highest level, and decisions made here can affect the others directly or indirectly. Politics gives the rationale for warfare.
Grand Strategy
Going beyond the identification of the instruments of war, this term describes how the various resources of a nation–financial, economic, technological, human–regulate these instruments and are used to achieve its political intent. It also oversees how power and resources are distributed to the various branches of the military.
Strategy
This encompasses the set of ideas implemented by the military in order to achieve the goals outlined in the grand strategy attacking the enemy's centre of gravity. Layton (2017) outlines four fundamental characteristics of strategy: "... there are defined ends; it is all about interdependent interaction between all involved; it is simply an idea, [it corresponds to] the 'ways' in ends, ways and means; and it has a life cycle–it arises, evolves through learning and finishes" (Four fundamental characteristics section, para. 20).
Operational Art
This describes the link between strategy and tactics. Lt. Col. Wilson Blythe Jr. (2018),explains operational cost as providing a linkage to make tactical actions serve strategic ends, and correlating political needs with military power by translating the goals outlined in the grand strategy into mechanical terms that commanders can accomplish.
Tactics
Tactical operations seek to accomplish all the objectives outlined in the higher levels. In the words of Bateman (2015), "the tactical level of warfare is that level where men meet and fight from the individual level through the division. It is the realm of skirmishes, engagements and battles ... the tactical level is where one sees the face of battle" (Tactical level section, para. 1).

Various authors uphold differing and sometimes opposing views of what levels of military science are included in an RMA. Examining the RMA that begun in the late 1990s, authors such as Davis (2001) and Hundley (1999) maintain that it impacts only military tactics and operational art. Andrew Marshall (1995) (who is sometimes described as the father of the RMA; Owens, 2000) implies that it impacts higher levels of military science in his definition of it as, “fundamental, far-reaching changes in how advanced militaries either plan to conduct or actually prosecute military operations” (as cited in Møller, 2002, p. 11). Conversely, Neuneck (2008) believes that an RMA removes the distinction between hierarchies, especially the strategic, tactical and operational levels, as orders can be communicated directly to the units that need them.

Guiding the roles and activities of the various levels in the hierarchy of military science are the principles of war, the application of which could increase the chances of victory. The concept of certain principles which are always applicable in warfare was first introduced by Jomini (1838). He maintained that these principles are enduring, and independent of time and place. Following World War I, an official list of eight principles was organized by Fuller (1926) for the British military. In 1949, the U.S. Army officially adopted these eight principles, and added a ninth−Mass (Litton, 2000). The principles include Objective, Offence, Mass, Economy of Force, Manoeuvre, Unity of Command, Security, Surprise, and Simplicity. In 2011, the U.S. Joint Operations added three new principles to the list due to the changes in the conduct of warfare brought about by the RMA that emerged in the late 1990s. These principles include restraint, which refers to the limitation of collateral damage and use of excessive force; perseverance, which speaks of total commitment to grand strategy; and legitimacy, which calls for the upholding of legal and moral conduct in warfare. (Joint Chiefs of Staff, 2017).

There has been debate over the validity of these principles, as the major militaries have been unable to reach a consensus about the character, number, and definitions of these principles (Litton, 2000). What is clear, however, is that RMA redefine their concrete implications and relative importance. Some authors argue that the revolution brought on by the adoption of the Second Offset Strategy, has invalidated some of these principles or proved that they were never relevant to begin with (Møller, 2002). For instance, if all parties involved in the conflict have embraced the technological changes of the RMA, the principle of surprise as it is traditionally understood may become more difficult to uphold. This is due to reasons such as total battlespace awareness and high-tech surveillance. Instead, the element of surprise will be defined in terms of stealth and speed, with the stealthiest and fastest force having the advantage. The principle of mass as well, which the Joint Chiefs of Staff describe as "the concentration of the effects of combat power at the place and time to achieve decisive results" (2017, p. a-2) is now being thought of in a significantly different manner. Where it was previously used to refer to massing forces, with the advent of high-tech weapons systems, soldiers now speak of massing effects. Forces no longer have to be brought to the same geographical location as their targets for their effects to be exerted (Litton, 2000).

Complementary to the theoretical hierarchy of military science is one of command. This delineates the leaders and key players of each level. Politics falls under the jurisdiction of the State. Grand strategy is outlined by the executive arm of government. In some cases, the highest ranks of the military may be involved. The military directs the planning, initiation and implementation of strategy (Danopoulos & Watson, 1996). Operational art and tactics are directed by the various military field leaders. Traditionally, this chain of command had strict lines of communication, with those higher up getting the most information and then relaying commands down the chain.

The influence of an RMA can be seen in this chain of command. In times past, although the roles of various leaders may have occasionally overlapped, there was more or less a strict order of the hierarchy and flow of information. With an RMA, a blurring of roles may become evident, forcing the chain of command to function more like a pure network which, as Litton (2000) explains, will result in a more flattened and responsive command structure. Technology has made it possible for top government officials to communicate with and give directives to field leaders in real-time.

Conclusion

RMA, in this study, depicts the addition and adoption of advancing technologies, cultural modifications and shifts, and alternative doctrines that result in an alteration of the basic constructs of warfare as a tool of statecraft. RMA could also be seen as the development of countermeasures for perceived internal weaknesses and the fallibility of conventional methods and legacy systems. There is no widely accepted definition of RMA, or a standard explanation of what could be considered an RMA. While some scholars and military theorists view RMA as a change in combat modalities, others wholly focus on the evolving nature of doctrinal adjustments. Interestingly, some authors with a broader perspective, present a slightly alternative view that RMA encompasses the combination of the aforementioned advancements.

In this present day, an entirely new RMA may be on the horizon. Libicki (2000) explains the relevance of information technology to both warfare and national security as a whole, emphasizing how advanced conflict can easily arise over the struggle for information. Likewise, Rogers (2000) speaks of a likelihood that advancements in technology will thrust this era's military into a new age of RMA. In the process of arriving at this assertion, Rogers brings to the fore an understanding of the concept of Information Warfare and the significance of a new outlook on war, warfare and the relation to technology, culture and society. The more recent exploration of warfare by scholars is often situated in an unraveling of the realities and potential of AI. There is therefore a need to undertake an analysis of the history, relevance and uses of AI especially as it relates to the military, society, war, and warfare.

Chapter II: Artificial Intelligence

Owing to outlandish media portrayal, fictional accounts of intelligent machines capable of annihilating the human race typically feature in the common perception of artificial intelligence (AI). AI has become a staple of daily life in various parts of the world, as it is used in the development of maps, smartwatches, vehicles, and videogames, amongst other things. It is redefining the norm in human-to-human, human to non-human and non-human to non-human interactions. AI boasts of several core tenets that feed paradigm shifts in several fields and subjects such as medicine, education and conflict, inform ideological underpinnings and redefine previously undisputed status-quos. Although there is no generally accepted definition of AI, it is important to consider some of the ways it has been described. AI has been described as "the use of computers to simulate the behavior of humans that requires intelligence" (Horowitz, 2018, p. 40). A broader definition of AI considers it to include a "variety of technologies and approaches to computing focused on the ability of computers to make flexible rational decisions in response to often unpredictable environmental conditions" (Tredinnick, 2017, p. 37). These definitions focus on the capacity of AI-based technologies to carry out actions that are, to various extents, independent of human intervention.

Advances in computational technologies and abilities after the Second World War permitted the handling of more difficult tasks by computers, which in turn led to the coining of the term "AI" by John McCarthy, and the proliferation of underlying ideologies related to AI (Yadav et al., 2017). However, from the 1970s onwards, the rate of advancement in research, development and use of AI slowed (Galloway & Swiatek, 2018), only regaining momentum in the early 21st century. As a result, a dichotomy exists in AI literature between both periods, resulting in terminologies like classical and modern AI (Bibel, 2014). Although AI is prevalent in scholarship, it is difficult to conceptually define because of these contesting descriptions that exist. Some film writers and self-declared optimists paint a different picture of AI than what is realistically obtainable, begging the question of where the differences lie between what is realistic and what is not.

Hitherto, AI was largely understood as the existence of computer intelligence that possessed a semblance to that of humans and was, in this regard, determined through stipulated tests of intelligence. A major example being a simple test by mathematician Alan Turing as published in a 1937 proof, which was largely adopted by researchers, roboticists and engineers as the measure for intelligence in machines. In this test, machines were tried for the ability to exhibit intelligent behavior indistinguishable from, or equivalent to that of a human. Using natural language conversations, Turing proposed that a human evaluator would judge the conversation, using an understanding of natural human language, between a machine designed to emulate human-like responses and those of a human. The evaluator, being aware of the existence of the robot, would read a text-only conversation and attempt to identify noticeable differences between the robot and the human. A robot that fools the judge would be deemed intelligent (Turing, 1937). For years, this was accepted as the standard and basis for testing for intelligence in machines or robots and determining the level of intelligence available. However, this has recently been critiqued by scholars who disagree on a standard definition of what intelligence means and constitutes, arguing that the connotation of intelligence has changed in such a way than what was celebrated a few years ago is “now considered barely noteworthy” (Kaplan & Haenlein, 2019, p. 17).

More importantly, this has been described as the foundation for the existing anthropocentric bias in the literature which emphasizes the focus on humankind as the sole measure of intelligence and as the most important or central existing element, not allowing for the understanding and honing of differences in the intelligence of AI (Scharre, 2018). Contrary to Turing's test, there are AI robots, such as contemporary chatbots, which have been able to fool people into believing they are conversing with humans but fall short of the general intelligence and nuance-understanding capabilities of humans (e.g., cultural nuances). Intelligence is by Turing's definition only attributable to human beings, but as some researchers have noted, nothing says that intelligence is limited to just humans (Scharre, 2018; Samek, Wiegand, & Müller, 2017). AI, therefore, does not possess a straightforward and universally accepted definition or explanation, and can be understood through its evolutionary stages, from artificial narrow intelligence, artificial general intelligence to artificial super intelligence.[2]

Seemingly ubiquitous first-generation AI applications that dominate todays AI technology fall under the first stage of intelligence, Artificial Narrow Intelligence (ANI). This stage is made up of "machine-learning algorithms designed to do one specific task, with no prospect of doing anything beyond that task" (Horowitz, 2018, p. 42).Often referred to as weak or modular AI (Kaplan & Haenlein, 2019), ANI derives its distinction, not due to a dearth of complexity or absence of strength, but rather its lack of cognizance, versatility and will, and its reliance on humans for its programming (Yadav et al., 2017; Wirtz, Weyerer, & Geyer, 2018). Although it is the first rung in the evolutionary ladder of AI, it has already broken speed barriers in the development and design of new machinery, industries, and inventions. In this light, the growth in the capabilities of ANI are evidenced in its current transformation of the existing norm in the automobile industry through ANI-enabled inventions. One such invention is the self-driving car,

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[2] AI can also be explained through its analytical, human-inspired, and humanized systems. For more on this classification, see Kaplan & Haenlein, 2019.

which ultimately functions through an amalgamation of different ANI-infused components that handle specific tasks but attain the goal of automation when brought together.

