ORCHESTRA OF CHANGE: STRATEGICALLY HARMONIZING NATIONAL CHARACTER, MILITARY FORCES, AND THE CHARACTER OF WAR

BY

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APPROVAL

The undersigned certify that this thesis meets master's-level standards of research, argumentation, and expression.

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DISCLAIMER

The conclusions and opinions expressed in this document are those of the author. They do not reflect the official position of the US Government, Department of Defense, the United States Air Force, or Air University.

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ABSTRACT

This study develops the theory that strategic harmonization of a country's national character, military forces, and the character of the wars in which it participates minimizes risk and creates conditions for success. The spectrum of socio-technological revolutions from revolutionary wave theory, to military revolutions, to revolutions in military affairs creates the structure for strategic harmonization. Harmonization occurs when the means, ways, and ends of military forces efficaciously translate the means, ways, and ends of national character into positive strategic effects in the character of war. The author applies this theory to case studies of the United States during the Industrial Revolution and the on-going Information Revolution. An analysis of the case studies determines that while the United States successfully harmonized during the Industrial Revolution, the US military forces' means and ways of organizing, training, and equipping that created this success are generating discord and causing strategic risk for the United States in the Information Revolution. The final section proposes a solution for strategic harmonization through investing in ubiquitous network architecture, training and empowering military forces to become a part of a complex, chaotic system at the edge of the battle space, and eliminating wasted bureaucratic overhead and organizational barriers to integration.

CONTENTS

Chapter 1

Introduction

> *We can thus only say that the aims a belligerent adopts, and the resources he employs, must be governed by the particular characteristics of his own position; but they will also conform to the spirit of the age and to its general character.*
>
> —Carl Von Clausewitz
> *On War*

As of mid-2014, 42.3 percent of the human population connects to the Internet, communicating over 30,000 gigabytes per second (GBps).[1] The numbers of people connected to the Internet and the amount of information they pass have grown and are expected to continue growing at exponential rates.[2] By 2018, the amount of information passed across the Internet in three minutes will exceed the data equivalent of every human movie ever made.[3] Discount retailer Target uses big data analytics of the information it collects to target individual shoppers with coupons.[4] The Los Angeles Police Department enlists heterogeneous streams of data and algorithms to identify likely trouble spots in the city and would-be repeat offenders.[5] The United States military uses analytics, learning algorithms, and visualization tools to mine data for patterns and trends to develop intelligence,[6] while their adversaries use chat rooms, mobile devices, and

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[1] Miniwatts Marketing Group, "Internet World Stats," *Internet World Stats*, February 27, 2015, http://www.internetworldstats.com/stats.htm.
[2] "Cisco Visual Networking Index: Forecast and Methodology, 2013–2018," *Cisco*, accessed February 26, 2015, http://cisco.com/c/en/us/solutions/collateral/service-provider/ip-ngn-ip-next-generation-network/white_paper_c11-481360.html.
[3] "Cisco Visual Networking Index."
[4] Charles Duhigg, "How Companies Learn Your Secrets," *The New York Times*, February 16, 2012, sec. Magazine, http://www.nytimes.com/2012/02/19/magazine/shopping-habits.html.
[5] Roy Howell, "LAPD Uses Big Data to Target Criminals," accessed February 27, 2015, http://www.cbsnews.com/news/lapd-uses-big-data-to-target-criminals/.
[6] Jeff Bertolucci, "Military Uses Big Data As Spy Tech," *InformationWeek*, accessed February 27, 2015, http://www.informationweek.com/big-data/news/big-data-analytics/military-uses-big-data-as-spy-tech/240153309.

other online tools to plan and coordinate attacks while avoiding detection.[7] The Information Revolution is here, it is real, and it is changing the way we live our lives, create business, police our streets, and fight our wars.

Despite the global proliferation of the Information Revolution, the United States military has been slow to adapt and fully leverage the opportunities or cope with the challenges generated within the revolution. The Secretaries of Defense over the last fifteen years have demanded transformation, avoiding "Next-War-itis," innovation, or reaching for "third offsets," yet the military slowly adapts by adopting some elements of the information revolution, while generally remaining insulated to the broader fundamental shifts in society.[8] Simultaneously, the United States and its military suffered setbacks in Iraq and Afghanistan that called into question the sufficiency of current military forces and other national instruments of power to achieve strategic success. Given the pressure from civilian leadership, the lessons of potential and near-strategic failures, and decreasing budgets, why is the US military still resistant to changing to fully leverage the fundamental shifts in the character of war and national power production brought on by the Information Revolution?

The answer is the pathways to success that made the United States and its military the dominant global power during the Industrial Revolution are also the source of its potential weakness during the Information Revolution. The harmony of national

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[7] Post Staff Report, "Al Qaeda Fighters Planning and Coordinating Attacks on Secret Chat Rooms and Internet Message Boards," *New York Post*, August 15, 2013, http://nypost.com/2013/08/15/al-qaeda-fighters-planning-and-coordinating-attacks-on-secret-chat-rooms-and-internet-message-boards/.

[8] Donald Rumsfeld led the charge for military transformation, Donald H. Rumsfeld, "Transforming the Military," *Foreign Affairs*, June 2002, http://www.foreignaffairs.com/articles/58020/donald-h-rumsfeld/transforming-the-military. Robert Gates claimed the Department of Defense concerned itself too much with Cold War-like conflict, developing "Next-War-itis", Robert Gates, "Remarks to the Heritage Foundation (Colorado Springs, CO)," May 13, 2008, http://www.defense.gov/speeches/speech.aspx?speechid=1240. Chuck Hagel requested innovation, then began the search for a "third-offset" that Secretary Bob Work continues, Cheryl Pellerin, "Hagel Announces New Defense Innovation, Reform Efforts," *U.S. Department of Defense*, November 15, 2014, http://www.defense.gov/news/newsarticle.aspx?id=123651.

industrial capability and military application created the great might of the US military during the culmination of the Industrial Revolution. Reinforced by time and lack of perceived failure in the intervening years, this harmony established physical, organizational, and mental pathways to success that shape and are shaped by the United States' strategy to organize, train, and equip its forces.

Unfortunately, the ossification over time of these pathways creates a US military optimized for the Industrial Revolution that lumbers through a world transformed by the Information Revolution. This strategic lethargy leads to dissonance among the US military's processes to organize, train, and equip its forces, the strengths of the nation that supplies it, and the character of the wars it will fight. Such dissonance increases inefficiencies and risk, driving up the costs to organize, train, and equip the military while decreasing its effectiveness and putting the nation at risk of broader strategic failures.

Research Approach

This paper seeks to define what the dissonance is, how it formed, and why and how the United States, its military, and specifically the US Air Force (USAF) must adapt to harmonize the people, military, and character of war in the Information Revolution. Chapter II defines what a revolution is and why it is important. Modern competing descriptions of technological revolutions cover the spectrum from technological determinism to social constructivism.

Strategy requires an understanding of the revolution across this spectrum. The revolution in military affairs (RMA) first espoused by the Department of Defense's (DOD) Office of Net Assessment (ONA) finds itself in the soft technologically deterministic side of the spectrum, while MacGregor Knox's and Williamson Murray's "military revolutions" are near the middle of the spectrum, and Alvin and Heidi Toffler's "revolutionary wave theory" anchors toward the social constructivist side of the scale.[9]

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[9] For ONA's RMA perspectives, see Andrew F. Krepinevich, "Cavalry to Computer: The Pattern of Military Revolutions," *The National Interest*, no. 37 (October 1, 1994): 30–42. Knox and Murray's theory is found in MacGregor Knox and Williamson Murray, eds.,

While presented as independent theories of revolution, they are intrinsically related, interacting with each other to create, grow, and progress socio-technological change. For the war-fighting strategist, these theories correlate to the three elements the strategist must harmonize to maximize military utility in an ever-changing world.

Chapter III links the theories of revolution to the three elements that govern a nation's effectiveness to achieve political aims through military means. Grounded in Carl von Clausewitz's trinity of violence, chance, and reason the three revolution theories describe significant shifts in the nation's strength, its military forces, and the character of war in which those forces operate.[10] The Toffler's three-wave theory illuminates the shifts in national character associated with revolutionary change in the production of wealth and the resultant social changes. Knox and MacGregor's military revolutions correspond to broader organization, training, and equipment changes of the military forces that connect national power to the character of war. The modern RMA theory, introduced by Andrew Marshall's Office of Net Assessment and his staff, including Andrew Krepinevich and Barry Watts, provides the final linkage by connecting technological change and its impact on the character and conduct of war.[11] Chapter III concludes by presenting the theory that nations are most powerful and successful when

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The Dynamics of Military Revolution, 1300-2050 (Cambridge, UK ; New York: Cambridge University Press, 2001), 6. The Toffler's elucidate their wave theory in a number of works, but the first is Alvin Toffler, *The Third Wave* (New York: Bantam Books, 1981).

[10] See Carl von Clausewitz, *On War*, ed. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1984), 89. This paper adopts a modified approach to Clausewitz's trinity. Violence translates to the people of a nation who create the national chracter, while reason applies to the rational process to decide how to organize, train, and equip the nations military forces, and chance is the ever-changing character and conduct of war.

[11] For one of the earliest works discussing RMAs, see Krepinevich, Andrew F. "Cavalry to Computer: The Pattern of Military Revolutions." *The National Interest*, no. 37 (October 1, 1994): 30–42. Since the mid-1990s to the present, Barry Watts wrote numerous works about the precision-strike revolution. For his most current work, see Watts, Barry. "The Evolution of Precision Strike." Center for Strategic and Budgetary Assessments, 2013. http://csbaonline.org/wp-content/uploads/2013/08/Evolution-of-Precision-Strike-final-v15.pdf

their strategy harmonizes the national character, the organizing, training, and equipping of their military forces, and the character and conduct of war.

Chapter IV presents a case study of the United States during the Industrial Revolution, spanning from mid-nineteenth century to post-World War II. The physical processes of resource collection, transportation, consolidation, and transformation into machines that extended mankind's ability to do things farther, faster, and more powerfully than ever before produced national wealth and strength during the Industrial Revolution. Those processes also shaped the character and conduct of war, especially World War II, and the nations that effectively harmonized the translation of national character through military force to the conduct of war were the most successful. However, those successful processes also created pathways to success that are not as ideal in the Information Revolution.

Chapter V applies the theory to the present state of the Information Revolution. The chapter begins by exploring the changes in resources and processes that create national wealth and strength in the Information Revolution. These same changes affect the character and conduct of war by focusing less on creating sources of power in what people can do and more on how people communicate and think. Since the Information Revolution has yet to witness a culminating war such as World War II, the chapter highlights indicators of change from the Vietnam War, through Operation DESERT STORM, to Operations IRAQI FREEDOM (OIF) and ENDURING FREEDOM (OEF). The United States was successful in many ways at adopting the means of the Information Revolution at the RMA level in the conduct of war. Viewed through the lens of these conflicts, however, a schism between the transformations of national character into the character of war appears at the military-revolution level, where US military forces fail to adapt to the ways of the Information Revolution. This dissonance of military forces, national character, and the character of war cost the United States much blood and treasure over the last decade-and-a-half, but could be catastrophic if faced by more capable adversaries who harmonize for the Information Revolution.

Chapter VI recommends a course of action to harmonize military forces with national character and the character of war. Analysis of the discord produced during the transition from the Industrial to the Information Revolution suggests the United States

must invest in a ubiquitous network that integrates forces at the front edge of the battle space, empower and train forces to operate in and on a complex system to create adaptable emergent behavior, and reform the military organization to reduce or eliminate unnecessary bureaucracy and undesirable hierarchical divisions and structures. Now is the time to make these changes at the convergence of emerging informationized threats, exponential growth of information generation and processing tools, and the development of theories of chaos and complexity. This chapter concludes with a summary of the paper and recommendations for future research to make the theory of strategic harmonization and its recommendations more robust.

Limitations and Assumptions

This paper presents a generalized theory of strategy based upon Clausewitz's trinity of violence, reason, and chance applied to the harmonizing of national character, military forces, and the character and conduct of war. While the theory aims to be general, the case studies and focus rests on the United States. The reasons are two-fold. First, the hope is that the US military adopts the recommendations generated by the paper to prepare the nation for the changes inherent in the Information Revolution. The second was simply to scope the paper to manageable limits. Future study should expand the case studies beyond the United States, potentially focusing on Maoist China, Stalinist USSR, Nazi Germany, or Al Qaeda insurgencies in the Middle East.

The paper also focuses on the Industrial Revolution in a more developed stage, post-1850. This date was chosen because the rapid growth of industrial productivity in the ensuing century more easily highlighted the shifts in national character and the character of war. An earlier study of the Industrial Revolution may be helpful to understanding the nascent nature of the Information Revolution, especially if one believes that the vast majority of revolutionary changes are just about to begin.

Additionally, this paper did not focus on the harmonizing that occurred between the Tofflers' first wave, the Agrarian Revolution, and the second wave, Industrial

Revolution.[12] Again, the scope of this paper necessitated this limitation, but an analysis of this process may illuminate an approach to transitioning between the second and third waves.

Finally, the paper limits its scope to a few key internal processes nations use to develop strength and wealth. While many more internal factors affect how nation-states create wealth and strength, this paper highlights what the author assesses are the dominant pathways and the ones most pertinent with which to align the organizing, training, and equipping of military forces. This paper also limits its discussion of foreign trade and diplomacy, which though important, are less dominant features in the strategic terrain covered.

A major assumption of this paper is that the nation-state is the primary agent for consideration. The limitation of focusing on US examples necessitates this assumption, although further research could remove the necessity. Applying the theoretical framework to Maoist revolutionary China or Ho Chi Minh's North Vietnam may prove just as appropriate.

Additionally, the paper assumes that the nature of war is immutable. The character and conduct of war may change, but as Clausewitz noted, "was is an extension of politics with other means."[13] Through all of the revolutions and the various forms of states and groups of people, this nature of war remains the same. The revolutions may affect the production of national wealth, as suggested by the Tofflers, or the character and conduct of war, as suggested by Colin Gray, but not its nature.[14]

The paper also assumes that revolutionary periods, adaptations, and events are useful ways to measure and bound human change. Chapter II argues the case by presenting and analyzing three socio-technological revolutionary theories. However,

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[12] Alvin Toffler and Heidi Toffler, *Revolutionary Wealth*, 1st ed (New York: Knopf, 2006).
[13] Clausewitz, *On War*, 87.
[14] Colin S. Gray, *Strategy for Chaos: Revolutions in Military Affairs and the Evidence of History* (London: Routledge, 2004), 6. Also, for a thorough discussion of the immutable nature of war in the face of revolutionary change, see Lonsdale, David J. *The Nature of War in the Information Age: Clausewitzian Future*. Psychology Press, 2004.

underlying this analysis is the assumption that it is logical and beneficial to categorize change in this manner. Even where the process is slow and evolutionary in nature, the end result is a significant change in the human condition.

Chapter 2

Spectrum of Revolutions

Ever-newer waters flow on those who step into the same rivers.

—Heraclitus

The ancient Greek philosopher, Heraclitus, wisely observed that change is the natural order. Heraclitus' millennia-old concept of ever-present change, sometimes quoted as "the only constant is change" rings true even today. One sees change everywhere: in the commercial sector, government, or military. Change is the reason Apple rebounded from a nearly defunct business to number five on Fortune's top 500 corporations.[1] Change is the reason the United States' economy went from practically non-existent in 1700, to rivaling all but the major powers of Europe by 1820, to the world's largest economy by 1900, to world dominating in the 1990s, only to see China rapidly getting closer to surpassing it at present.[2] Change, for the military, is more than simply a constant. It is a matter of life and death.

Change and Revolutions

Militaries and their supporting governments must perceive both that change is occurring and the character of that change. Not being present for change can result in military or societal devastation. The natives of both Africa and the Americas experienced this lesson at the hands of colonial Europe. Unable to adapt to or unaware of the changes occurring in their midst, such as the machine gun, accurate rapid-fire artillery, and the

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[1] Fortune, "Fortune 500 2014," January 2015, http://fortune.com/fortune500/.
[2] The OECD offers searchable data sets of historic economic performance. For a decent summary view of major economies at key times over the last two millennia, see OECD, "World GDP, 20 Countries and Regional Totals, 0-1998 A.D.," *The World Economy*, accessed March 17, 2015, http://www.theworldeconomy.org/MaddisonTables/MaddisontableB-18.pdf; OECD, "OECD.StatExtracts," *OECD*, accessed March 17, 2015, http://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE1.

ability to rapidly shift forces across the battle front, led the militaries of Western Europe to the extended trench warfare of World War I. Perceiving change, but misunderstanding its character and implications is equally pernicious, as the French found out in the six weeks it took German forces to circumvent the Maginot Line at the outset of World War II. Recognizing, characterizing, and predicting the shifting sands of warfare can mean the difference between life and death, success and failure. The responsibility to do so rests with the strategist.

In *Strategy for Chaos: Revolutions in Military Affairs and the Evidence of History,* Colin Gray juxtaposes strategy and a social science interpretation of chaos theory to show that while difficult, complex, and non-linear, strategy is possible.[3] The role of strategy and of the strategist is to peer through the chaotic, complex, and non-linearity of war and strategy to discern the characteristic of change. Gray notes, "The strategist has to predict how well his military power will perform in action against a live, distinctive, and reacting foe; that is the challenge of predicting military effectiveness. More difficult still is the need for the strategist to predict how much, and what kinds of, military effectiveness will be required to yield the strategic effectiveness that matches political goals."[4] Given the importance and difficulty of prediction, any concept, hypothesis, or theory that can aid the strategist in this endeavor is of great value. Gray correctly establishes the RMA as such an aid.

Gray acknowledges the limitations of the RMA concept in providing a concrete path through the chaotic landscape of strategy and warfare. Although limited in capability, Gray asserts "the RMA hypothesis, for all its fragilities, has an intriguing potential to provide, slingshot-like, 'gravity-assist' acceleration to the spacecraft of the theory of strategy … RMA theory can help us understand how strategy works."[5] Before one understands how RMA theory illuminates strategy, however, one must understand what the RMA theory entails.

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[3] Colin S. Gray, *Strategy for Chaos: Revolutions in Military Affairs and the Evidence of History* (London: Routledge, 2004), 109.
[4] Gray, *Strategy for Chaos*, 98.
[5] Gray, *Strategy for Chaos*, 91.

Definitions of what constitutes an RMA and for representative candidate events abound. Colin Gray' *Strategy for Chaos* and Keith Shimko's *The Iraq Wars and America's Military Revolution* traverse the RMA landscape, providing the perspectives of leading theorists on what constitutes revolutions.[6] The common categorizations of revolutions include variations of scope, magnitude, and rate of change.[7] The theorists accept that rates of change may vary with different definitions of revolution, but claim varying magnitudes and scopes of change to identify their versions of revolution.

The other contentious point is the primacy of technological change. Some, such as Richard Hundley, contend a "paradigm shift in the nature and conduct of military operations" through the incorporation of technology and the associated systems, operational concepts, and organization suffice for an RMA.[8] On the other end of the spectrum, the Tofflers claim that real revolutions are much broader, changing institutions to such a degree that they "break down and reorganize what social psychologists call the role structure of society."[9] One could get caught up in this debate in a vain effort to offer one more version of an RMA, but doing so misses the value of the varied discourse on the subject, and as Gray observed, its application to strategy. [10]

Defending or debating a single version of revolution risks missing the opportunity presented to the strategist by synthesizing revolution's multiple forms to generate a broader conception of historical, present, and future change. Shimko's RMA criteria of magnitude, scope, and duration can segregate the various revolution theories. At one end of the spectrum is the traditional RMA and military-technical revolution, which are limited in scope, magnitude, and duration, although may in aggregate constitute or necessitate broader change. Knox and Murray's military revolutions accommodate such

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[6] Keith L. Shimko, *The Iraq Wars and America's Military Revolution* (New York, NY: Cambridge University Press, 2010).
[7] Shimko, *The Iraq Wars and America's Military Revolution*, 4–5.
[8] Richard O. Hundley, *Past Revolutions, Future Transformations: What Can the History of Revolutions in Military Affairs Tell Us about Transforming the U.S. Military?* (Santa Monica, CA: Rand, 1999), iii.
[9] Alvin Toffler and Heidi Toffler, *Revolutionary Wealth*, 1st ed (New York: Knopf, 2006), 7.
[10] Gray, *Strategy for Chaos*, 31.

change by significantly altering the ways in which military forces organize, train, and equip. The Tofflers' revolutionary wave theory is the most far-reaching of the theories, indicating how societies and technology shape each other through national wealth production. The strategist must understand each version of revolution, however, as each crucially impacts strategy and military effectiveness.