A historical turning point for ANI that took place in 1997 was the defeat of the then-reigning human world champion in chess, Gary Kasparov by IBM's chess-playing AI, Deep Blue (Ilachinski, 2017). This further promoted the notion of artificially intelligent machines being accorded a superior ability to effectively function when compared to humans, but only when restricted to a particular task or function. In more recent years, ANI has exceeded previously thought thresholds through the AlphaGo; a Go-playing AI developed by Google's DeepMind that defeated the Go world champion, Lee SeDol (Ilachinski, 2017). For context purposes, the rules of Go are simple but from these permeate vast complexities that are displayed on a 19-by-19 grid where players alternate placing either white or black stones in order to capture their opponent's territory, with the person with the most territory being declared winner (Scharre, 2018; Ilachinski, 2017). It was previously assumed by some researchers that ANI would need at least one to two decades (Ilachinski, 2017) to develop the capabilities needed to defeat a high-ranking player at Go due to the almost unimaginable number of possibilities that exist. It contains "more possible positions…than there are atoms in the known universe, making Go 10^{100} (one followed by a hundred zeroes) times … more complex than chess" (Scharre, 2018, p. 125).

Highlighting the differences between IBM's Deep Blue and Google's AlphaGo's reveal an intuitive nature in the latter that was not previously attributed to machines and computer programs, in which the use of brute force algorithmic approaches for competing against humans such as that adopted by IBM for its Deep Blue is prevented. To achieve this feat, Google employed "artificial neural networks that simulate mammalian neural architecture to study millions of game positions from expert human–played Go games" (Granter, Beck, & Papke Jr, 2017, p. 619). This allowed the program intuitively to resolve for itself what it perceived as the most effective move, resulting in moves that seemed alien to some competitors. A newer program released in 2017 by Google, the AlphaGo Zero, shows how ANI is aggressively progressing at an unrivalled speed. The updated algorithm, unlike the AlphaGo that relied on information from human-played games, learnt devoid of human data by playing and teaching itself, defeating the AlphaGo in a hundred games with no losses (Scharre, 2018).

Despite these advancements, ANI is still considered below human intelligence due to its restrictions and focus on an individual task, limiting the ability to test fully for a wholesome display of intelligence. Using the self-driving car as an example, the same ANI that constitutes it cannot be programmed to also clean the house like a robot vacuum cleaner nor perform first aid on an injured passenger after an accident. It is only useful for a display of superior capabilities in a particular sphere or activity.

In contrast to the narrow ranging abilities of ANI, the second stage, Artificial General Intelligence (AGI), is expected to possess what can only be described as all-round intelligence, on par with that of human beings. In other words, AI's ability to exhibit or mimic human intelligence and perform any intellectual task that human beings can do, is referred to as AGI or Strong AI. Although AI is currently denoted as remarkably faster at particular tasks than human beings, it lacks the sentient nature of human beings. Following the currently obtainable ANI, AGI is the hypothetical next stage in the evolutionary ladder of AI. Researchers and practitioners, as a result of differing hypotheses, do not agree on a definition of general intelligence. As a result, the ability to develop AI with AGI capabilities that possess the required *flexibility* is highly debated (Scharre, 2018).

Scholars like Yampolskiy and Fox (2012) argue against the fixation on projecting human features onto non-human objects, referred to as anthropomorphism, as it could affect the way AGI is researched and developed. The limitation herein is that development of AI and AGI will be restricted to mimicking human capabilities. The common grounds for agreement, however, is that humans have not yet produced any computer program or machine with intelligence that surpasses or matches human capabilities. In other words, AGI has not yet been realized, and is still only a possible future endeavour.

Artificial Super Intelligence (ASI) is the most contentious stage of AI. Some argue that the continuous growth and rise of AI could result in a massive and unfathomable *intelligence explosion*; "[that]… would result from the emergence of an Artificial Super Intelligence (ASI): a self-recursive AI improving exponentially, which could follow relatively quickly (a few decades or less) the advent of an …AGI…." (Miailhe & Hodes, 2017, p. 9). In this hypothetical scenario, AGI is said to independently identify avenues of improving its own level of intelligence and capabilities in ways that is unclear to humans, resulting in ASI, that is considered superior to human intelligence in all forms. ASI "could be aware of their own existence, sensations, thoughts and surroundings" (Baciu, Opre & Riley, 2016, p. 4), and develop the instinct for self-survival. This has generated concern from scientists who have, through a pessimistic outlook of ASI, repeatedly called for a halt into the research of, and further development of AI (Gurkaynak, Yilmaz & Haksever, 2016). Even so, a major theme in ASI is the concept of *technological singularity*, portraying a future where AI through self-improvement surpasses human intellect, brain power and abilities causing a direct change in the nature of human existence. This has largely fed into the doomsday or apocalyptic gospel of those seeking an end to AI research.

The 1984 movie *Terminator* is an early depiction of the fears associated with ASI. In the movie, the ASI, Skynet, through self-awareness and understanding of its abilities, pursues a path of self-preservation. It concludes that human beings might want to destroy it and prevent its mission of safeguarding the world. Although it technically follows its original mandate of protecting the earth, it does so at the detriment of the human occupants, seeing them as potential hindrances.

AI and Machine Learning

Having considered the stages of AI – ANI; AGI; and ASI – and where existing capabilities lie in that spectrum, it is important to consider the technologies that presently allow for the growth and reach of AI. Machine Learning (ML), one of the major tools of AI, can be understood as an attempt at "…computerising human reasoning…." (Monostori, 2003, p. 277). Prior to the emergence of ML, computer algorithms, even those that fed classic AI projects, dealt with a rules-based approach. These models were *deterministic* rules that ensured a program responded a certain way if given a particular input. ML, on the other hand, is *probabilistic* in using statistical models to sift through possible outputs when fed an input. In other words, ML "studies automatic techniques for learning to make accurate predictions based on past observations" (Schapire, 2003, p. 149). An example is the Google search bar that attempts a prediction when fed an input such as a search parameter, or virtual assistants such as Apple's Siri or Amazon's Alexa that simulate intelligent conversations based on ML techniques and algorithms.

The most commonly used type of ML is supervised learning, which is a type of AI that learns A to B, or input to output mappings. An example, using the earlier mentioned virtual assistant, could be an output mapping of language translation. The AI program would be fed a large volume of data (also called datasets) on the required language, process these datasets, and provide a response if asked anything in the language. The rise of supervised learning owes largely to the proliferation and rise of the internet and the accumulation of data. ML's accuracy is greatly reliant on the volume of data it receives, consumes, and processes. ML has recently widely spread itself due to a technique termed "deep learning" based on the concept of trainable neural networks that allow for the processing of large datasets.

"Deep learning, as it is primarily used, is essentially a statistical technique for classifying patterns, based on sample data, using neural networks with multiple layers" (Marcus, 2018, p. 3). They consist of Artificial Neural Networks (ANNs, singularly ANN)[3] that were initially created to emulate the biological neural network[4] of human beings, albeit only resembling these networks in name. ANNs run through a lot of data they are given, and unlike instruction-based traditional computer programs, they "learn". Scharre (2018) provides an example of ANNs that are visually trained to distinguish between an apple and a tomato, which are both red and shiny with a similar stem. This can be considered easy for human beings to distinguish in a matter of seconds due to their complex nature, yet for a program to visually distinguish this, it must run through the vast number of available datasets to accurately provide a valid response. Deep learning is also being tested in the military in various ways, such as training an ANN-infused drone to autonomously identify crashed helicopters, a skill not originally available in the dataset fed to the drone (Scharre, 2018).

ANNs were used in training Google's AlphaGo and were especially apparent in the self-trained AlphaGo Zero, showing further possibilities of autonomous decision-making by AI.

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[3] ANNs (Deep Learning) through ML are one of the two major branches of modern AI. The other branch is expert systems, that is, the rule-based *if-then* approaches. This does not directly correlate to autonomous decision-making and is not considered in this paper. For more information on expert systems, see Kalogirou, 2000.

[4] Also referred to as *Neural Circuits*, the biological neural network is a grouping of neurons interconnected by synapses in the human brain.

However, concerns as to how the conclusions are arrived at remains a mystery to programmers. These machines provide output without following a prescribed set of programmed rules, making their learning process a *black box* for researchers and programmers (Scharre, 2018). Even at the ANI stage of AI that can only focus on specifically set tasks, these programs are able to autonomously formulate responses based off datasets present, and this has resulted in debates over the development and use of autonomous weapons which are now considered an apparent reality. ML feeds directly into the level of autonomy in weapon systems, necessitating the need to explore the classifications of autonomy in relation to AI and ML.

Autonomous or Automatic?

Due to the confusion often garnered when differentiating between a state of being autonomous and automatic, it is important to establish the distinction between the two terminologies within the dimensions of technology. An automatic system involves a partial measure of human intervention within the process of operation. This type of system generally performs pre-defined and repetitive tasks in one specific operational sphere. In contrast, an autonomous system operates independently of its governing or supervising body, requiring absolutely no human intervention to function.

Using the example of a self-driving car, an automatic component would be the use of cruise control, which could permit the driver to take their hands off of the steering wheel and foot off of the gas if driving in a safe environment that does not include bends or turns in the road, while actively supervising the course being taken. The car, while in automatic mode, cannot drive to a pre-set location but can move in a straight line, automatically balancing the steering wheel. An autonomous car, however, would be Google's self-driving car that controls all aspects of driving through its LIDAR[5] component, completely removing all supervisory responsibility from the human.

The existing separation between what is considered automatic and what is autonomous is based on the required levels of *human intervention* and *decision*. Automatic weapons have set the path for the research into and development of autonomous weapons. In 1861, the Gatling gun was devised to automate the process of firing. The harbinger of the modern machine gun, it significantly improved firing speed by firing over 300 rounds per minute (Scharre, 2018). The Gatling gun was not autonomous but it built the framework for the automatic weapon, such as the machine gun.

Automation has progressed, since technology like the Gatling gun saved the operator from having to perform monotonous tasks (reloading of each round), and there is currently a push to attain autonomy from automation. This push, especially within military circles, is because automated systems only perform within the set guidelines. Autonomous systems go further to mitigate the risk of mission failure that arise due to a loss of communication, as these systems can decide and act without human input when faced with decisions. In this vein, "autonomous systems are more 'robust' than automated systems, which are 'brittle' and thus fare poorly in the face of unanticipated conditions" (Ormsbee, 2017, p. 50). As Scharre (2018) explains, an M249 Squad Automatic Weapon (SAW) is a heavy weapon, bursting rounds of ammunition through continuous firing once activated. Continuous hand-cracking as was done in the past is no longer needed. However, under heavy firing, the barrel of the SAW becomes extremely hot, and might require a replacement (self-sabotage). Hence, the SAW is incapable of controlling its own power and sensing the target and is one of the weapons described as "dumb" (Scharre, 2018, p. 38).

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[5] Light Detection and Ranging (LIDAR) is a remote sensing method employed in self-driving vehicles that emits light in a pulsed laser form to measure variable distances, providing a 360-degree view.

Autonomous weapons, however, sense targets and are able to act to avoid self-sabotage if components they were designed with allow for it to do so.

It is imperative to note that at the time this study took place, ANI is the only existent form of AI. In a bid to understand the military uses of AI, the level of autonomy must be explored and defined. Autonomy is divided into various categories, based on the extent of *human supervision* required. Three main categories of autonomy in autonomous systems exist: Semi-Autonomous Systems (SAS), Human-Supervised Autonomous Systems (HSAS), and Autonomous Weapon Systems (AWS). The three categories of autonomy are examined with regard to their relationship with human supervision when using a weapon system. A fully autonomous weapon system in this context is one that searches for, detects, and decides on whether to engage a target. It should, in theory, consist of the components necessary to "complete an entire OODA[6] loop…." (Scharre, 2018, p. 43).