Revolutions in Military Affairs and Military-Technical Revolutions

The revolution in military affairs (RMA) and its technologically focused subsidiary, the military-technical revolution (MTR), generally involve the quickest rate of change, the most-narrow focus, and least pervasiveness of the three categories of revolution. This is especially true of the MTR, although the RMA and the military revolution of the next section overlap areas depending upon one's definitions. A brief history of the MTR and its development into the RMA sheds light on this overlap.

The Department of Defense's (DOD) Office of Net Assessment (ONA) made famous the MTR and RMA concepts as American interpretations of a Soviet assessment of change.[11] In the 1970s, the Soviet General Staff began writing about an RMA associated with the United States' advancing technology, including precision-guided munitions (PGM), wide-area sensors, and computerized command and control systems. The potential for new operational concepts to provide the United States a significant combat edge most concerned the Soviets.

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[11] Much of this summary derives from the authoritative historical descriptions by three former members of ONA, Andrew F. Krepinevich, "The Military-Technical Revolution: A Preliminary Assessment" (Center for Strategic and Budgetary Assessments, October 2, 2002), 4–7, http://www.csbaonline.org/4Publications/PubLibrary/R.20021002.MTR/R.20021002.MTR.pdf., Barry Watts, "The Maturing Revolution in Military Affairs" (Center for Strategic and Budgetary Assessments, 2011), 1–5, http://www.csbaonline.org/wp-content/uploads/2011/06/2011.06.02-Maturing-Revolution-In-Military-Affairs1.pdf., and Eliot A. Cohen, "A Revolution in Warfare," *Foreign Affairs*, April 1996, http://www.foreignaffairs.com/articles/51841/eliot-a-cohen/a-revolution-in-warfare. Krepinevich's 2002 work is a republication of ONA's 1992 report he authored that began the RMA fervor within DoD.

Soviet Marshal Nikolai Ogarkov, chief of the Soviet General Staff, in 1984 wrote about the impending US reconnaissance-strike-complex (RSC, or RUK from the Russian Рекогносцировочно-ударный комплекс).[12] The Soviets concluded the RSC was the operational application of the previously assessed advanced technologies and represented the maturation of the MTR they so feared. Ogarkov's 1984 writings found their way into the hands of ONA, led by Mr. Andrew Marshall, who, by 1987, concluded the Soviets were correct. Marshall's team further sought to characterize the MTR by understanding the magnitude and form of the changes the MTR indicated, as well as identify ways to shape its trajectory to benefit the United States.[13]

The ONA team, led by Krepinevich identified four elements of the MTR: technological change, military systems evolution, operational innovation, and organizational adaptation.[14] For the RSC, technological change included the invention of the transistor and the resultant creation of cruise missiles and other PGM. The operational innovations of dynamic and time-sensitive targeting realized the RSC, while the adoption of the Air Operations Center (AOC) as a command and control organization made directing those innovations possibly. Marshall's team elected to change MTR to RMA to emphasize the broader scope of the elements beyond just technical change. Krepinevich's publication of his 1992 ONA report ignited the RMA debate within DOD.

The debate centered around either affirmatively or negatively answering the question: are we in the midst of an RMA? The authors seeking to answer the question also personally nuanced the categorization and definition of RMA through their writings. In 1994, Krepinevich described an RMA as "what occurs 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

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[12] Watts, "The Maturing Revolution in Military Affairs," 2.
[13] Krepinevich, "The Military-Technical Revolution: A Preliminary Assessment," iii–iv. Of note, Krepinevich self-admittedly uses the phrase "military revolution" in his later publications in place of RMA to better align with "scholarly literature."
[14] Krepinevich provides a list of the elements of the MTR on page 3 of Krepinevich, "The Military-Technical Revolution: A Preliminary Assessment," 11–38. On pages 11-38, Krepinevich describes and further sub-categorizes each element. The example in the rest of this paragraph derived from page 8 of the same text.

character and conduct of conflict … by producing a dramatic increase—often an order of magnitude or greater—in the combat potential and military effectiveness of armed forces."[15] Barry Watts highlights "it is not the speed with which changes in war's conduct occur but their magnitude as reflected in the emergence of new operational concepts and organizations, thereby generating new military competencies or obsolescing earlier ones."[16]

Outside of former ONA members, RMA definitions vary more significantly. Richard Hundley, in a 1999 study for RAND states, "An RMA involves a paradigm shift in the nature and conduct of military operations, which either *renders obsolete or irrelevant* one or more *core competencies* of a dominant player, or creates one or more new core competencies, in some new dimension of warfare, or both."[17] Hundley's RMA emphasizes the operational innovation aspect of ONA's original MTR concept. However, he remains true to RMA's impact on the "nature and conduct of military operations."

Colin Gray offers the most basic RMA definition. Gray's RMA is "a radical change in the character or conduct of war."[18] Seemingly simplistic, Gray's definition is important because it highlights the defining characteristic common to the prominent perspectives of the RMA: the output of change. ONA's original RMA concept includes four elements, but the importance of those elements is the resultant significant increase in military effectiveness. Through this lens of the character and conduct of war, RMA theory identifies potential RMA-like events and characterizes the changes brought on warfare by them. This output-focused analysis of what militaries *do* has the potential to undervalue or entirely miss broader and deeper changes of what militaries *are*. This is unfortunate since Krepinevich's original study revealed, "that the most difficult part of the transition will come in the area of organizational innovation. Large-scale organizations—especially military organizations (including perhaps their requirements

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[15] Andrew F. Krepinevich, "Cavalry to Computer: The Pattern of Military Revolutions," *The National Interest*, no. 37 (October 1, 1994): 30.
[16] Watts, "The Maturing Revolution in Military Affairs," 3.
[17] Hundley, *Past Revolutions, Future Transformations*, 9. Emphasis from original.
[18] Gray, *Strategy for Chaos*, 4.

and acquisition components, and industrial base as well), with their high regard for tradition and the limited availability of feedback—are often highly resistant to change."[19] Luckily, Knox and Murray's military revolutions illuminate changes not just in what militaries *do* in war, but more importantly, what they *are* and how they change during peace and war.

Military Revolutions

Military revolutions are broader and more profound changes in how entire militaries prepare for and conduct war. An RMA occurs when technological change leads to new military systems requiring organizational adaption to support innovative operational concepts that result in a radical change to the character and conduct of war. While this definition includes an element of organizational change, the RMA focuses on the effect on the output of that change. Military revolutions focus on the military forces responsible for creating the output and the connection between changes in those military forces and broader societal and political shifts.

MacGregor Knox and Williamson Murray astutely separate the military revolution (MR) from RMA. They claim an MR results "from massive social and political changes that have restructured societies and states, and fundamentally altered the manner in which military organizations prepared for and conducted war."[20] Knox and Murray categorically separate the MR and RMA by describing RMA as "periods of innovation in which armed forces develop novel concepts involving changes in doctrine, tactics, procedures, and technology."[21] The MR, driven by broader societal change, alters the military organization that goes through one or multiple RMA to adjust how it conducts war.

The nature of the societal shifts serving as the impetus for the military revolution makes the MR uncontrollable, Knox and Murray contend. During these periods of great

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[19] Krepinevich, "The Military-Technical Revolution: A Preliminary Assessment," 37.
[20] MacGregor Knox and Williamson Murray, eds., *The Dynamics of Military Revolution, 1300-2050* (Cambridge, UK ; New York: Cambridge University Press, 2001), 176.
[21] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 179.

social change, military organizations "find themselves at best engaged in a desperate struggle to adapt to drastic changes in the very patterns of culture and society."[22] This desperate struggle to adapt makes MR "uncontrollable, unpredictable, and unforeseeable."[23] Based upon this analysis, military forces and their organization are begrudging riders on a wave of societal change.

The military, while powerless to guide the adaptations that occur, will change as part of the MR that "fundamentally changes the framework of war."[24] Knox and Murray never explicitly detail what is the "framework of war" or how it changes, although their five examples of modern MR hint at common features.[25] The examples suggest that the framework of war encompasses how society raises, organizes, trains, and equips its military forces. The rise of the modern nation-state in the seventeenth century transitioned armies from temporary or contracted fighting forces to permanent and professional forces that uphold the nation-state. The French Revolution expanded the army to the entire populace in either combat arms or material support, while the Industrial Revolution expanded the ability to equip and move a national force as well as the destruction wrought by the force. The fourth revolution, World War I, was an operationally realized culmination of the three prior revolutions.[26]

Each of Knox and Murray's first four MR entailed a significant change to the organization, training, and equipping of military forces. These adaptations corresponded to great shifts in the size and scope of warfare, often conferring temporary advantage on those who adopted the associated RMA most quickly. The fifth MR, nuclear weapons and ballistic missile delivery systems, is an outlier, appearing more technologically rather than organizationally focused. Likely due to the inclusion of this MR as a response to

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[22] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 176.
[23] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 7.
[24] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 6.
[25] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 13. Knox and Murray provide a table on page 13 categorizing their five MR and associated RMA.
[26] Knox and Murray's description of the RMA associated with their fourth MR, World War I, implies the revolution extended through World War II. The RMA include Blitzkreig operations, strategic-bombing, carrier warfare, radar, etc. While some of these were present during World War I, most reached maturation in World War II.

criticism of earlier work in this field, the RMA associated with the fifth revolution are much broader than either nuclear weapons or ballistic missiles, implying that this MR is either misnamed or its implications are unclear as of yet.[27]

Knox and Murray's description of MR and its separation from RMA has some faults, but is an important concept and distinction that highlights the instrument of change instead of the outcome of change. It simply is not necessary to recast military organizations every time a new technology or operational concept is incorporated. There are times, however, when the cumulative requirements of multiple RMAs necessitate broader military forces adaptation. More importantly, Knox and Murray note that significant shifts in the society or culture that create and supply the military instrument may drive an MR.[28] While the MR does not recast society, it may be indicative of a society that is in the process of recasting itself. When this occurs, the wave of the change ridden by the MR is likely part of the Tofflers' revolutionary wave theory.

Revolutionary Wave Theory

The Tofflers' revolutionary wave theory identifies sweeping changes in civilizations and, as an aside, their influences on militaries and war. The theory therefore focuses on the input into the framework of war. The RMA indicates changes in output, while the MR identifies changes in the instrument; wave theory addresses the input to the framework: civilization and its realization as nation-states.

The Tofflers describe civilization as including "such varied matters as technology, family life, religion, culture, politics, business, hierarchy, leadership, values, sexual morality, and epistemology."[29] Each nation uniquely exhibits traits within each of those varied matters, but categorizes into one of the three broad waves of civilizations the Tofflers identify: agricultural, industrial, and knowledge-based. The source of national

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[27] Colin Gray offers an effective summary and criticism of Knox and Murray's work, highlighting the addition of the fifth MR in: Gray, *Strategy for Chaos*, 39–46.
[28] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050,* 7.
[29] Alvin Toffler and Heidi Toffler, *War and Anti-War* (New York: Warner Books, 1995), 23.

wealth production is the primary distinction between the three waves as this determines the society's power holders, values, structure, and capabilities.[30]

Various nations exist in each of the three stages of civilizations and multiple stages of civilizations may exist within a single nation. Unfortunately, competing interests, priorities, values, and needs among disparate civilizations result in conflict. The American Civil War provides an example when the second-wave industrial North fought against and defeated the first-wave agricultural-based South.[31] Current environmental conflicts, though less violent, persist among third-wave nations attempting to transition to cleaner fuels and growing second-wave nations striving to mature and grow their wealth. The process of transitioning between civilizations not only generates conflict, it also revolutionizes the militaries that fight those conflicts.

Only revolutions capable of re-shaping a society into a new civilization bring about revolutionary military change, according to the Tofflers. They analogize warfare to a game, claiming that true revolutions "change the game itself, including its rules, its equipment, the size and organization of the 'teams,' their training, doctrine, tactics, and just about everything else … Even more important, it changes the relationship of the game to society itself."[32] Understanding the societal shifts and the impact on the military and its relationship with society is vital since "a military revolution, in the fullest sense, occurs only when a new civilization arises to challenge the old, when an *entire* society transforms itself, forcing its armed services to change at every level simultaneously—from technology and culture to organization, strategy, tactics, training, doctrine, and logistics."[33]

Throughout *War and Anti-War*, the Tofflers effectively connect societal changes with United States military adaptations in the knowledge-based third wave of civilization. They detail how Paul Strassmann, a former Xerox strategic planner and information officer, brought his society-grown information technology knowledge and theory into

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[30] Toffler and Toffler, *Revolutionary Wealth*, xiv.
[31] Toffler and Toffler, *War and Anti-War*, 21.
[32] Toffler and Toffler, *War and Anti-War*, 32.
[33] Toffler and Toffler, *War and Anti-War*, 34., emphasis added.

DOD as the Pentagon's Director of Information.[34] A nation's education system also aids military transformation as the "work force and war-force change in tandem. Mindless warriors are to Third [Information] Wave war what unskilled manual laborers are to the Third Wave economy—an endangered species."[35] The Tofflers' lock-step transformation of society and military forces is insightful and over-reaching simultaneously.

The proposition that military revolutions occur in the "fullest sense" only when societies experience civilization transformations may be correct, but is less useful in its grandness. The interaction of Greek society between 750 and 650 BCE and its military's adoption of *hoplites* occurred in the heart of First Wave civilization, but provides good grist for studying military-society interactions.[36] The unique geopolitics and economics of Italian city-states that promulgated the use of *condottieri* to serve as hired armies stood in marked contrast with the feudal systems that preceded and the standing armies of nation-states that followed, but is not considered a sufficient military revolution by the Tofflers.[37] The wave theory, while informative, should not restrict considerations of less-full military revolutions.

The most informative and important aspect of the Tofflers' theory of revolution is the linkage between society, its civilization characterization and sources of wealth, and the military forces it supports. The society provides the funding, the people, and processes that create, support, and equip its military. The society's wealth determines the level of funding it is willing and capable of providing. The people educated by the society become members of the military, with all of the biases, frames of reference, and habits brought with them from the parent society. Since most militaries do not equip themselves, the society's processes of wealth generation are the sources of production

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[34] Toffler and Toffler, *War and Anti-War*, 163–164.
[35] Toffler and Toffler, *War and Anti-War*, 87.
[36] For a brief and informative account of this interaction, see Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age*, Cass Series--Strategy and History (London ; Portland, OR: Frank Cass, 2002), 19–23.
[37] Jurgen Brauer and Hubert P. Van Tuyll, *Castles, Battles, & Bombs: How Economics Explains Military History* (Chicago: University of Chicago Press, 2008), 80–118. Brauer and Van Tuyll present an argument for military entity change based upon the shifting economic and political aspects of the supporting society.

that supply the military with its means for conducting warfare. Society's changes, whether part of revolutionary waves or smaller perturbations, impact the form and capability of the military it supports.

Conclusion

Change is constant. Adaptation, innovation, and sometimes-uncontrollable shifts occur in the outputs, instruments, and suppliers of war. RMA theory informs on change in the output, the character and conduct of war, generated by the instrument of war. Knox and Murray's military revolution theory highlights the broader change in military organization, the instrument of war, generated by cumulative RMA events or socio-cultural changes. Alvin and Heidi Toffler's revolutionary wave theory illuminates the effect generated by changes in the supplier, the nation's method of producing wealth, on the instrument and conduct of war. Juxtaposing these three revolution theories generates a three-tiered revolution theory connecting societal, military, and character of war in a spectrum of revolutionary change.

The spectrum of revolution developed provides more than just a lens for viewing change. Colin Gray says, "It is much more important to understand strategy, what it is and how it works, than it is to develop RMA theory."[38] Synthesizing RMA theory provides little guidance on predicting future change or recommending coping or adaptive actions for such change. For those purposes, one must turn to strategic theory.

[38] Gray, *Strategy for Chaos*, 91.

Chapter 3

Theory of Strategic Harmonization

There is but a single theory of strategy; its function is to educate those whose profession it is to hold open a bridge between politics and action.

—Colin Gray
The Strategy Bridge

The spectrum of revolution theory spans dramatic shifts in national character, military forces, and the character and conduct of war, in turn offering a link to strategy. The spectrum's importance lies in the relationships it illuminates among the means, ways, ends, and risks of translating national productivity and culture through military forces into strategic effects within the constantly shifting terrain of the character and conduct of war. When the elements of means, ways, and ends are in-tune, the translation of strength through force into effect attains a strategic harmony allowing the nation's power to resonate while minimizing risk. When out of tune, strategic discord ensues leading to ineffectiveness and increased risk of failure.

Across the spectrum of revolution, the purpose of strategy is to harmonize national character, military forces, and the character of war. Military forces are the bridge used to communicate national character into strategic effect in the conduct of war. Clausewitz identified violence, chance, and reason as the paradoxical trinity of war, with theory being "like an object suspended by three magnets."[1] The national character, similar to Clausewitz's violence, is the generally uncontrollable trajectory of a national polity. The character of war is replete with chance, being the shapeable but unbridled change. Through reason, military forces can be rationally organized, trained, and equipped to translate the violence of national character into the chance of the character of war. Strategic harmony occurs when reason creates military forces that coincide with,

[1] Carl von Clausewitz, *On War*, ed. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1984), 89.

magnify, and translate national character into strategic effect appropriate for the ever-changing character of war.

Strategy

Strategy is many things to many people. From its humble beginnings as the Greek *strategos* and *strategia*, meaning general and generalship respectively, the modern concept of strategy originated in France in the late eighteenth century and has spread to other sectors of government, business, and even into sports.[2] The proliferation of the word strategy, however, does not ensure widespread understanding of what strategy is or how to define it. The ubiquitous use of the term strategy is a contemporary development; the challenge of defining strategy is not.[3]

Finding a definition of strategy to inform the spectrum of revolution is even more difficult because many military strategists confine strategy to wartime application. The father of contemporary Western thought on war and strategy, Carl von Clausewitz, is a source of strategy's narrow focus. Clausewitz wrote that strategy is "the use of engagements for the object of war."[4] He specifically excluded creating, training, and maintaining the fighting forces from his discussion of strategy (these he placed into the common contemporary category of grand tactics) and limited his analysis of the art of war to the utilization of those forces, what he describes as the "conduct of war."[5]

For Clausewitz, living in the shadow of the impact of France's *levée en masse* across continental Europe, the organization, training, and equipping of military forces were of secondary importance: "The knowledge and skills involved in the preparations will be concerned with the creation, training, and maintenance of the fighting forces …

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[2] Colin S. Gray, *The Strategy Bridge: Theory for Practice* (Oxford ; New York, NY: Oxford University Press, 2010), 4.
[3] J. Boone Batholomees provides an exceptional summary of different definitions of strategy and perspectives on its application from leading historical military strategists in J. Boone Bartholomees, Jr., ed., *U.S. Army War College Guide to National Security Policy and Strategy*, 2nd ed. (U.S. Army war College, 2006), 79–106, http://www.au.af.mil/au/awc/awcgate/ssi/policy_strategy.pdf.
[4] Clausewitz, *On War*, 128.
[5] Clausewitz, *On War*, 127–129.

The theory of war proper, on the other hand, is concerned with the use of these means, once they have been developed, for the purposes of the war. All that is required of the first group is the end product, as understanding of their main characteristics."[6] Although Clausewitz appears disinterested in the processes that create the end product of military forces to be used in engagements for the objects of war, his five elements of strategy belie a broader appreciation.

Three of Clausewitz's five elements of strategy focus less on the engagement of military forces than on the composition of the forces themselves. The first element, moral, "covers everything that is created by intellectual and psychological qualities." The general may be responsible for sustaining those moral qualities in war, but the foundation derives from the society and culture of the state that raised the army. The second element, physical, "consists of the size of the armed forces, their composition, armament, and so forth," all of which Clausewitz previously described as preparations outside of war proper. The third and fourth elements, mathematical and geography, describe how and over what terrain an army travels and fall well within Clausewitz's definition of strategy. The fifth element, statistical, covering support and maintenance, was specifically delimited out of strategy by Clausewitz previously.[7] Clausewitz's varying scope on strategy highlights the difficulty of defining the term, but also of trying to confine strategy to wartime.

A twentieth-century strategist, B. H. Liddell Hart, expanded strategy beyond its wartime military application. Liddell Hart introduced the concept of "grand strategy [to] coordinate and direct all the resources of a nation, or band of nations, towards the attainment of the political object of war—the goal defined by fundamental policy."[8] Grand strategy manages the economic and moral resources of the nation to support its fighting forces, regulates power distribution among the services and industry, and accounts for the other forms of national power including financial, diplomatic,

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[6] Clausewitz, *On War*, 132.
[7] Clausewitz, *On War*, 183.
[8] Basil Henry Liddell Hart, *Strategy*, 2nd rev. ed (New York, N.Y., U.S.A: Meridian, 1991), 322.

commercial, and ethical pressure.[9] Unlike strategy, which is "bounded by the war, grand strategy looks beyond the war to the subsequent peace."[10] Although Liddell Hart's grand strategy concept expands strategy beyond the military and looks past war to a better peace, the theory provides little insight into what should occur during the peace that follows war.