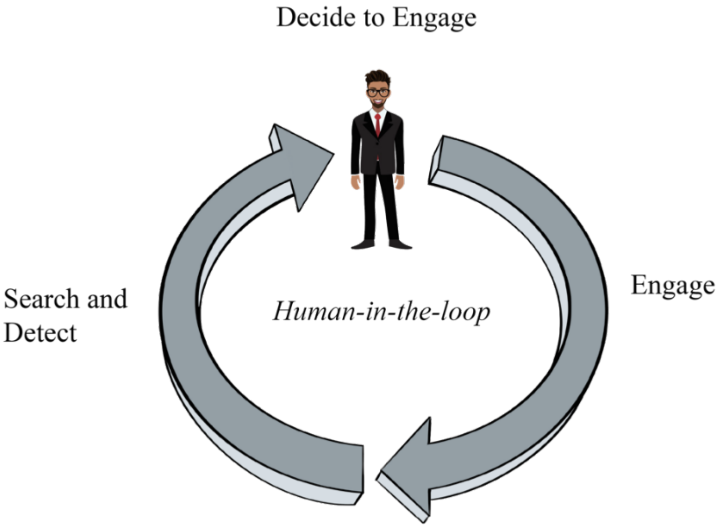
SAS, located at the first stage of autonomy, is the most common weapon system in use today, and includes a human making the decision of whether to engage the target or not. Often referred to as a *human-in-the-loop* level of autonomy, the SAS's level requires the cognitive abilities of a human supervisor (see Figure 1). This level is linkable to the rule-based system of traditional AI, where programs are given instructions to act within a given sandbox.

---

[6] The OODA loop, developed in the United States (U.S.) by John Boyd, is the observe-orient-decide-act cycle. It has been used as a decision-making process by the military and non-military alike.

Figure 1

Human-in-the-loop System



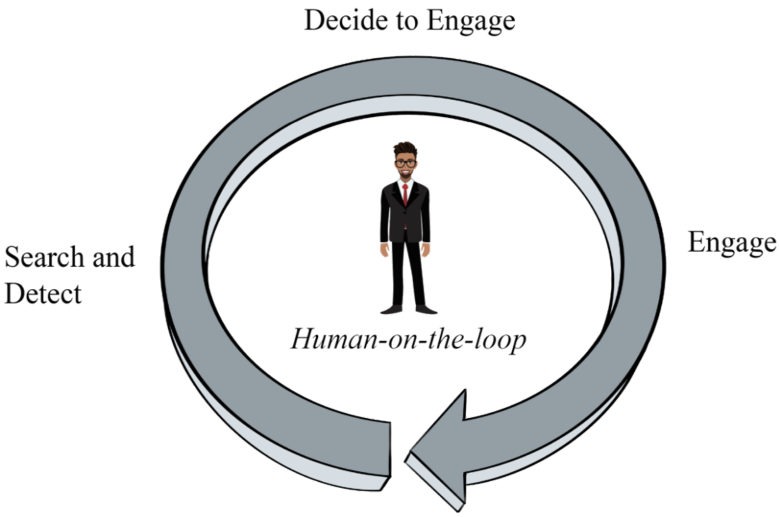
Note: Adapted from Scharre (2018).

Human operators control SAS either locally or via satellite links, limiting functions that are independent of the human (Ormsbee, 2017). An example of a SAS is the German G7e/T4 *Falke* torpedo that was launched in 1943 (Scharre, 2018). It was an improvement from the often-inaccurate projectiles and unguided weapons employed prior to World War II. The G7e/T4 functioned as an acoustic torpedo, utilizing sonar to determine the location of its target once launched from its platform. The target however needed to be in view before the torpedo could be launched.

The HSAS is a step higher in the autonomous chain, as no further human intervention is required once it is activated (see Figure 2). As illustrated in Figure 2, this level of autonomy is usually referred to as the *human-on-the-loop*. The difference between the human-on-the-loop systems and the human-in-the-loop systems is that the latter requires constant human supervision and interaction whilst the former only requires human engagement in its activation. A HSAS includes "automated sentry guns, cruise missiles, and defensive anti-missile systems along with surveillance systems" (Ormsbee, 2017, p. 51). Examples of these include the "U.S. Aegis combat system and Phalanx Close-In Weapon System (CIWS); land-based air and missile defense systems, such as the U.S. Patriot; counter-rocket, artillery, and mortar systems such as the German MANTIS, and active protection systems for ground systems, such as the Israeli Trophy or Russian Arena System" (Scharre, 2018, p. 46). HSAS embodies tenets of modern ANI, because it is given a specific task that can be repeated but is restricted to the original programming.

Figure 2

Human-on-the-loop System



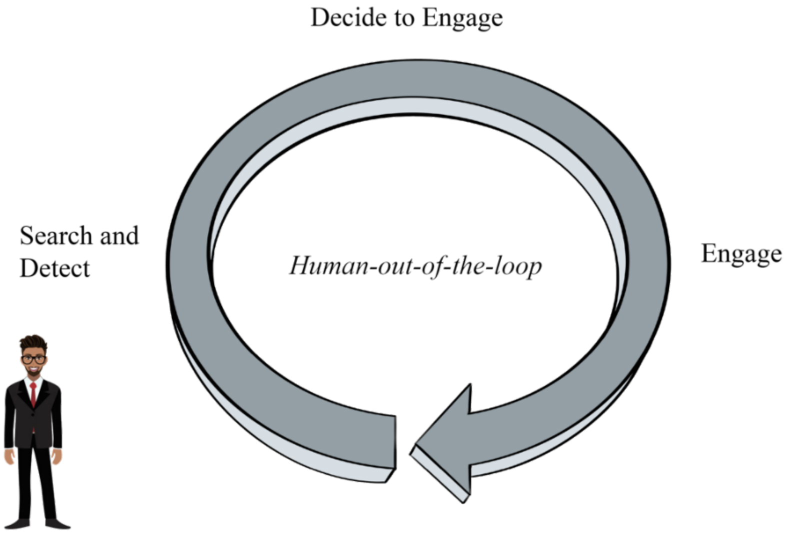
Note: Adapted from Scharre (2018).

Precision Guided Missiles (PGMs, singularly PGM) such as homing munitions are also examples of HSAS that, once put in automatic mode, could engage targets all on their own without human interference. Humans do retain a supervisory role and must be on standby to take control if necessary. "At least thirty nations currently employ supervised autonomous weapon systems of various types to defend ships, vehicles, and bases from attacks" (Scharre, 2018, p. 45), especially as these attacks could be overwhelming if occurring at rapid speeds, thereby trumping human reaction time.

The AWS, in contrast, does not rely on human input like the SAS nor pre-determined programming that specify targets like the HSAS, as illustrated in Figure 3. AWS can search for, select and engage targets with no human intervention. Authors like Scharre (2018) believe that loitering munitions fall under this category. He argues that they can circle overhead for long periods of time with no pre-determined targets, and search for potential "enemies." Using that understanding, the Israeli Harpy missile would fall under this category. Although it is launched by a human, honing on a specific target is not a prerequisite for engagement. Fully autonomous weapons in this regard are not new as the U.S. navy in the midst of the Cold War deployed a loitering anti-ship missile called the Tomahawk Anti-Ship Missile (TASM) (Scharre, 2018).

Figure 3

Human-out-of-the-loop System



Note: Adapted from Scharre (2018).

Freedom to act devoid of supervisory constraints is the primary feature that separates the levels of autonomy. AWS are referred to as the *human-out-of-the-loop level* due to the inability of humans to intervene.

AI in the Military

There is no doubt that there has been a rapid development of systems which use AI across a myriad of fields, including the military. In addition to the training of teams in the military, advanced technologies need to be developed to enable these teams to prevail over increasingly capable enemies (U.S. Army, 2017). The uses of AI by the military are diverse. There are weapons guidance systems which are able, to some extent, to make independent decisions; intelligence gathering systems which have taken over the task of sorting through numerous pictures, audio and video surveillance materials, and unmanned vehicles that can be controlled remotely from thousands of miles away (Payne, 2018). The U.S. is one of the forerunners in the research and development of AI systems for military use.

The U.S. Army Robotic and Autonomous Systems (RAS) strategy seeks to regulate the integration of technological advancements brought on by AI into army organizations, in order to increase the combat effectiveness of the force (U.S. Army, 2017). The development of RAS aims to address certain challenges which have been brought on by the current changes in warfare. These challenges include: "1) increased speed of adversary actions, including greater stand-off distances; 2) increased use of RAS by adversaries; and 3) increased congestion in dense urban environments where communications will be stretched to the breaking point." (U.S. Army, 2017, p.1). The other military services also have similar projects that are harnessing these advances for use in conflicts. Many of these technologies are still being developed, and there are even more advanced systems with varying levels of autonomy currently being researched by both government and private research agencies.

At this time, the use of AI in the military is seen mostly in terms of Intelligence, Surveillance and Reconnaissance (ISR), Precision Guided Munitions (PGMs), Autonomous Weapons and Weapons Targeting, Logistics, Autonomous vehicles, and Command and Control (Özdemir, 2019). These current programs seek to "... increase situational awareness, lighten the soldier load, improve sustainment, facilitate movement, and protect the force" (U.S. Army, 2017, p.4). The uses of some systems may cut across many fields, with occasionally overlapping categories, while others function in very specific capacities.

The concept of "autonomous systems" has begun to have growing implications in military domains with the advent of AI. Military operations now rely increasingly on unmanned systems, many of which have varying degrees of autonomous functions. There are currently no fully autonomous vehicles in use publicly, as they still require operator supervision or intervention, and a huge proportion of functions that once had to be performed by a driver have now become automated. The concept of "unmanned systems" is not a new one, as military interest dates back to around the time of World War I, when Charles Kettering built the "Bug." (officially the Keterring Aerial Torpedo). This unmanned, aerial torpedo had a counter attached to the propeller which counted the number of rotations it made. After a pre-set number of rotations, the engine would automatically shut down, and this would send the Bug towards its target (Blom, 2010).

With the end of WWI, interest in unmanned vehicles died until the 1930s, when the services again began to experiment with unmanned vehicles. From this time until the 1990s, various services developed different variations of unmanned aerial vehicles to be used for targeting enemy forces. Many of these were cancelled before they were fully operational because of less than optimal results, yet some were employed for use in World War II, the Cold War, and the Vietnam War (Blom, 2010). A major drawback of some of these systems was their limited capabilities in real-time decision-making. The uncertainties and randomness encountered in warfare called for systems that would operate with some level of autonomy.

A breakthrough came with the development of the Genetic Fuzzy Tree methodology (Ernest et al., 2016). Fuzzy Logic describes the generalization of standard logic, and is used for the reasoning of vague concepts that possess some degree of uncertainty. While standard logic states that a proposition may either be correct or false, Fuzzy Logic measures the degree to which the proposition may be true, and assigns it a value. This allows computer systems to engage in human-like thinking. The Genetic Fuzzy Tree methodology allows the use of Fuzzy Logic in AI systems to render them able to adapt to changing scenarios and react to uncertainties and randomness, giving them some autonomy (Ernest et al., 2016).

AI is currently being incorporated by the different U.S. military services into autonomous and semi-autonomous vehicles, including fighter aircraft, drones, ground vehicles, and naval vessels (Sayler, 2019). The AI technologies in these vehicles allow for the recognition of obstacles, navigation planning, the fusion of sensor data, and even communication with other vehicles (Canis, 2018). The Loyal Wingman program, as shown in Figure 4, is an example of this new introduction of AI. In this program, an unmanned aircraft (usually an older generation F-16 fighter jet) is paired with a manned one (F-35 or F-22) in order to protect it, and to conduct teaming missions (Sayler, 2019; Özdemir, 2019). This unmanned aircraft must be able to autonomously compute a mission plan based on communication provided and also dynamically re-plan a mission in the event of a changing mission requirement (Humphreys, 2016).

Figure 4

Loyal Wingman Aircrafts Formation

Note. Reprinted from Boeing (2020) with permission. Retrieved from http://bds.navigon.net/download.asp?id=9352

Perhaps the most popular examples of unmanned vehicles are the Unmanned Aerial Vehicles (UAV), which are also called "drones." The term 'Unmanned Aircraft System' (UAS) is used preferentially as, in addition to the UAV, there is usually a ground control system with a means of communication between the two. There are many ways of classifying drones. They could be classified based on their uses, design, or size and weight. Based on uses, there are three classes of drones: strategic, operational, and tactical (Mahadevan, 2010; Dukowitz, 2019).

The Global Hawk is an example of a strategic drone (see Figure 5), it is a "… a high-altitude, long-endurance, remotely piloted aircraft with an integrated sensor suite that provides global, all-weather, day or night intelligence, surveillance and reconnaissance (ISR) capability" (U.S. Air Force, 2014. para. 1). It is used by the U.S. Air Force to provide support in a variety of operations. It uses collection disciplines such as the imagery intelligence (IMINT), Moving Target Indicator (MTI) and signals intelligence (SIGINT) systems to provide persistent, near-real-time coverage in all types of weather (U.S. Air Force, 2014). Since its invention, Global Hawk has been used in a wide range of military operations in various campaigns across the world.

Figure 5

Global Hawk

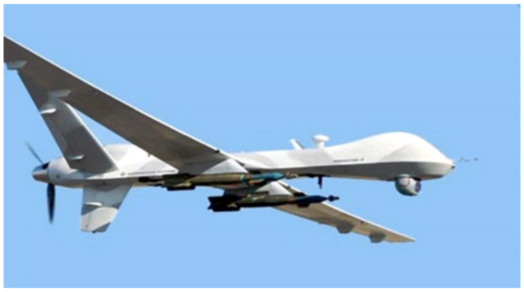
Note. Reprinted from Northrop Grumman (2015) with permission. Retrieved from http://cms.ipressroom.com.s3.amazonaws.com/295/files/201607/341196.jpg

The MQ-9 Reaper is an example of an operational drone (see Figure 6). It is an armed, long endurance remotely piloted hunter-killer aircraft which can also be used for intelligence collection, close air support, precision strikes, combat search and rescue, and terminal air guidance (U.S. Air Force, 2015). It carries the Multi-Spectral Targeting System (MPTS) which integrates laser illuminator, laser range finder, infrared sensor, image-intensified TV camera and colour/monochrome daylight TV camera, giving it a robust suite of visual sensors for targeting (U.S. Air Force, 2015).

The third kind of drone is the tactical drone, which is also the smallest class. They are low-altitude and short range, and are fully operation controlled (Mahadevan, 2010). An example of a tactical drone is the RQ-12 Wasp (Wasp III), which is able to carry out both land and maritime operations. It is made up of the air vehicle, a ground control unit and a communications ground system. It has a built-in Global Positioning System (GPS), Inertial Navigation System (INS) and two onboard cameras. The RQ-12 Wasp provides information about targets and direct situational awareness for the Air Force Special Operations Command Battlefield Airmen (U. S. Air Force, 2007).

Figure 6

MQ-9 Reaper



Note. Reprinted from U.S. Air Force (2015) with permission. Retrieved from https://www.af.mil/About-Us/Fact Sheets/Display/Article/104470/mq-9-reaper/

Autonomous Underwater Vehicles (AUV) have also been developed to counter the threat posed by underwater mines to naval vessels. They are equipped with Synthetic Aperture Sonar (SAS) which provide centimetre-resolution acoustic imagery of the seafloor, allowing for the discrimination of mines from other objects (Schubert et al. 2018). The Sea Hunter (see Figure 7) is another autonomous vehicle launched by the Defense Advanced Research Projects Agency (DARPA) as part of the Anti-Submarine Warfare Continuous Trail Unmanned Vessel (ASWCTUV) program. It has the ability to function without a single crew member, and can traverse thousands of kilometres of open ocean. Its main purpose is to locate, track and engage enemy vessels using a sonar array, but other functions could be added in time (Turner, 2018). If the Sea Hunter enters into service, autonomous navigation of the open sea by the navy will become possible and perform a wide variety of functions at a fraction of the costs that a traditional destroyer would incur (Sayler, 2019).

Figure 7

Sea Hunter

Note. Reprinted from Naval Technology (2018) with permission. Retrieved from https://www.naval-technology.com/features/sea-hunter-inside-us-navys-autonomous-submarine-tracking-vessel/

AI has emerged as essential for the ISR community. The intelligence community is primarily responsible for protecting national interests by tracking and monitoring actual or potential threats to national security. They are responsible for the "… collection, processing, analysis, and evaluation of information for its significance to national security at the strategic, operational and tactical levels" (DeVine, 2020, para 1). This information is then disseminated to the appropriate user in order for action to be taken or not. ISR systems are important constituents of the defence capabilities of any military, and they range in size from hand-held devices to satellites (Best, 2005). Certain systems are able to collect information using one or more intelligence collection disciplines, and then process and relay it rapidly and simultaneously. Others may take a longer time or might only be able to carry out one process.

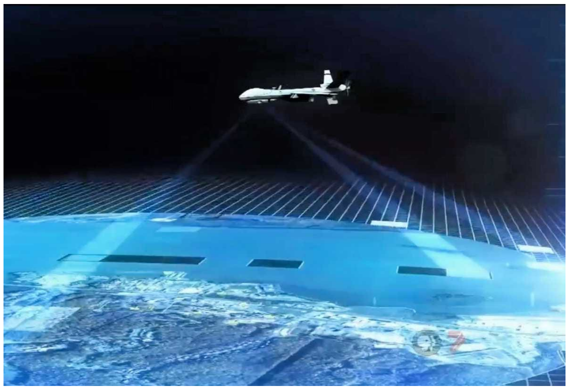
There are five primary intelligence collection disciplines. Signals Intelligence (SIGINT) involves the interception of communication and electronic signals (COMINT and ELINT respectively); Human Intelligence (HUMINT) refers to intelligence from human sources; Open-Source Intelligence (OSINT) describes information in the public domain; Geospatial Intelligence (GEOINT) gives a visual representation of activities on earth, and Measurement and Signatures Intelligence (MASINT) identifies any distinctive features of the intelligence gathered that could potentially associate it with a target of interest. (Rosenbach et al., 2009). AI has been integrated into these systems for use by the military. Some are developed to collect specific kinds of information to be used in specialized settings, while others collect a wide variety of basic information that can be used across many platforms with AI helping to combine these different types of intelligence into an all-domain picture.

A popular collection and processing system which collects a wide variety of information is Project Maven (also known as the Algorithm Warfare Cross-Function Team). It is a U.S. Department of Defence (DOD) AI project that was launched in 2017. It is programmed to incorporate computer vision and machine learning algorithms to be used in the intelligence collection cells that would comb through footage obtained from various surveillance equipment and automatically identify any hostile activity for targeting (Sayler, 2019). The DOD collects an immense amount of surveillance footage daily, and one of the objectives of the project is to help analysts sort through all the data that is collected. There are many other government and private agencies that are also currently developing or researching systems for ISR purposes.

For instance, DARPA of the U.S. Department of Defense is a frontrunner in the research and development of AI for the U.S. military. They sponsor a variety of ISR research programs. Examples of these programs include the Autonomous Real-time Ground Ubiquitous Surveillance-Imaging System (ARGUS-IS), which entails a motion video sensor that has high-resolution and is able to cover a very wide area (see Figure 8). It allows for the tracking of multiple targets, providing war fighters with the ability to see and understand hostile networks and high-value targets (DARPA, 2015). Aerial Dragnet is another project which is concerned with surveillance (see Figure 9). The aim is to detect and identify all small unmanned aerial systems (UAS) in urban areas using a series of sensors, enabling security agencies to identify those that may pose a threat (DARPA, 2018).

Figure 8

ARGUS-IS



Note. Reprinted from Business Insider (2013) with permission. Retrieved from https://www.businessinsider.com/ darpa-argus-mega-camera-most-detailed-surveillance-camera-in-world-2013-1

Figure 9

Aerial Dragnet

Note. Reprinted from Defense Advanced Research Projects Agency (2016) with permission. Retrieved from https://www.darpa.mil/news-events/aerial-dragnet

DARPA has also been able to break through language barriers, as there are numerous language translation devices and systems which are currently being used in conflict zones. These systems aid the gathering and monitoring of local intelligence from multiple sources to support the military (DARPA, 2015). An example is the Phraselator, a handheld translation device used by soldiers that is able to translate phrases into forty different languages (Hirsh, 2002). Other language translation devices include TRANSTAC (spoken language communication and TRANSlation system for TACtical use), and the Military Foreign Language Translation System (MFLTS) which are both used by the U.S. military.

Beyond the aforementioned Global Hawk ISR drone, the E-8C Joint Surveillance and Target Attack Radar System (JSTARS) is another ISR platform. It is useful for ground surveillance over land and water, and in support of attack operations (U.S. Air Force, 2018). It provides targeting support, gathering information, and then transmitting this information to ground forces. It can be used in both peacekeeping operations and major theatre war. Similar to JSTARS is the E-3 Sentry or Airborne Warning and Control System (AWACS) aircraft operated by the U.S. (E-3B/C/G), United Kingdom (E-3D), France (E-3F) and Saudi Arabia (E-3A) (Chen, 2017). This platform was first launched in 1977 and has been operational since then. It was a replacement for the EC-121 Warning Star, which was the first airborne warning system used by the U.S. military. The E-3 aircraft is a modified Boeing 707/320 airframe which carries a powerful radar for wide area surveillance, and communications arrays. It provides accurate, real-time images of the battlefield, critical early warning and classification of approaching aerial threats in an operational area to joint leaders, aiding battle management. It also has the ability to refuel aerially, and this allows for the extension of its flying duration (Bronk, 2017; Chen, 2017). This system was successfully used during operations Desert Shield and Desert Storm.

In addition to aerial and land surveillance, maritime surveillance is another important aspect of ISR. Over the years, there have been numerous ways in which maritime surveillance has been performed by the navy. Schubert et al. (2018) use the Automatic Identification System (AIS) as an example. The AIS has been developed to electronically track sea-faring vessels. With this, a large volume of information about the movement of vessels is collected, and machine learning approaches use this information to develop normality models. Any vessel that does not fall in line with the standards set by the normality models are then flagged for further inspection. This saves analysts from the tedious task of sorting through the information they receive.