Two other military theorists, separated by millennia, but both discussing naval matters, provide insight on the impacts of peacetime behavior and national capabilities on strategy. Alfred Thayer Mahan, writing in the late nineteenth century, wrote: "Naval strategy has for its end to found, support, and increase, as well in peace as in war, the sea power of a country."[11] Mahan's elements of sea power included the state's physical elements of size, location, and environment, as well as human elements of population size, character, and type of governance.[12] Sea power as the goal of naval strategy lacks any mention of military forces or their use in engagements. For Mahan, true strategy was less how to use military force and more how to be a nation that fostered a strong military force.

Two millennia earlier, Thucydides documented one of the pivotal orations of the Peloponnesian War and highlighted the importance of national character to foster strong military forces. Pericles, whom Thucydides considered "the first man of his time at Athens," spoke to the Athenians during their deliberations on war with Sparta.[13] Pericles described the Spartans as farmers who were "incapable of often manning a fleet or often sending out an army: they cannot afford the absence from their homes, the expenditure from their own funds; and besides they have not command of the sea."[14] Additionally, Pericles claimed the Spartans' form of distributed government hobbled their ability to make decisions and wage war while their agrarian subsistence economy lacked the ability

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[9] Liddell Hart, *Strategy*, 322.
[10] Liddell Hart, *Strategy*, 322.
[11] Alfred Thayer Mahan, *The Influence of Sea Power Upon History, 1660 - 1783* (Cosimo Classics, 2007), 89.
[12] Mahan, *The Influence of Sea Power Upon History, 1660 - 1783*, 28–29.
[13] Thucydides, *The Landmark Thucydides: A Comprehensive Guide to the Peloponnesian War*, ed. Robert B. Strassler (New York: Simon & Schuster, 1998), 1.139.
[14] Thucydides, *The Landmark Thucydides*, 1.141.

to fund a long war.[15] Finally, Pericles extolled the virtues of Athens, its form of government, its wealth, and the nature of its sailing people to best the land-based farmers of Sparta.[16] Much like Mahan long after him, Pericles believed power rested in national character, not in immediate military might. Pericles also understood that the purpose of strategy is to translate national character into military forces that could dominate in war.

Colin Gray's framework in *The Strategy Bridge: Theory for Practice* further illuminates Pericles' notions of turning national character into effects in war. Gray, a contemporary leader of strategic theory, broadly defines strategy in a content-neutral form as "the direction and use made of means by chosen ways in order to achieve desired ends."[17] The strategist achieves those ends through strategic effect, "the cumulative and sequential impact of strategic performance upon the course of events."[18] Gray, a self-professed believer in the value Clausewitz's writings, claims the proper application of strategy generates strategic effect and "strategy has just one function; to provide a secure connection between the worlds of purpose … generally called policy, though politics may be more accurate, and its agents and instruments, including the military."[19] Gray uses the bridge metaphor to illustrate this connection between policy ends and military means.

Even though Gray confines his study of strategy to wartime military applications, the abstraction of strategy as a bridge is useful for a broader definition of strategy, "A bridge, even a metaphorical one, has to connect two distinctive entities or phenomena that otherwise would be divided … this is exactly the function of strategy … The concept of the strategy bridge is extraordinarily significant because it draws attention to the vital distinction between means and ends."[20] The other extraordinary significance of strategy as a bridge is the concept of strategy as a line of communication between two vast landscapes on either side of an abyss. This is the concept that informs and illuminates the spectrum of revolution.

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[15] Thucydides, *The Landmark Thucydides*, 1.141–1.142.
[16] Thucydides, *The Landmark Thucydides*, 1.143.
[17] Gray, *The Strategy Bridge*, 18.
[18] Gray, *The Strategy Bridge*, 18.
[19] Gray, *The Strategy Bridge*, 29.
[20] Gray, *The Strategy Bridge*, 7.

Pericles and Mahan both highlighted the importance of national character to develop the right military strengths for the potential war at hand. Clausewitz recognizes the importance of effectively organizing, training, and equipping the forces, and Liddell Hart connects the economic and military well being of the nation to these efforts. Gray clarifies how those military forces connect the desires of policy to strategic effects against specific opponents in times of war, but says little of strategy's purpose outside of war when policy, military forces, and the range of potential adversaries constantly shift. Gray, however, provides the insightful strategy bridge analogy and the broader definition of strategy as connecting means through ways to ends.

Synthesizing the theoretical concepts of strategy and the spectrum of revolution creates the framework for understanding strategic harmonization. In the grandest sense, national character forms the means, military forces form the ways, and strategic effect in the conduct of war are the ends. Harmonizing among these three elements reduces risk by ensuring that military forces make optimal use of national character to generate appropriate strategic effects within the character of war. Strategic harmonization is not achieved simply by making sure the military employs the national product effectively against a specific adversary.

The challenge is three-fold. First, the three elements, national character, military forces, and the character of war, each consist of their own unique description of ends, ways, and means. Second, the ends, ways, and means in one element interact with those of the other elements. As an example, the ways of national character, such as specialization and vertical integration, provide models for the ways military forces organize into functionally specialized services, arms, and directorates. The means of national character during the height of the industrial revolution, in the form of resources such as oil and metal required for production, became the ends in the conduct of World War II, in the form of strategic bombing, is another example. Third, during periods of peace one cannot be certain of who will be the next adversary, and therefore any attempt at harmonization must consider broad generalities on the character of war, as shaped by

the national characters of potential adversaries.[21] These challenges, however, also provide an opportunity to understand strategic harmonization.

National Character, Military Forces, and the Character of War

The definition of strategy as using means in certain ways to achieve desired ends also serves as a general description of any process of translation or transformation. The means or resources are transformed by the ways into something that is of use, the ends. The application of reason to this process by tailoring means and ways to achieve certain ends aligns with Gray's content-neutral definition of strategy.[22] The means-ways-ends translation is just as useful as a framework for systems that develop not out of strategic direction, but through the cumulative effects of a populace's actions and the vagaries of war. The risks of not harmonizing the translation effectively are just as real as not aligning the means and ways applied to desired ends. The concept of interrelated means, ways, ends, and risks therefore, provides a framework to analyze national character, military forces, and the character of war.

National character is the means in the broader strategic harmonization challenge. The description of a nation's character includes many elements, the categorization and analysis of which are beyond the scope of this work. Luckily, Alvin and Heidi Toffler offer the concept of the wealth system of a nation as equivalent to the overall character or civilization, "No wealth system exists in isolation. A wealth system is only one component, although a very powerful one, of a still larger macrosystem whose other components—social, cultural, religious, political—are in constant feedback with it and with one another. Together they form a civilization or way of life roughly compatible with the wealth system."[23]

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[21] Throughout the paper "national character" will refer to both state and non-state actors. In the case of non-state actors, the nation is the collection of people, and their resources, processes, and organizations for creating wealth.
[22] Gray, *The Strategy Bridge*, 18.
[23] Alvin Toffler and Heidi Toffler, *Revolutionary Wealth*, 1st ed (New York: Knopf, 2006), xiv.

The Tofflers define wealth as more than just money or material possession, but the satisfaction of both tangible and intangible desires.[24] Such desires include acquiring food for one's family or using Facebook to meet social needs. Although the intangible elements of wealth are important, the tangible production of wealth as an end is more easily accessible as an indicator of the ways and means to generate wealth. Therefore, the national character is described by the means and ways that generate the ends of tangible national wealth.

The means of generating national wealth consist of the people of the nation and the primary resources they use to create wealth.[25] The value of the people as means resides in what the people can physically accomplish and what they mentally know. The size of the population of a nation and its physical health provides an indicator of what it can do. On the other hand, the skills and knowledge the people develop through education and experience defines their knowledge value.[26]

The resources used to create wealth are the other means that define the national character. Traditional resources include steel, rare metals, oil, wood, or arable land. More recently, information is flourishing as a resource within the means of national wealth production.[27] More important than the means, however, are the ways the nation uses those means to create and grow wealth.

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[24] Toffler and Toffler, *Revolutionary Wealth*, 14.

[25] Economists often use the land, labor, and capital model. This paper equates resources with land, the people with labor, and organization, use, and types of capital as ways. For more on the economic perspective in the Industrial Revolution, see Charles More, *Understanding the Industrial Revolution* (London: Routledge, 2000), 9–11, https://aufric.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=63920&site=ehost-live&scope=site&custid=airuniv.

[26] Mahan, *The Influence of Sea Power Upon History, 1660 - 1783*, 29–69., describes physical/geographical and population-based indicators of a nation's sea power potential. Translating Mahan's factors into this paper's analysis, physical and geographic features indicate resource potential, while the population factors of size, national character, and government indicate the population's value. Mahan's national character and aptitude equates to this paper's description of the knowledge and skills of the people.

[27] Nazli Choucri, *Cyberpolitics in International Relations* (Cambridge, Mass: MIT Press, 2012), 71–88., analyzes the importance of information (described by Choucri as knowledge) as a source of value in modern economies and the impacts on international

The ways of national character are the methods used to turn resources into national wealth. The ways include how wealth-generating organizations, primarily corporations in the United States, organize and utilize people to add value to the resources.[28] How the resources are transported, organized, and processed into finished products and how those products satisfy desires to create wealth are included as well.[29] Security from outside threats is one of the most important desires, and a nation's military forces hold primary responsibility for satisfying it.

The ends of military forces, whether in peacetime or war, are to make more secure the nation from which they were created. Military forces seek to achieve this end through generating strategic effects.[30] Gray notes these effects occur through the use of force in conflict, as well as the latent power of threatening military forces without resorting to the actual application of force. The effect of nuclear deterrence during the Cold War provides a recent example, while Sun Tzu's classic averment that "to subdue the enemy without fighting is the acme of skill" speaks to the same concept.[31] Whether in peace or war, military forces must have ways to apply their means to create strategic effects that will make their nation more secure.

The means of the military forces are the people inherited from the nation's population, the material produced and supplied by the nation, and the resources both physical and informational the military generates on its own. The value of people in the military parallels their value in the national character: what they can do and what they

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relations. See Viktor Mayer-Schönberger, *Big Data: A Revolution That Will Transform How We Live, Work, and Think*, First Mariner Books edition (Boston: Mariner Books, Houghton Mifflin Harcourt, 2014), 98–122., chapter six, titled "Value," provides examples of how and why information (authors use data) creates value. Toffler and Toffler, *Revolutionary Wealth*, 100–101., describes how information (authors use knowledge) differs from traditional physical resources.