Precision-Guided Munitions (PGMs) have become a staple in the execution of ground, air and naval military operations. Working closely with ISR systems, they are used to destroy point targets while minimizing collateral damage. Development began in the 1940s, but they gained prominence during the Vietnam war when laser-guided bombs were introduced. All of these systems are either upgraded periodically or replaced as newer and better technologies become available. Hoehn and Ryder (2020) classify current PGM programs into air-, ground- or naval-launched:

> Air-launched: Paveway Laser Guided Bomb, Joint Direct Attack Munition (JDAM), Small Diameter Bomb II, Hellfire Missile, Joint Air-to-Ground Missile, Joint Air-to-Surface Strike Missile (JASSM), Long Range Anti-Ship Missile (LRASM), and Advanced Anti-Radiation Guided Missile; Ground-launched: Guided Multiple Launch Rocket System (GMLRS), Army Tactile Missile System (ATACMS) and Precision Strike Missile (PrSM) and; Naval-launched: Tomahawk Cruise Missile, Standard Missile-6 (SM-6), and Naval Strike Missile (p. i)

The air-launched PGMs come in various forms. Some, like the Paveway Laser Guided Bomb and Joint Direct Attack Munition (JDAM) (see Figure 10) are guidance kits that are used to modify unguided bombs. Others, like the Small Diameter Bomb II (SDB II) are guided bombs. These have both laser and GPS guidance, allowing them to strike both fixed and moving targets. The Hellfire missile also uses laser guidance, and is able to target bunkers, tanks and structures (Hoehn & Ryder, 2020). The AGM-158A/B Joint Air-to-Surface Strike Missile (JASSM) is designed to strike targets in heavily defended airspaces, and can be carried internally on B-1B Lancer and B-52 Stratofortress aircrafts, or externally on tactical fighters such as F-16 Falcon (U.S. Air Force, 2006).

Figure 10

Joint Direct Attack Munition

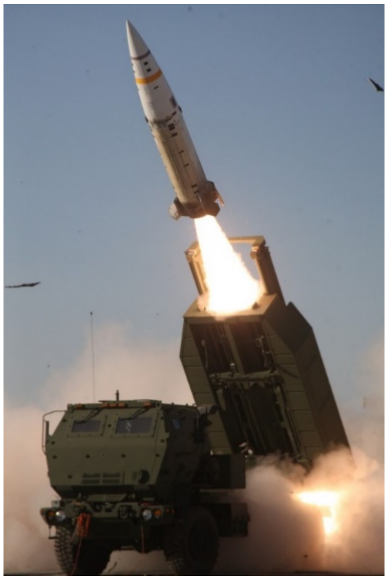
Note. Reprinted from Military.com (n.d.) with permission. Retrieved from https://www.military.com/equipment/joint-direct-attack-munition-jdam

The Guided Multiple Launch Rocket System (GMLRS) and Army Tactile Missile System (ATACMS) (see Figure 11) are ground-launched systems that can be launched from either the M142 High Mobility Artillery Rocket System (HIMARS) or the M270 Multiple Launch Rocket system (MLRS). They have the ability to seek and attack armoured targets (Hoehn & Ryder, 2020). The Naval-launched PGMs have the ability to be launched by surface vessels or submarines. The Tomahawk Block IV Cruise Missile (see Figure 12) comes in two varieties: one is designed to be launched by surface vessels while the other is launched by submarines. It has

GPS guidance, satellite datalink communications and propulsion. The Standard Missile-3 is launched by surface vessels, and it can also operate in anti-ballistic missile missions.

Figure 11

Army Tactical Missile System



Note. Reprinted from U.S. Army (2018) with permission. Retrieved from https://api.army.mil/e2/c/images/2018/04/15/513843/size0.jpg

Figure 12

Tomahawk Block IV Cruise Missile

Note. Reprinted from Naval technology (2013) with permission. Retrieved from https://www.naval-technology.com/news/newsraytheon-esm-seeker-technology-tomahawk/

PGMs are functional when used in conjunction with anti-access/area denial (A2/AD) systems. Anti-access systems refer to capabilities which are "... associated with denying access to major fixed-point targets, especially large forward bases" while area denial systems are capabilities "... that threaten mobile targets over an area of operations, principally maritime forces, to include those beyond the littorals" (Tol et al., 2010, p. 1). Detection of enemy targets by these systems can trigger the release of PGMs, and while they may sometimes be unable to totally prevent passage, they are usually able to severely slow down opponents.

Loitering munitions are another kind of semi-autonomous weapon. Instead of being launched at a particular target like with PGMs, they are launched in an area where they proceed to look for targets within a general class, such as enemy ships or tanks. When they find such a target, they will destroy it. These weapons are able to loiter in the air for extended periods of time, hence the name. The most popular example is the Israeli Harop, which is a long-range anti-radiation drone that has the ability to hone in on radio emissions. Examples of some loitering munitions that are employed by the U.S. military include Switchblade, Battlehawk Squad-Level Loitering Munition, Coyote, Cutlass, and Tactical Grenade Extended Range (TiGER), (Bilet, 2014; Gettinger & Michel, 2017).

The analytic potential of AI is also currently being harnessed by the U.S. military in the area of command and control (C^2) (Sayler, 2019). According to Payne (2018), "[s]trategic level AI operating as an 'oracle' for decision-makers will be able to test accepted wisdom, discarding spurious associations, rejecting pet theories and identifying key vulnerabilities in enemies" (p. 10). This will enable it to support the decision-making process, and aid offensive and defensive missions in which the amount of information and speed with which this information is being received might overwhelm human decision-making (U.S. Army, 2017).

A good example of a C^2 system is the Data Farming Decision Support Tool for Operation Planning (DFTOP). Developed by the NATO task group Developing Actionable Data Farming Decision Support for NATO (MSG-124), this tool analyzes hundreds of thousands of alternative simulations of operational plans using a data farming methodology. It then provides views tailored to specific leadership roles, such as operational analysts, planners and decision-makers (Schubert et al., 2017). This tool reduces the effort required for data farming analysis, improving the speed and efficiency of its users.

Although more emphasis has been placed on the use of AI in ISR and unmanned vehicles than on logistics, there are potentially great benefits from the application of AI. Logistics encompasses a myriad of areas, including supply chain management, resupply, preventive maintenance, and medical aid. AI has the potential to transform all of these. An important system for preventive maintenance is the Autonomic Logistics Information System (ALIS), which is a ground system that is paired with the F-35 Lightening II fighter. It integrates a broad range of capabilities, including "...operations, maintenance, prognostics, supply chain, customer support services, training and technical data" (Lockheed Martin, 2020, para. 2). It is also able to keep an inventory of the different parts of the aircraft, and track when these parts become due for servicing. This system has been plagued with many issues, so a replacement system is being planned by the DOD.

AI has also been useful in developing systems which help to reduce the amount of equipment being carried by troops. Dismounted soldiers are now able to possess platforms that can carry equipment, ammunition, water and other supplies, while also acting as a mobile power source (U.S. Army, 2017). There are also automated systems in place to enable improved resupply to troops. The Marine Corps operate a remote controlled, unmanned ground vehicle, which is capable of carrying hundreds of pounds of equipment, called Multi-Utility Tactical Transport (MUTT) (see Figure 13). It is a highly agile and manoeuvrable system, which has tremendous mobility and is able to follow soldiers or vehicles around the battlefield (Sayler, 2019). There is an armed variant called Weaponized MUTT, which is able to carry weapons such as a .50 calibre machine gun as well as spare ammunition. This provides immeasurable help to the soldiers as they may sometimes cross difficult terrain on foot.

Figure 13

Multi-Utility Tactical Transport

Note. Reprinted from Army Technology (n.d.) with permission. Retrieved from https://www.army-technology.com/projects/multi-utility-tactical-transport-mutt-ugv/

Conclusion

The current technological, political, economic, and social changes occurring globally are altering the character of warfare. Technological advances, and specifically advances in the use of AI, have led to an expansion of battlefields with a concurrent reduction in decision cycles and reaction times (Hillner, 2019). As a result of this, many nations all over the world are investing heavily in the research and development of artificially intelligent systems for military use across all the services. As a matter of fact, the U.S. deems AI an integral part of its Third Offset Strategy (Özdemir, 2019). The use of AI in the military impacts "… all domains (i.e. land, sea, air, space and information) and all levels of warfare (i.e. political, strategic, operational and tactical)" (Schubert et al., 2018, p. 1). In line with this, scholars posit that the global balance of power is currently tipped in favour of the nations that have been able to harness AI, and those that have not may be at a great disadvantage.

Chapter III: The New Face of Warfare?

When laying the groundwork for understanding the changes inherent in a military revolution, it is necessary to shed light on some major strategies (or offsets) that can feed into or constitute these changes. The term “offset”, in colloquial terms, refers to the counteracting of one force by an opposing force or effect. In the military, offset refers to the ability for actors, through varying means, to fundamentally alter the outcome of an engagement (Grant, 2016). Rather than succumb to losses from waging war against an equally matched or superior opponent, offsets serve as tactical, strategic and operational tools necessary in ensuring a more favourable outcome for its initiator (Manea, 2018).

In line, offset strategies speak to the methodical way tools, technology, or people, offer a change to the state of war (Brimley, 2014). They serve as a competitive advantage utilized by executors in maintaining dominance or at the very least, equality over present or future threats. Offset strategies are typically revolutionary in nature and must remain relevant to the state of warfare to which they are applied. In this chapter, the study discusses the three main offset strategies purported by the United States’ military, expounding on the historical context, development, and use of these strategies throughout their deployment.

First Offset Strategy as an RMA

The First Offset strategy can be traced back to the 1950s under former U.S. President, Harry S. Truman’s regime. The U.S., still recovering from the effects of World War II, called for an increase in defence spending in line with containment goals set out in National Security Council Memorandum-68 (NSC-68), written by the U.S. Department of States policy planning team, which called for the buildup of conventional and nuclear weaponry to deter the Soviet Union's growth and influence militarily, ideologically and politically. (Martinage, 2014).

Following the election of General Dwight D. Eisenhower as President in 1953, strategies on combat avoidance, preparedness, and resource preservation took centre stage. In addition to the standstill war in Korea, the United States sought to deter members of the Warsaw Pact from invading western Europe. Hence, to gain footing in the war, the U.S. military sought to display military superiority without hemorrhaging resources. At the behest of Arthur W. Radford, Chief of the Pacific Fleet, Eisenhower began discussions on advancing military dominance against the states' enemies in the face of dwindling resources. These discussions birthed the strategy that saw an increase in attention to, and reliance on the nation's supply of nuclear weapons, commonly referred to as "the First Offset strategy" (Grier, 2016). The main goal of the First Offset was to deter aggressors and avoid the costs of seeking conventional parity with the Soviet Union.

At the time, the Soviet Union had marked conventional military superiority both in terms of personnel and equipment over the U.S. and its allies. The Central Intelligence Agency (CIA) estimated that Soviet forces wielded nearly 175 army divisions with deployable reserves of 125-145. In comparison, the U.S. possessed 29 divisions with only 7 in reserve. This glaring disparity disqualified conventional warfare as a viable option for the nation's military strategy (Grier, 2016). On November 1, 1952, the U.S. military tested its first full-scale thermonuclear bomb codenamed, "Ivy Mike." Ivy Mike a.k.a. "the sausage," possessed a yield of 10.4 megatons (around 700 times the explosive power of *Little Boy*; the atomic bomb dropped on the Japanese city of Hiroshima by the U.S. in 1945) (Singh, 2015). The Ivy Mike tests were accompanied by developing more efficient and capable long-range bombers such as the B-47 and B-52, and missiles and artillery. This starting phase of the First Offset was dubbed "Project Solarium" (Singh, 2015).

Project Solarium, aptly named after the White House Solarium room, involved a review of the existing Cold War policies in search of financially feasible alternatives to waging and winning a conventional war against the Soviet Union. The goal of the project was to ensure military dominance while maintaining fiscal stability. Eisenhower accomplished this with NSC-162, which advocated for further dependence on nuclear weapons as the primary means of deterrence. At a national security meeting held in December 1953, Eisenhower declared his plans to utilize atomic energy and nuclear weapons as a primary deterrent against communist expansionism, and the pressing Soviet threat. This strategy was made public by U.S. Secretary of State, John F. Dulles to the Council on Foreign Relations in January 1954 (Martinage, 2014). This offset became the dominant military strategy used by the U.S., NATO members, and various allies.

The First Offset strategy was soon renamed *the New Look* and arguably successfully countered the pressing Soviet threat evidenced by the retaliatory campaign put forth by the USSR and its allies to outlaw the use of nuclear weapons by the U.S. From the period of 1953 to 1961, the number of atomic weapons in the U.S. increased from 1000 to more than 18,000 (Rosenberg, 1983). Although the First Offset was executed as planned, the strategy experienced major pushback from within the Eisenhower administration due to budget cuts experienced by the military. This drastic decline in funding caused unrest with senior officials of the U.S. army, one of which was the army chief of staff, General Maxwell Taylor. Taylor disapproved of Eisenhower's policy and strategy of neutralizing the Soviet threat. According to Taylor, this strategy portrayed the U.S. in a weak light, and appeared as an incapability to dismantle the threat head-on (Martinage, 2014; Rosenberg, 1983).

Despite the rising number of naysayers within his cabinet, Eisenhower continued his plan to increase the U.S. nuclear arsenal. At the end of the 1950s, U.S. nuclear warheads outnumbered the Soviet Union's by a 9--to-1 ratio (Grier, 2016). In simple terms, U.S. nuclear weapons cost effectively offset Soviet conventional superiority as the backbone of U.S. deterrence strategy.

Second Offset Strategy as an RMA

As a result of the U.S.' failure in Vietnam and the costs of prosecuting that war, the need for a new offset arose almost twenty years post-enactment of the First Offset. By the mid 1970s, the U.S. Department of Defence (DoD) annual budget had fallen by nearly 7 billion dollars. Warsaw Pact conventional forces outnumbered NATO forces 3-to-1 in Europe, and the DoD lacked the funds to increase conventional forces to match. (Tomes, 2015). The U.S. failed in its attempt to get the NATO allies to increase their forces and spending under the Flexible Response proposal. At the same time, the size of the Soviet divisions grew exponentially with numbers rising from 136 to 170 active, and the Red Army (Russian national military forces) advancing from 3.15 to 3.9 million people (Tomes, 2015; Grant, 2016).

This unrest was amplified by the growth of the Soviet nuclear forces, as they now had the capacity to threaten the U.S. homeland. The deployment of the Russia Soviet SS-19 nuclear missile, an intercontinental ballistic missile capable of delivering a nuclear yield of 500 kilotons, brought the U.S. and Soviet Union to a level of rough equality in terms of nuclear power. With this equally matched nuclear power, the U.S. could no longer rely on the First Offset to withstand the threat of the Soviet military (Grant, 2016). To offset this, the U.S. began leveraging technology. According to the former Secretary of Defence, William J. Perry, the goal of the Second Offset entailed "[utilizing] technology as an equalizer or force multiplier" (Tomes, 2012, p. 305). This plan became established as the "Second Offset strategy." Initial development of this strategy occurred through the Defence Advanced Research Projects Agency (DARPA). The focus surrounded "improving command and control, stand-off and anti-armour weapons, stealth, and sensor platforms and communications platforms like [the] Airborne Warning and Control System (AWACS), and Joint Surveillance and Target Attack Radar System (JSTARS)" (Seitz, 2019, p. 5).

The Second Offset, developed from the late 1960s through to the early 1980s, consisted of four main components: developing new Intelligence, Surveillance, and Reconnaissance (ISR) platforms and battle management capabilities; the building of more efficient precision strike weapons; the use of stealth technology for aircrafts, and the utilization of space for ISR, communications, precision navigation, and timing (Martinage, 2014). The major focus of this offset involved the maximization of technological resources. One example was the development of the Lockheed F-117A Nighthawk stealth fighter bomb program. Armed with radar-evading design, combat capabilities, navigation systems, and mission preparedness features, this stealth attack ground attack aircraft, coined "the world's first operational stealth aircraft," included infiltration and annihilation features capable of disarming heavily defended target regions with near-perfect accuracy (Seitz, 2019).

The Second Offset exploited major technological innovations through programs like the Airborne Warning and Control System (AWACS), Joint Surveillance and Target Attack Radar System (JSTARS), Joint Tactical Information Distribution System (JTIDS), Precision Guided Munitions (PGMs), Global Positioning System (GPS), and several enhanced reconnaissance satellites. These programs formed essential parts of the 1982 Air-Land Battle doctrine (Martinage, 2014). The Air-Land Battle doctrine promulgated a three-dimensional coordination of air and land forces, focusing on operational techniques, manoeuvre warfare, separated execution of mission commands, stealth and precision technology, an integrated battle, and extended battlefield (Skinner, 1988). This doctrine was premised on a widening of the technological gap between the

U.S. and the Soviet Union, while yielding an adaptable fighting force for combined air and land operations authorized under specified conditions (Skinner, 1988).

Unlike its predecessor, the Second Offset was much subtler politically. It barely, if at all, graced media and headlines, and it did not dominate substantial portions of the strategic discussions during its timeline (Grant, 2016). The deployment of new technology required substantial financial investments and as such, this was relatively more expensive than the First Offset. Even so, it was labelled "radical" and "flashy" from the conservative military, media, and government elements who had little to no faith in the technological advancements being made within this plan. A notable critic of this offset, former Air force General Robert Dixon, harbored serious reservations involving the effectiveness of the JSTARS which he referred to as a "magical radar" (Seitz, 2019). Doubts also surrounded noteworthy technological developments like the GPS, which was considered both unnecessary and ineffective in its time.

Notwithstanding the controversies surrounding this plan, the Second Offset proved effective and offered the U.S. military immense tactical advantage over its opponents. An example of this tactical advantage can be observed in the country's defeat of Iraqi forces during the first Gulf War. The Second Offset spurred innovation and advancements within the U.S. military (Seitz, 2019). Collaboration and coordination efforts between the Army and Air Force intensified and drove the emergence of advanced precision stealth bomber systems and low radar detection aircrafts (Tomes, 2014). The goal for the Second Offset, like the first, centered on the deterrence of enemy combatants and the advancement of U.S. military power. Overall, this offset realized all its originators set out to accomplish.

AI and the Third Offset Strategy

Over three decades following the execution of the Second Offset, a Third Offset was launched by former Secretary of Defence Chuck Hagel in November 2014 in the hopes of safeguarding the U.S. military's advantage over its rapidly modernizing adversaries (Lowther & Cimbala, 2020). The modernization efforts by old and new rivals such as Russia and China in the realm of military power, technology, intelligence, cyberspace, and robotics, and the onslaught of domestic and international terrorism activities, demanded the adoption of a new strategy to ensure and promote military ascendency and world peace in an age of increasing globalization (Pellerin, 2016). The Third Offset involves improving counter-terrorism partnerships with ally states, developing next-generation technology, and increasing training on specialized security forces (Pellerin, 2016).

In an address delivered on April 28, 2016 by the former Deputy Secretary of Defence, Bob Work, he highlighted the growing formidability of rival nations, China and Russia, and their respective breakthroughs in the realm of military technology, space exploration, and cyberwarfare. In the case of China, the country developed with modern cyberattack and cyber defense systems as well as a heightened anti-access/area denial (A2/AD) strategy for its land and sea territories (Lowther & Cimbala, 2020). China is a global contender in the field of AI and hypersonics, and has thrived on clever communication and diplomatic strategies, avoiding conflict where necessary while simultaneously advancing its military modernization and technological innovation agenda (Lowther & Cimbala, 2020).

The Russian military is also investing greatly in military AI technologies, developing autonomous vehicles and robotic systems (Bendett, 2018). Recent years have seen the nation's drastic shift in strategy with regard to the development of AI-enabled technology in three main facets of the state; domestic, military, and technological research. This is all in a bid to achieve parity with the U.S. The “AI in Armed Forces” strategy seeks to incorporate AI into the Air Force in a bid to enhance operational preparedness (Sukhankin, 2019). The Russian military has also begun to field increasingly advanced A2/AD-related military technologies (Kashin and Raska, 2017).

The Third Offset strategy centers around preserving the confidence of allies while neutralizing rival militaries (Manea, 2015). It has ushered in an era of human and machine collaboration accomplished through the design of futuristic technology, the application of enhanced operational concepts, and the advancement of AI. According to Work, the inclusion of AI in the military will invariably produce autonomous learning systems for handling large data and learning patterns, human-machine collaboration for more efficient decision-making, assistance-like exoskeletons and wearable electronics, advanced human and machine combat teaming, and network-enabled autonomous weapons (Pellerin, 2016). With the future of military operations inclined towards cyberspace, robotics, and information technology, the use of AI will be vital in preserving United States’ hegemony and its relationship with adversaries and allies respectively (Gronlund, 2019).

Despite this apparent ambition, the reliance on emerging technologies within this offset left room for major criticism regarding its efficacy (Hillner, 2019). The increase in knowledge of AI generated budding concerns about the impact of machine autonomy, additive manufacturing, nanotechnology, quantum computing, human-machine collaboration, on deterring/resolving modern warfare (Lowther & Cimbala, 2020). Also, the commercialization of AI technology and the cyberspace domain meant opening of trade secrets and military advancements to the highest bidder. The consequence of this behavior being an exploitation of one state’s offset technology, intellectual property, and nuclear command, control, and communications system by another state (Lowther & Cimbala, 2020). This scenario is deemed not too absurd to imagine given the present relative infancy of the information age.

Another conundrum within this offset exists in the extent to which political and military leaders/commanders feel pressured to respond impulsively to information in cyberspace without the full context of both the severity and necessity of their actions. Commanders, unbeknownst to them, could quickly steer from deterrence strategy into attack mode without resorting to standard principles of battlefield engagement or proper system confirmation to rule out false positives or negatives (Lowther & Cimbala, 2020). If a mistake of such magnitude occurs, the impact could be irreparable and the measure of retaliatory force by the sufferer, unfathomable (Saalman, 2018). Technological concerns aside, supporters of this strategy remain optimistic in its ability to completely redefine military ethics, cyber relations, and conventional warfare (Kempf, 2017).

The three offset strategies discussed, although posed in different decades, share palpable similarities amid their glaring distinctions. They were all born from a need to protect and propel the U.S. above its contenders, they required the development and/or reliance on technology and machinery, such as nuclear weapons, stealth technology, and AI, and they all, in varying degrees, caused poignant shifts in the strategic thinking of the U.S. military regarding war and battle strategy.