[28] Toffler and Toffler, *Revolutionary Wealth*, 6–10.

[29] Max Boot, *War Made New: Technology, Warfare, and the Course of History, 1500 to Today* (New York: Gotham Books, 2006), 207., highlights Henry Ford's contribution to United State's wealth was not the products he made, but how he made them.

[30] Gray, *The Strategy Bridge*, 18.

[31] Sun Tzu, *The Illustrated Art of War*, trans. Samuel B. Griffith (New York: Oxford University Press, 2005), 115.

know. One of the key differences, however, is that by the time individuals enter the military for indoctrination into military culture, they have been indoctrinated into the national character already.

Although for years the military has actively adapted its soldiers, sailors, and recently airmen to military culture, the national character of the people determine the ease of the indoctrination while the character of war determines its usefulness. The larger the difference between skills and knowledge required by the military and those developed by the nation, the more challenging and costly is the training of the forces.[32] More importantly, strategic discord occurs when the military's processes of organizing the people and utilizing their skills and knowledge counteracts the nation's methods of better wealth generation. The results are a more costly and less flexible military incapable of maximizing strategic effect and an increasing risk of strategic failure. A similar discord develops between the military forces and the character of war when the effect generated by the military forces and that demanded by the character of war do not align. The military can still generate effects, but they are unlikely to be strategic, or at least not positively so. Similar discord can develop in the means and ways of resources.

The nation supplies the majority of resources military forces use. The nation creates the wealth necessary to fund the military and produces or purchases the physical means the military forces employ. The national character determines the amount of wealth, but also how that wealth is generated. The materials, processes, and products the nation employs to create wealth result in an economy of scale for similar products.[33] Much like with human capital, the similarity of process and type of physical capital

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[32] William Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power--Economic and Military* (Tuscaloosa, AL: University of Alabama Press, 2009), 6–7., describes the importance of "air-going people" within a nation to build a strong air force, similar to Mahan's discussion of needing sea-faring people to be readily available for military duties in a sea power nation Mahan, *The Influence of Sea Power Upon History, 1660 - 1783*, 45.

[33] Colin S. Gray, *Recognizing and Understanding Revolutionary Change in Warfare: The Sovereignty of Context* (Carlisle Barracks, PA: Strategic Studies Institute, U.S. Army War College, 2006), 19–20. Gray argues that socio-cultural national trends engender change in the nation's armed forces.

required by military forces with those the nation produces influences cost and flexibility: the less similar the physical capital, the fewer economies of scale available to keep costs of producing military goods low. Additionally, significant differences in physical resources limit the transferability of commercial innovations to the military, increasing military research and development costs and reducing the avenues for adaptability in peace or war. Limited adaptability creates strategic discord in any conflict, but becomes especially debilitating as the character and conduct of war exhibits accelerating cycles of change.

One of the most significant contributors to the acceleration of change, and a bridging concept between the military forces and the character of war, is the increasing production of information by military forces.[34] Unlike human and physical capital, the military is capable of independently producing vast quantities of information. Like human physical and capital, however, the similarities and differences between national and military methods of procuring, organizing, processing, and making useful information create harmony or discord. Equally important, the efficacy of creating and utilizing information depends upon the harmonization of the character of the military forces and the character and conduct of war.

The nature of war, its political purpose, is immutable as proposed by Clausewitz when he wrote, "war is simply a continuation of political intercourse, with the addition of other means."[35] The purpose of the political intercourse is to attain a better peace and one must generate strategic effect appropriate to the character and conduct of war to achieve the political purpose.[36] The character and conduct of war are more challenging to categorize and describe than the national or military characters.

Clausewitz theorizes on the character of absolute war first, and then tempers his theory with wars of more limited aims. As his starting point, the claims "the aim of war

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[34] Isaac Porche III et al., "Data Flood: Helping the Navy Address the Rising Tide of Sensor Information" (RAND Corporation, 2014), 3., in a RAND study of the challenges of Big Data for the Navy, noted that in 2011 the Navy produced 200 terabytes every other day. This is equivalent to the amount of information stored in the Library of Congress.
[35] Clausewitz, *On War*, 605.
[36] Gray, *The Strategy Bridge*, 33.

should be what its very concept implies—to defeat the enemy."[37] Clausewitz argues "one must keep the dominant characteristics of both belligerents in mind. Out of these characteristics a certain center of gravity develops, the hub of all power and movement … that is the point against which all our energies should be directed."[38] The character of the nations and militaries shape the character of war by defining the centers of gravity, their vulnerabilities, and the means to affect them. The trend of war to approach the theoretical absolute war or remain limited also determines its character.

Clausewitz makes a clear distinction between the character of war in theoretical absolute war and the more historically prevalent limited wars. In absolute war, where the aim of war is to disarm the enemy, he defines the spectrum of objectives as "the *armed forces*, the *country*, and the *enemy's will*."[39] One must destroy the armed forces so they cannot fight, occupy the country to prevent the raising of additional armed forces, and break the will so any remaining forces do not desire to fight. The centers of gravity one must affect to achieve any or all of these objectives, the destruction of the army being the primary, shape the character of absolute war. They also shape the character of limited war.

The political nature of war limits its scope and determines its character.[40] The spectrum of objectives remains the same, but the logic of limited wars dictates a lower threshold of desired accomplishment for any objective. Instead, one attacks the centers of gravity associated with some or all the objectives to increase the enemy's improbability of victory or expected costs of achieving victory to unacceptable levels.[41] Victory is achieved not by disarming the enemy from fighting, but by dissuading the enemy by demonstrating the improbability of success, expected costs that outweigh potential benefits, or through sheer exhaustion. Although focused on affecting the enemy's choice more than their ability to wage war, limited wars cover the same

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[37] Clausewitz, *On War*, 595.
[38] Clausewitz, *On War*, 595–596.
[39] Clausewitz, *On War*, 90. The framework for the next two paragraphs derives from Clausewitz's Book One, Chapter Two, "Purpose and Means in War."
[40] Clausewitz, *On War*, 603–604.
[41] Clausewitz, *On War*, 91.

spectrum of objectives as absolute war, tempering the degree of effort and scope of objectives sought, but not the categorization of the objectives themselves. The belligerents' policies' ambitions and vigor determine how limited or absolute the character of war is, but the nations and their military forces determine the character of the spectrum of objectives.[42] Clausewitz's timeless character of war framework illuminates the ends and means of the character of war.

The ends of the character of war are to generate strategic effects thereby eliminating the adversary's means, the ability to employ their means, the ability to generate more means, or the will to do so. The adversary's means equate to the means of the military forces and the ability to employ those forces equate to the ways and ends of military forces. On the other hand, the ability to generate additional means and the will to do so equate to the portions of the national character that supplies those means. The particulars of the adversary's national character and military forces define the ends of the character of war.

Paralleling this logic, the ends, ways, and means of military forces supply the means and ways available within the character of war. At the onset of war, the ends of military forces create the foundation for the means and ways of the character of war. Military forces traditionally fight in war the way they train and are structured in peace.[43] Wartime innovation creates new ways of fighting and requires adaptations to military organization, equipment, and training to adjust to an unexpected character of war. Innovation takes time and may not make available the ways or means necessitated by the character of war quickly enough.[44] The result is discord between military forces and the character of war. This logic argues that military forces should have at least some portion of its force organized, trained, and equipped to harmonize with a myriad of potentially

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[42] Clausewitz, *On War*, 606.
[43] Donald J. Mrozek, *Airpower and the Ground War in Vietnam.* (Maxwell AFB, AL: Air University Press, 1988), 180–185. Mrozek illustrates how peacetime doctrine, and the way one prepares to fight, can affect and limit the ways one fights in war as illustrated by the United States, and especially its Air Force in the Vietnam War.
[44] Stephen Peter Rosen, *Winning the next War: Innovation and the Modern Military* (Ithaca: Cornell University Press, 1991), 180–181.

likely or expected characters of war, with the ability to expand at a quick enough pace to supply the means and ways necessary to achieve the ends of war. The ability to expand and adapt in times of war is closely related to the harmonization of military forces with the national character.

Conclusion

Strategy, as a translation of means through ways to create strategic effects that achieve ends, creates a framework to analyze and address the challenge of harmonizing across the spectrum of revolutions. The nation's processes to turn resources into wealth directly affect the people and materials available for the military to use, as well as the cost and flexibility of the military's methods for using those resources. The effectiveness of the ends of military forces, and their ability to generate strategic effects, is linked to the means and methods available to potential adversaries within the character and conduct of war. Simultaneously, the means and methods available to one's military forces in specific wartime scenarios derive from the means and methods developed in peacetime. In a period of change across the revolutionary spectrum of national character, military forces, and the character of war, these interactions create a very real risk for discord and ineffectiveness, as well as great opportunities for those who successfully harmonize across the spectrum. The United States' performance during the Industrial Revolution, culminating in World War II, was a spectacular harmonization.

Chapter 4

Industrial Harmony

The first essential condition for an army to be able to stand the strain of battle is an adequate stocks of weapons, petrol and ammunition. In fact, the battle is fought and decided by the Quartermasters before the shooting begins. The bravest men can do nothing without guns, the guns nothing without plenty of ammunition, and neither guns nor ammunition are of much use in mobile warfare unless there are vehicles with sufficient petrol to haul them around.

—Field Marshal Erwin Rommel
The Rommel Papers

Writing after the crippling loss at El Alamein, Field Marshal Rommel captured the essence of the changes in the character of warfare wrought by two hundred years of Industrial Revolution culminating in the devastation of World War II and the advent of the nuclear weapon.[1] Exactly when the Industrial Revolution began is unclear. That the nations caught in its wave shifted the preponderance of effort for wealth creation and military destruction from feeding people to feeding the machines people used is undeniable. This is the essence of the Industrial Revolution: the creation, sustainment, and supply of machines to improve humankind's ability to do things farther, faster, and more effectively than ever before. Strategic harmonization occurs when the national character, military forces, and character of war all align with this mechanization of means, ways, and ends, reducing risk for those who harmonize most effectively and proving disastrous for those who cannot or will not.