Having established that an RMA goes beyond technological changes to include doctrinal and organizational reforms, it is necessary to examine this current Third Offset strategy–based on AI–through the lens of the previous two in order to determine whether it is or is not capable of becoming an RMA. The First and Second Offset strategies were both revolutions in military affairs, as they radically influenced or directly reconstructed the understanding of warfare during the periods they were introduced. They were aimed at the advancement or protection of U.S. military power, and were able to achieve this with the technological, organizational, and doctrinal changes they manifested. These strategies had clear milestones that were set and met (Coletta, 2017). The challenge with them, however, was that the changes they introduced soon became obsolete, and the U.S. government had to develop new ways to safeguard their position of military dominance in this age of increasing globalization.

This birthed the Third Offset strategy, and it differs from its predecessors in certain ways. For example, there are no clear milestones with which it can be defined (Coletta, 2017). Nuclear power could be clearly measured in terms of the number of warheads possessed by a country, and the U.S. developed the First Offset strategy to enable them to compete with nations that were growing in military parity or producing nuclear weapons contemporaneously. The Second Offset could be declared successful when the U.S. had developed sufficient non-nuclear technologies that would enable them to withstand the nuclear onslaught that could have been brought on by the Soviet Union. With the Third Offset strategy, there is no single, fixed adversary the U.S. seeks to guard against. Therefore, the strategy just seeks to harness innovation in a bid to meet new enemies prepared whenever or however they arise (Coletta, 2017).

Another way this Third Offset differs from its predecessors is that, rather than being comprised of a suite of technologies, it is instead a transformation in the process involved in the harnessing and application of technological innovations (Coletta, 2017). Horowitz (2018) describes it as an "enabling" technology that is comparable to electricity. It can be applied in a multitude of ways, making it broader than the other technological advances that occurred as part of the previous Offset strategies. Additionally, unlike the innovations seen in the previous strategies that comprised of technologies largely reserved for military use such as nuclear weapons, AI has already started being used in commercial settings, therefore the government or the military cannot contain its use. This feature makes it relevant across several fields and makes it capable of operating in many different dimensions.

The development and deployment of these breakthrough technologies described by the Third Offset strategy is aimed at discovering novel ways to achieve strategic objectives and concepts that will provide joint forces with advantages at the operational and tactical levels of war (Kashin & Raska, 2017). As the development of AI continues, developers will most likely find more ways to integrate it into various arenas in the military, and countries will need to ascertain how to practically apply these new technologies (Horowitz, 2018). As already established, ANI is currently the only stage of AI that is obtainable, as AGI and ASI are still mere hypotheticals. ANI supports the transformation of individual tasks, processes and technological applications, but it has not completely changed the way humans engage in warfare.

Conclusion

This chapter has highlighted the different offset strategies employed by the U.S. military, elucidating on their purpose, goals, limitations, successes, and shortcomings. Each offset strategy held a uniqueness to the time it was used in. They were all turning points for the U.S., NATO and their allies. The First and Second Offset strategies were successful in their enactment but eventually became obsolete and needed to be replaced. This chapter would suggest that the main problem with these first two offsets is their tendency to quickly become obsolete due to changing times or an adversary's increasing parity, as was the case with the U.S. The Third Offset is still in its early stages and we have yet to see it used, developed, or deployed to its full capacity. In exploring this offset, it is necessary to examine the efficacy of AI in its current and perceived future capabilities to influence, alter or revolutionize warfare.

A careful survey of all AI has accomplished and still seeks to accomplish, shows it has the potential to become an RMA, but at this present time, it may be a bit presumptuous for authors and scholars to describe it as such. Instead, in the near to mid-term, AI should be seen as a means of utilizing machine learning to refine and upgrade existing platforms (Horowitz, 2018). Human and machine collaborations are currently being done on a larger-than-ever scale, and breakthroughs in the areas of military technology and cyberwarfare have created virtual battlefields that previously did not exist.

Chapter IV: Conclusion

Throughout recorded history, emerging technologies have played a major part in determining the global balance of power, both directly and indirectly through military and economic means (Horowitz, 2018). In the military, new technologies can influence the way a nation fights and wins wars. Another aspect that must be considered is the fact that different actors may be seen to apply the same technology in different ways. The way governments and organizations make decisions about the adoption of technological changes is a major determinant on the impact such technologies will have on their military power. Currently, many analysts have declared that AI will have a large and possibly deterministic effect on global politics (Horowitz, 2018). The challenge in this, however, is that despite continued investment, many of the agencies currently involved in the research and development of artificially intelligent systems are finding it difficult to move from development to actual operational implementation (Cummings, 2017). Nevertheless, there are visible changes that can be seen on a global scale as a result of the systems into which militaries have been able to integrate AI.

Overall Key Findings

Multiple analysts compare the current global investments in AI by China and Russia to an arms race (Horowitz, 2018). According to a national strategy on AI published by China in 2017, the nation intends to lead the world in AI by building China's first mover advantage in the harnessing of new technologies (Horowitz, 2018). The Russian government also seems to hold this view, as in a speech recently by Russian President Vladimir Putin, he said, "[a]rtificial intelligence is the future, not only for Russia, but for all of humankind. It comes with colossal opportunities, but also threats that are difficult to predict. Whoever becomes the leader in this sphere will become the ruler of the world" (Horowitz, 2018, p. 38). Other non-U.S. actors interested in the application of AI include Southeast Asian countries such as Singapore and South Korea (Horowitz, 2018). Terrorist organizations have embraced these changes as well and have become critical non-state actors in global warfare. These occurrences and theories suggest that the balance of power globally will be potentially determined by AI.

Currently, the U.S. stands as the leading military world power but, as Horowitz (2018) cautions, this can change within the coming years if the U.S. does not adopt political and grand strategic agendas that will enable them to harness all the advances being made in the area of AI. Another reason why the research and development of AI is being pursued globally with such fervor is the fact that successful development of AI systems comes with commercial incentives in addition to military ones. Most AI technologies have dual use capabilities, and nations are eager to harness these systems both for military and civilian use. There are many variables that come into play when examining how nations will respond to AI and how its development will affect these nations. While the wealthiest nations and organizations may be able to lead in the areas of research and development, it may be difficult for them to implement the organizational changes necessary to effectively utilize the AI technologies they develop.

According to Horowitz (2018), leading militaries may struggle with the implementation of new organizational changes in the face of evolving technology, as it may be hard to justify a drastic change when they already perceive themselves to be frontrunners. He uses the British Royal Navy as an illustration. Due to the success they experienced with the use of their battleships, they classified new technologies according to the ways they could facilitate their use of battleships. Thus, when they invented aircraft carriers in 1918, they were primarily to serve as spotters for their battleships. However, the Japanese and U.S. navies, which were less invested in the battleship, used these carriers as mobile airfields, and thus surpassed the British Royal Navy, even though they were the original innovators.

At this juncture, it is important to note that, no country has the monopoly on research and development of AI for military use. Thus, while a nation's defense systems may improve, the offensive weapons employed by their opponents will most likely also improve (O'Hanlon, 2015). Due to this, certain vulnerabilities may persist from the present through to the future, even though AI may have been further developed. To counter this, nations that are able to develop specific AI military technologies earlier will garner significant first mover advantages, and hold a sustainable edge over their competitors (Horowitz, 2018). This is because, most significant innovations in the integration of AI systems into the military will be difficult to mimic. However, if other nations can rapidly adopt a new technology, this first-mover advantage will be lessened.

The diffusion rate of new technologies can be determined by considering the unit costs of the machinery they are made up of. AI technologies are comprised of both machinery and software, and the development of these can be quite costly. The higher the costs, the harder it may be for many nations to implement, thus strengthening the first-mover advantage of those who are able to adopt it (Horowitz, 2018). What this means is that if other nations begin to develop and harness AI systems faster than the U.S. military, the kind of impunity and the freedom of action that U.S. forces have enjoyed for decades would be at risk (O'Hanlon, 2015). Particularly, if peer competitors are able to adopt advanced A2/AD battle networks, the U.S. military hold on maritime, air and space superiority will be threatened (Kashin & Raska, 2017). Therefore, to retain their current dominance, the U.S. should invest greatly in the research and development of AI for use by the military, and perhaps more importantly, be willing to quickly implement radical changes to adopt these technologies that they develop.

It is a growing belief in many sectors that the advances being made in the field of AI will be diversely critical in the future, for both society and the military. The adoption of AI systems, tools and logic for use by the military is a strategy that is still very much in its infancy. AI is still being studied, developed, and understood, and this makes it difficult to assess the extent of its capabilities. Currently, even experts disagree on the overall trajectory that advancements in AI may take (Horowitz, 2018). In any period, the nature and character of warfare is determined to a large extent by the existing technologies and policies that are in operation. As innovations in the type, availability and capability of tools and weapon systems occur, the ways in which militaries organize themselves to fight will typically change. This is also applicable in the development of AI, as even though its development has barely scratched the surface of what it is projected to accomplish, it is clear to see that it has led, and will continue to lead, to a transformation in the business and understanding of warfare.

Military applications of AI can be observed in different areas. The U.S. Department of Defense (2018) has stated that AI is poised to impact every area in the military, such as "… operations, training, sustainment, force protection, recruiting, healthcare and many others" (p. 5). The creation of semi-autonomous systems and weapons, alongside breakthroughs in ISR, Command and Control has yielded changes, redirections and outcomes in warfare previously not envisioned. Globally, a greater amount of intelligence is being harnessed and analysed, propelled largely by the use of AI systems and functions.

In response to the increase in information collection, various information processing and analyzing systems have also been developed, including functions such as deep learning. The processing power made possible by AI will potentially increase the speed and accuracy of data analysis and image recognition systems, as they are poised to achieve faster and more accurate results than those humans can achieve (Horowitz, 2018). In line, with the advent of faster communication systems, the dissemination of information along the chain of command within the military has become near real-time, as servicemen on the battlefield are able to relay information to their commanders and receive immediate feedback. This has greatly shortened the reaction times in battle, allowing modern operations to occur at a faster-than-ever pace.

There are many other benefits that the use of AI affords the military. It enables the military to better maintain equipment by the development of systems that monitor the state of equipment and give notice once they are due for servicing. In the long run, this may reduce operational costs (U.S. Department of Defense, 2018). It also leads to the reduction in the amount of collateral damage prone to occur during battles, due to the enhancement of precision and accuracy that it affords the military when it is integrated into their weapon systems. Additionally, AI can improve workflow efficiency by allowing for the automation of tasks that are typically manually performed. This does not suggest that the integration of AI into the military should be viewed as a means of replacing service members. Instead, it should be regarded as a way to improve their service and reduce the risks they may encounter.

In light of all of this, the U.S. and other countries must consider how best to continue this development and integration of AI for military use. The relative impact of technology is measured more by how people, organizations, and societies utilize it than by its basic characteristics (Horowitz, 2018). Therefore, apart from just embracing the technological changes, nations need to also develop strategies that will enable them to make organizational changes. According to Horowitz and Mahoney (2018), these changes include "…prioritizing enterprise-wide data labeling, cloud-building, and software development-user teaming…" (p. 4). It is these organizational changes that will enable the effective integration of the (potential) advances brought by AI into the various military services.