From Fields to Factories: National Character in the Industrial Revolution

The Industrial Revolution transformed the national character's means, ways, and ends. The ends of national character transformed from the wealth generated by the land, crafts, and trading to wealth generated by the massive collection, transportation, and

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[1] Erwin Rommel, *The Rommel Papers*, ed. Basil Henry Liddell Hart, A Da Capo Paperback (New York: Da Capo Press, 1982), 328.

production of resources and goods by machines. The means shifted from uneducated farmers, wind, water, and wood to urban factory workers, coal, oil, and steel. The ways consolidated productivity into hierarchical bureaucracies overseeing the centralized and standardized mass production of goods within urban sprawls connected by vast transportation systems. Changes in wealth production as the ends of national character illuminate the shifts brought on by the Industrial Revolution.

Prior to the Industrial Revolution the ends of national character and wealth production were based on the value of land. Nations created wealth through trading limited surpluses of agricultural output, extracted raw materials, and the production of textiles by dispersed craftspeople.[2] Most of the agricultural production went to sustaining or increasing the population, with division of labor slowly increasing as people invented more effective methods of farming.[3] The materials extracted from the Earth, such as gold or silver, created wealth in their raw form or with limited manipulation by craftspeople.[4] Textiles and other finished goods also generated wealth, but were created by hand or aided by some mechanization fueled by water, wind, or animal power.[5]

The Industrial Revolution changed the ends of wealth creation from the productivity man could generate with the land to the value man could create with machines and the resources that fueled them. The shift from man and land to man and machine created exponential growth in population, productivity, and wealth for the nations that transitioned effectively, such as the United States.[6] Exponential growth of

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[2] For a brief synopsis of wealth production before the Industrial Revolution, see Alvin Toffler and Heidi Toffler, *Revolutionary Wealth*, 1st ed (New York: Knopf, 2006), 20. Also, Carroll W. Pursell, *The Machine in America a Social History of Technology* (Baltimore: Johns Hopkins Univ. Press, 1996), 9–33., describes some of the transitions experienced by early Americans at the beginning of the Industrial Revolution.
[3] Lynn White, *Medieval Technology and Social Change* (London: Oxford Univ. Press, 1980), 19–38.
[4] For discussion of production of Spanish steel, see William H. McNeill, *The Pursuit of Power: Technology, Armed Force, and Society since A.D. 1000* (Chicago: Univ. of Chicago Press, 1993), 113–116.
[5] Pursell, *The Machine in America a Social History of Technology*, 2.
[6] For the reinforcing growth of population and industry, see Charles More, *Understanding the Industrial Revolution* (London: Routledge, 2000), 118,

machine use created explosive increases in the requirement for and wealth derived from new sources of energy, such as coal, oil, and electricity. The need to consolidate resources to derive value from economies of scale imbued transportation organizations, such as railroad corporations and later car manufacturers, with great wealth.[7] New sources of wealth generation demanded new means and ways of translating those means into ends.

The means of national character are the wealth generating people and the resources. Before the Industrial Revolution, most people worked in in rural areas in agriculture. In the United States 80 percent of the working population participated in agricultural occupations in 1800.[8] By 1920, over half of the American population lived in urban environments, many working in industrial occupations.[9] Over the course of the nineteenth century, engineering developed as a profession and source of innovation by mixing science and craftsmanship knowledge.[10] The growth of engineers and profit derived from machine knowledge shaped the education of Americans and their professions into ones based more and more on science and technology instead of farming and craftsmanship.[11]

The Industrial Revolution also transformed the resources required to power the new science and technology. Previously, water, wind, wood, and animals were the resources man harnessed to generate wealth. As the British ran out of forests to burn, they turned to coal as a source of energy.[12] Increased extraction of coal in locations removed from sources of water transport necessitated better and cheaper forms of overland transportation. Coal burns hotter than wood making the refinement of iron more efficient, improving the quantities and qualities of iron necessary for improvements in

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https://aufric.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=63920&site=ehost-live&scope=site&custid=airuniv., and Pursell, *The Machine in America a Social History of Technology*, 147.

[7] Pursell, *The Machine in America a Social History of Technology*, 92, 176.

[8] Pursell, *The Machine in America a Social History of Technology*, 109.

[9] Pursell, *The Machine in America a Social History of Technology*, 131–132.

[10] Pursell, *The Machine in America a Social History of Technology*, 100.

[11] More, *Understanding the Industrial Revolution*, 164–165.

[12] More, *Understanding the Industrial Revolution*, 114–115.

mechanical devices like the steam engine.[13] Iron's importance grew exponentially after the mass adoption of the steam engine, accelerating the pace of the Industrial Revolution. Later, the steam engine gave way to the gasoline-powered reciprocating engine, with oil replacing coal as the most important resource in the Industrial Revolution.

The key traits of the industrial nation's means are the people's scientific rationalization and engineering and the destructive transformation of resources into more complex and capable machines. The nature of these means drive momentous shifts in the ways of wealth production, creating the most sweeping changes in national character.

The ways of the Industrial Revolution turned the means of wealth production into vertically organized, centrally controlled, and rationally designed elements of a societal machine. Standardization and the concept of replaceable parts began with the Swedish Army's drill and discipline of soldiers in the 1600s, turning soldiers into the standardized replaceable cogs of an efficient military machine.[14] Frederick Winslow Taylor's Scientific Management principles, developed at the end of the nineteenth and beginning of the twentieth centuries, applied a rational and systematic approach grounded in rules, laws, and principles to the standardization of the workforce and its processes.[15]

The growth of machine-produced goods in the Industrial Revolution led to the inevitable adoption of standardization in machine parts, first known as armory practice in the United States, and evolved into assembly line production by Henry Ford.[16] Assembly lines furthered the application of standardization and specialization to the workforce as people were expected to perform the same, simple, standardized, repetitive task throughout the workday. Standardization of what industrial workers made and how they made them created value by improving efficiency and flexibility of mechanistically deterministic processes. Industrial specialization, the process of people or things focusing on single or few tasks and functions, created value by allowing those people or things to become very proficient at the unique tasks they performed which improved the

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[13] Pursell, *The Machine in America a Social History of Technology*, 56.
[14] McNeill, *The Pursuit of Power*, 117.
[15] Pursell, *The Machine in America a Social History of Technology*, 210.
[16] Pursell, *The Machine in America a Social History of Technology*, 87–92.

efficacy of the broader system to which they belonged. Introduced in 1913 by Henry Ford, the assembly line "raised productivity from 50 to 1,000 percent with a relatively small additional monetary investment in machinery."[17]

The increased productivity of Ford's assembly line accelerated the centralization and urbanization of the Industrial Revolution. Cities rose up as focal points for the collection and mechanized transformation of resources into finished goods. The specialization of cities into residential, commercial, and industrial zones also created cauldrons of innovation and invention, drawing more workers from rural areas and accelerating change.[18] By 1920 over half of Americans lived in urban environments. Cities required vast "engineering infrastructure of streets, sewers, water supply, and electrical lines."[19] None was more important than the transportation facilities, especially those that brought in raw materials and took out finished goods through mechanical power. For most of the Industrial Revolution, the railroad was the most important form of transportation.

The railroad system in the United States and Europe was the circulatory system on which industrialization relied. The expanding rail system allowed people and material to flock to urban industrial hubs.[20] In the United States the railroad system expanded from 9,021 miles in 1850, to 30,626 in 1860, to 52,922 in 1870, to 166,703 in 1890, and 397,232 in 1950.[21] Carroll Pursell notes "the giant size and scale of operations of railroads by midcentury led them to become the first modern corporations, in which scores of the details of modern life were worked out to suit the needs of bureaucratic organization. Not the least of these was the adoption, in 1883, of standard time zones for the nation … it was an omen of new standardizations and uniformities to come."[22]

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[17] Pursell, *The Machine in America a Social History of Technology*, 92.
[18] More, *Understanding the Industrial Revolution*, 164–165.
[19] Pursell, *The Machine in America a Social History of Technology*, 131–132.
[20] More, *Understanding the Industrial Revolution*, 118.
[21] The Association of American Railroads, "Maps Showing the Progressive Development of US Railroads - 1830 to 1950," *Central Pacific Railroad Photographic History Museum*, accessed April 17, 2015, http://cprr.org/Museum/RR_Development.html.
[22] Pursell, *The Machine in America a Social History of Technology*, 82.

Railroads may have been the first, but were certainly not the only large corporations and bureaucracies created by industrialization. The parallel processes of production mechanization and the rise of administrative overhead grew during the Industrial Revolution.[23] From 1907 to 1948 the percentage of administrative employees in the British industrial sector grew from 8.6 percent to 20.0 percent of the total workforce. Industrial growth presaged bureaucratic growth. Growth was in "response to problems of maintaining and expanding firm positions under changing financial, commercial, and production conditions."[24] Problems included "raw material supply, cost control, tax accounting, labor recruiting, labor deployment, industrial relations, export sales, office operations, material control, expansion of planning departments, worker supervision, and controlling the organization structures of the management group."[25] Increasing managerial overhead was the solution to controlling the increasing complexities of integrating the resources and processes of industrialization.

The national character created by the Industrial Revolution was vastly different than the preceding agrarian one. The relationship between humans and the land, or water, determined the wealth and strength of a nation no longer. The interaction of people and machines to extract more material from the land, move the material farther and faster, and then be exponentially more productive with that material at its destination created industrial wealth. The increased systemic complexities accompanying industrialization necessitated human and machine specialization, standardization, centralization, and direction by expanding bureaucracies of hierarchical control. The changes wrought by industrialization changed the character of military forces, and anticipated the shifts in the character of war.

Military Mechanization in the Industrial Revolution

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[23] Seymour Melman, *Dynamic Factors in Industrial Productivity*, 1st ed. (New York: John Wiley & Sons Inc., 1956), v.
[24] Melman, *Dynamic Factors in Industrial Productivity*, 93.
[25] Melman, *Dynamic Factors in Industrial Productivity*, 93–94.

The character of military forces during the Industrial Revolution evolved in an upward spiraling dance of mechanization with the national character. Military forces led the national character in the use of replaceable parts by making the infantry soldiers interchangeable through drill and discipline, standardizing the parts of the weapons used by the infantry, and increasing the centralization of bureaucracies to control large forces. It was the nation, however, that embraced, refined, and built a culture of people and products out of these concepts, then exported them back to the military forces for harmonized use in industrial war. Ultimately, the industrialized national character provided the means and ways that led to the ends of military forces.

The means of military forces consist of the people and products supplied by the nation to prepare for, prevent, and fight in war. Both people and products were well suited to military forces at the height of the Industrial Revolution because of an historic convergence of the ways of organizing, training, and equipping military forces and the ways and ends of the national character. The training and organization of military forces actually anticipated similar developments in the national character.