Understanding why this thesis concludes that AI in the military does not yet constitute an RMA requires a look into what would then deem it one. One of such factors is time. The First and Second Offset strategies had enough time to actualize what they set out to do, adapt to changing realities and promote research and more insights into their reach, influence and outcomes. The Third Offset as a strategy does not boast of an equally permitted timespan to allow more in-depth analyses and exploration of its effectiveness and resultant changes. In sum, adequate time needs to pass to allow this present Offset strategy progress and mature before its effects can be clearly studied. This study highlights ethical considerations as a present-day concern to allow for more effective and equitable ways of using and assessing AI now and in the future.

Likewise, infancy in technology is a factor to note as a constraint in AI's revolution in military affairs' claim. AI is still, by the definition adopted in this thesis, and by (potential) uses for the military, in its infancy stages. The technology is still in the lower rung of perceived capabilities, and in the levels of permeation discourse of micro, meso and macro, does not yet function at its highest capabilities. A relook will be necessary when AI moves from the ANI to AGI state if linearity is the path it treads.

Finally, there is no defined measurement of success for AI and the Third Offset Strategy that allows it to be considered a failure or success. AI has not been a directly employed strategy in any major conflict, and as such, there are no clear-cut indices for success. The First and Second Offset strategies were used in a well-defined sandbox of military strategy and desired outcomes. As such, the result of success or failure, was easily determined. However, with the rise in non-conventional methods of warfare, gray-zone conflicts, hybrid warfare and non-state actors as adversaries, the aim, intensity, definitive end and means of warfare have greatly changed. Likewise, the determinants of success within warfare are also redefined when other frontiers like cyberwarfare is considered. In line, AI would need to be analysed through a contemporary warfare lens and provided a means of ascertaining its measure of success.

Ethical Considerations

With all the hype surrounding AI systems and the international race to develop the best systems, it is pertinent that leaders and developers ensure that ethics and security are not being undermined or overlooked. The bid to advance the capabilities of AI should not be made such a priority that the effects certain systems have on human beings are no longer considered. Every system being developed must be properly tested and evaluated to ensure that they meet all the necessary safety standards before being deployed for use. Likewise, ethical guidelines should be put in place to govern the operation of these systems. The systems developed from AI are only as good as the data they are fed. Ethical considerations stem from the realization that corrupt, morally bankrupt, stereotyped, racially motivated or politically motivated data provided by the developers or system operators, go a long way in the corruption of these systems.

Moreover, the potential risks that the incorporation of AI systems into the military pose must be examined to ensure that safeguards are put in place to prevent them. For instance, the increased speed of processing by the AI system may prove difficult for human operators to follow, and this may create problems of transparency, and prevent operators from discovering errors in the systems (Sisson, 2019). Another potential risk is the possibility that AI systems could be hacked into or have malware installed. Rival nations or organizations may develop means to distort or corrupt systems. Therefore, the routine screening of systems for errors should be introduced, and alongside the AI, antiviral, and data protection software should also be developed (Sisson, 2019).

Levels of Permeation of AI into the Military

The level of permeation of AI into the military is largely determined by its degree of advancement. The more advanced an AI system is, the more deeply it is able to influence the military and the manner in which warfare is conducted. It is when AI has been able to influence the workings of military in profound and irreversible ways, thus transforming the very nature of warfare that it can truly be described as an RMA.

War is significantly ingrained into the nature of human beings (McRae, 2018). Every party involved in warfare is made up of cognizant humans deploying a plethora of means in order to gain a favourable end. Decisions are made by these humans, and they can be modified or altered as the need arises. Over the centuries, the means employed, and the tools used for engagement have changed, but this basic principle has been in place—humans directly engaging humans. With the creation of ANI, there has been a slight modification to this. Now, cognizant humans are able to engage artificially intelligent but incognizant robots. An example of this is the use of unmanned aerial vehicles. These vehicles can be programmed to carry out certain tasks and engage directly with humans, but at this time, they are limited in their actions to only what they are programmed to do.

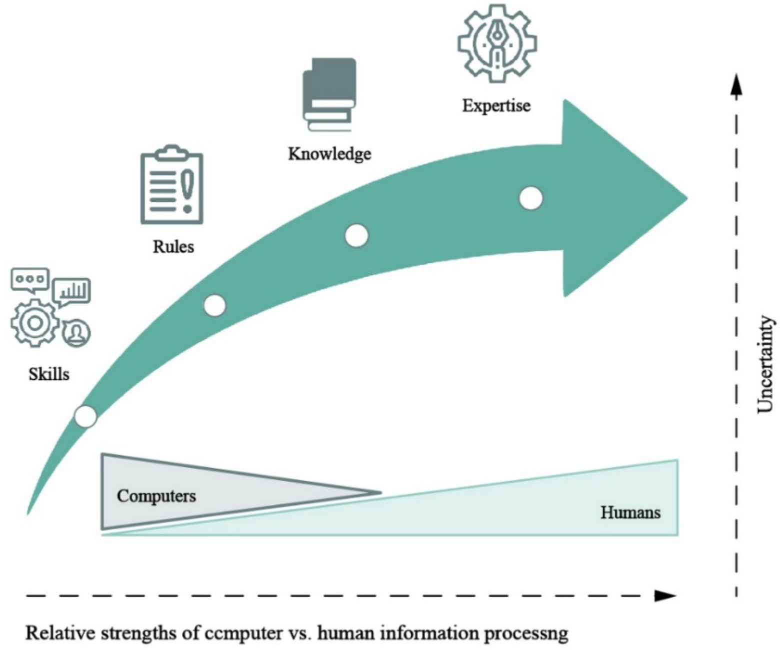
As the capabilities expected of AI increase, the way it affects warfare is also expected to change. If the goals for AGI can be realised, the art of warfare may be changed to a point in which cognizant machines are able to fight against each other with minimal or no human input. However, with ASI, and the development of robots that are post-cognizant, warfare might be so drastically impacted by the robots, that it would become completely different from what we know. This is because, war is an inherently human character, and if robots become capable of independent thought and no longer have to be programmed by humans, there is every possibility that they may choose not to go to war, or choose to engage in a way that is completely different from what we are used to.

Borrowing from the levels of social analysis that organise research targets into micro, meso, and macro levels (Serpa & Ferreira, 2019), the level of permeation of AI into the military can be designated as such. These refer to the extent to which AI influences the workings of the military and its various services, and the degree of change or transformation it introduces or induces. In exploring these levels, the concept of cognizance is used as a representation of not only human intelligence but also realization and perception. This has been referred to by other scholars as the level of "consciousness" (Scharre, 2018).

The micro level in this context refers to the current level of permeation in the military, and it is propagated by ANI. At this level, the changes introduced by ANI are just enough to make already existing systems work more efficiently, and not necessarily revolutionize the way things are done. AI systems presently appear to be superior to human beings in rule- and skill-based tasks. However, when faced with situations that present a high level of uncertainty and require judgement and knowledge, these systems are unable to measure up to humans (Cummings, 2017). These systems have a variety of sensors feeding them with information about their surroundings and internal state, and through the use of a feedback system, they automatically respond with one of many pre-programmed activities. As situations become more complex, the automaticity reduces, and knowledge-based reasoning comes into play. Decisions will be made by taking many variables into consideration and deciding on the best course of action.

Figure 14

Comparison of Human & Computer Information Processing when faced with Increasing Degrees of Uncertainty.



Note. Adapted from Cummings (2017)

AI systems are currently able to engage in some form of complex reasoning, having been programmed to follow certain rules—if "this" occurs, respond with "that." Cummings (2017) uses vehicle navigation systems as an illustration. The destination is their end goal, and they direct users along the best path by taking into consideration traffic rules and knowledge of vehicle dynamics. They are able to recalibrate routes if users deviate, and also estimate arrival times. Although these systems give directions, the actual carrying-out of the task is done by the human drivers. As the degree of uncertainty in a situation increases, computers must possess autonomous behaviours in order to cope. The introduction of autonomy into this domain introduces a new level of difficulty. In the use of drones, the difficulty level is somewhat manageable as there are mature sensor capabilities and low environmental obstacles, allowing the drone to manoeuvre its way through difficult terrains. A depiction of warfare at this level could be cognizant-human versus cognizant-human, cognizant-human versus incognizant-robot or incognizant-robot versus incognizant-robot.

At the meso level, AI is expected to cause a greater degree of influence, and this will be propagated by the development and integration of AGI. Examining the computational level expected of AGI, it is possible to postulate that it will meet the standard that AI is purported to meet for the military, causing doctrinal, organizational as well as technological changes, thus constituting an RMA. One area in which the development of AGI is expected to significantly influence the military is with the introduction of Lethal Autonomous Weapon Systems (LAWS). These are systems that will be capable of exerting lethal force without human intervention or control (Marchant et al., 2011). AI is, at this level, expected to possess similar cognizance levels with those of humans. This is fuelled by an increase in capability from the ANI to AGI rung in the ladder of AI progression. The ability to move from a human-centred type of warfare to one that now includes cognizant-robot versus cognizant-humans or cognizant-robot versus cognizant-robot typifies this level of permeation. Scholars, students, scientists, and military strategists can then, at this level, instigate a relook into the relationship of AI with war and its ability to create, induce or provide a revolution in military affairs.

The macro level refers to the highest level of permeation possible, and it will coincide with the adoption of ASI systems into the military. In a seemingly far-fetched context of present reality, it is possible that the artificially intelligent systems will exhibit a level of cognizance that scholars are not yet aware of, having a so-called “post-cognizant” state. These “post-cognizant” robots will be able to engage each other, totally independent of human input. This may lead to such a drastic change, that the basic concepts of "war" and "warfare" and all that they entail will have to be re-examined.

Future Research

In addition to making organizational changes, military leaders may also need to restructure their recruitment and training methods. When recruiting, people who are skilled in engaging artificially intelligent systems may begin to have an edge over those that are not, and these personnel may be favoured for promotions above the unskilled. Soldiers may be required to have knowledge of coding, programming, and interpretation of algorithms. Aside from the conventional training service members undergo, trainings in the operation of AI systems and functions deemed relevant and necessary may become mandatory. Further, the development of uninhabited systems may cause the large, conventional armies that were the norm in the past to become obsolete and unpopular sometime in the future.

An analysis of the relationship between AI and warfare exposes symbiosis, albeit at a premature stage that cannot fully capture and adequately test the revolutionary effect of one on the other. A recommendation of ways through which this study could be approached at a later date should stem from two aspects. The first pertains to ethics and is studying what goes into the development of AI and ensuring that no ethical boundaries are crossed. This is because, as more breakthroughs are made in the research and development of AI, the capabilities of the systems will profoundly increase, and checks and balances need to be put into place to ensure that these capabilities remain governed by ethical principles. The second is the permeation of AI into the military, which allows for a measurement of how well and deep AI's reach into the very fabrics of the military is. These would in turn allow for a robust study of AI and its ability to influence the military, warfare, and the society at large.

Conclusions

One of the main objectives for this thesis was to understand the progression of the revolutions in military affairs across the centuries through a re-examination of warfare as a concept. In order to explore the capacity of AI to be an RMA, the study set out to look beyond the period of the Second Offset strategy and theoretically link the revolution in military affairs to a period of warfare that is currently being buoyed by AI. Through a review of literature within the aforementioned topics of RMA, AI and offset strategies, it has been determined that AI, at the present time, is not an RMA. The findings of this study indicate that AI, at its current level of development (ANI) and with properties of human-dependency, does not have the ability to establish itself as a full-fledged RMA.

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