The organization and training of military forces were the vanguards of specialization, standardization, and centralization as methods for the efficacious use of large groups of disparate means. Maurice of Nassau, the Prince of Orange, pioneered the concept of replaceable parts and standardization in his sixteenth century Dutch forces.[26] Maurice used drill and discipline to create uniformity within his infantry in which the "army became an articulated organism with a central nervous system that allowed sensitive and more or less intelligent response to unforeseen circumstances," setting the standard for most future successful militaries.[27] It would be another three centuries before the Industrial Revolution applied these same principles to machine parts.[28] Military forces also led the specialization of its work forces.

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[26] McNeill, *The Pursuit of Power*, 126–130.
[27] See McNeill, *The Pursuit of Power*, 130., and John Lynn in MacGregor Knox and Williamson Murray, eds., *The Dynamics of Military Revolution, 1300-2050* (Cambridge, UK ; New York: Cambridge University Press, 2001), 47–48.
[28] Pursell, *The Machine in America a Social History of Technology*, 87.

From the dawn of recorded history, military forces have specialized their personnel. The ancient Greeks segregated forces into specialized foot soldiers, archers, and cavalry.[29] Medieval forces included mounted knights, pike men, archers, and later crossbowmen. As the Industrial Revolution produced new and more plentiful machines to aid man's ability to do more, specialization increased greatly in military forces. Napoleonic armies included specializations of artillery, cavalry, and infantry. World War I saw the introduction of aircraft pilots, submariners, machine gun crews, grenadiers, and more. By World War II, most of the specializations from World War I were further sub-specialized with limited ability to cross between sub-specialties. As the national character demanded greater specialization to efficiently produce its myriad mechanical devices, so too the military increasingly specialized to use them. The organizational bureaucratic structure necessary to coordinate and control the vast disparate forces evolved in military forces as well.

The nationalistic furor sparked by the French Revolution led to the *levée en masse* and created the largest military force the world had ever seen. By 1794, the French army totaled 750,000 men in the field and would raise over two million more men between 1800 and 1814.[30] These vast forces demanded a rational organizational system and bureaucracy for effective control. The vast size of the French army necessitated splitting them into corps limited in size by movement and supply constraints. Multiple corps required an equally large centralized bureaucracy and staff to coordinate movements in time and space. This coordination allowed Napoleon to reinforce any corps engaged with the enemy with subsequent corps arriving along other avenues of approach within a day or two, flanking or encircling the opponent.

The coordinated movement of corps, often attributed to Napoleon's genius, needed a large bureaucracy to control effectively. Napoleon inherited, then refined and expanded the military bureaucracy, numbering 3,500 officers and 10,000 men by 1812.[31]

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[29] Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age*, Cass Series--Strategy and History (London ; Portland, OR: Frank Cass, 2002), 16–18.
[30] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 66–67.
[31] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 67.

The arrival of improved means of communication only magnified bureaucratic challenges previously faced by Napoleon.

The advent of the railroad and telegraph during the Industrial Revolution further increased and enabled bureaucratic growth. Railroad expansion drove bureaucratic growth by both requiring and facilitating larger peacetime standing armies that could be more quickly mobilized and deployed than ever before.[32] Wartime railroad use also required large staffs to coordinate the efficient flow of railcars to move supplies and forces, especially infantry, from the rear to the front lines and across the front, where able.[33] Coordination required an effective means to communicate the staff's commands to the farthest reaches of the railways.

Telegraphs offered a means to extend the range and speed of the bureaucracy's command and control function. General Helmuth Karl Bernhard von Moltke, a leading figure in western military thought, wrote about the significance of the telegraph in the Franco-Prussian War. "The ability to send reports quickly to even the most distant points and by circuitous routes offer the means to direct separated parts of the army according to a single will toward a common goal … All independently operating parts of the army must always take care quickly to establish and maintain connections with the telegraph networks in their rear so they can send reports and receive orders in a timely manner."[34] A central agency's ability to gather greater awareness on the distant battle frontier, then issue orders to the units on that frontier, accelerated the growth of bureaucratic staffs and the centralization of control. Such staffs were required to cope with the explosive growth of specialization by function and mechanical system, the need to supply those systems,

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[32] Helmuth Moltke, *Moltke on the Art of War: Selected Writings*, ed. Daniel J Hughes (Novato, CA: Presidio Press, 1995), 109–110.
[33] See Moltke, *Moltke on the Art of War*, 110–112. In 1870, Prussia had enough railcars to stretch 245 miles when placed end-to-end, but only four bridges across the Rhine and seven across the Elbe. Coordinating and rationalizing the movement of these railcars fell on the Prussian general staff in times of war. Also, on the Prussian general staff's perspective of the railroad, see Geoffrey Parker, ed., *The Cambridge History of Warfare* (Cambridge [u.a.]: Cambridge Univ. Press, 2005), 239.
[34] Moltke, *Moltke on the Art of War*, 113.

and the coordination necessary to integrate the equipment and resources of industrialized military forces.

Large bureaucracies aligned the organizing, equipping, and training of military forces with the necessary resources to conduct operations in industrialized war. The training and employment of military forces during the Industrial Revolution harmonized with the specialization and vertical integration of industry in the national character. While some forces, like the United States Marines integrated specializations on land, sea, and eventually air, most military forces trained and employed within their specialized function, with limited coordination or training with other specializations. Although German ground forces successfully integrated varied combat arms, creating the combined-arms warfare of *blitzkrieg*, most of the allies remained wedded to parochial separations of infantry, armor, cavalry, and artillery.[35]

Parochial separations widened into broad chasms of specialization between air and land forces. The German's vaunted "tank-stuka teams" were initially poorly coordinated due to a lack of integrated training and tactics, and improved only through the cauldron of war.[36] The United States fared even worse as the parochial arguments for an independent air force drove a wedge between air and land forces, as well as among the fighter and bomber force. Specialization delayed coordinated air-land tactics until mid-way through the war and, along with the misperception of bomber invincibility, hindered the development of a long-range fighter capable of escorting the strategic bomber force.[37]

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[35] For a comprehensive summary of the differences between German and allied land warfare developments and suggested reasons for the disparities, see Terry Pierce, *Warfighting and Disruptive Technologies: Disguising Innovation*, Reissue edition (London; New York: Routledge, 2005), 32–47.

[36] See Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 163., and Martin Van Creveld, Steven L Canby, and Kenneth S Brower, *Air Power and Maneuver Warfare* (Maxwell AFB : Air University Press, 1994), 37–38.

[37] For a discussion of the effects of the independent service rhetoric, the delay of fighter escort developments, and strategic bombing, see Tami Davis Biddle, *Rhetoric and Reality in Air Warfare: The Evolution of British and American Ideas about Strategic Bombing, 1914-1945* (Princeton, N.J.: Princeton University Press, 2002), 164–170. Also, regarding air-land coordination and strategic bombing perspective, see R. J. Overy, *The Air War*,

Over the course of the war, US military forces coordinated more effectively resulting in improved tactical success, but it was the US industry's capability to out produce its adversaries that led to strategic victory while demanding more physical resources and supplies than ever before.

The means and ways offered by these resources are the final components leading to the ends of military forces. Prior to the Industrial Revolution, the resources supplied by the nation to the military forces were primarily in the form of weapons and sometimes armor or clothing. Armies kept on the move, allowing them to forage food, while navies acquired their own foodstuffs in ports.[38] Static forces, especially during sieges, required supply lines of food and fodder because the land was soon barren from foraging. These conditions held during Napoleon's nationalization of warfare. During the American Civil War and the Franco-Prussian War, the first wars with railroads playing prominent roles, railways primarily supplied food and fodder to and the occasional movement of forces well behind the front lines.[39] Even during the Franco-Prussian War, less than one percent of all supplies were ammunition, the rest being almost exclusively food for the men and fodder for their horses.[40] Not until the static Western Front of World War I developed did this pattern change.

The Industrial Revolution between the mid-nineteenth century and the beginning of World War I created vast changes in the character of the resources required by military forces in parallel with the changes in national character. The concepts of Scientific Management, replaceable parts, assembly line manufacturing, machine tools, and increased mechanical invention shifted the amount and type of resources demanded by World War I armies from food and fodder to bullets and shells: "the period from 1870 to 1914 saw tremendous advances in military technology, particularly the rise of the

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1939-1945, 1st ed, Cornerstones of Military History (Washington, D.C: Potomac Books, Inc, 2005), 8–11.

[38] Martin Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 2nd ed (Cambridge ; New York: Cambridge University Press, 2004), 2.

[39] Van Creveld, *Supplying War*, 130.

[40] Van Creveld, *Supplying War*, 233.

magazine rifle, machine guns, and, above all, quick-firing artillery."[41] Much like in wars of the past, the armies waging static trench warfare required resupply. The massive movement of these supplies required that railways move the new equipment from its production sites in the cities of the rear to near the front line, but still required man and horsepower to move it to the front. This slow process aided the devolution of combat into trench warfare as much as the defensive firepower of the time, and would have to wait until the next war and the proliferation of the internal combustion engine to change.[42]

By World War II, the resources of the military forces, like the nations for which they fought, were fully industrialized. The maturation of motor vehicles alleviated many of the logistical challenges imposed by reliance on railroads, but still limited the extent and pace of movement because of the internal combustion engine's fuel needs. Roughly ninety percent of the supplies armies required "now consisted of factory-produced items which could only be procured far in the rear and, once this had been done, had to be transported to the front."[43] By the end of World War II, "subsistence accounted for only eight to twelve percent of all supplies."[44] The massive increase in non-food supplies was the result of the increasing need for industrialized forces to feed the machines men used as much as it needed to feed the men themselves.

The machines equipping military forces during World War II, products of industrialized nations, empowered mankind to act faster, farther, and more effectively than ever before. Just as machines allowed the nation to create wealth more quickly, effectively, and on a grander scale, so too it allowed military forces to destroy on a scale previously unimaginable. Use of machine guns, artillery, tanks, armored vehicles, aircraft, and mechanized air defenses emerged in World War I to support the infantry and expanded by World War II into their own corps and branches of service, attempting to

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[41] Van Creveld, *Supplying War*, 250.
[42] Van Creveld, *Supplying War*, 250.
[43] Van Creveld, *Supplying War*, 250.
[44] Van Creveld, *Supplying War*, 233.

service the ends of the character of war in their own right.[45] A single Panzer Group attempting to cross the Meuse in 1940 incorporated over 40,000 trucks and motor vehicles, including 1,222 tanks.[46] On the other side of the Atlantic, the United States alone produced over 96,000 aircraft in 1944 at the peak of aircraft production.[47] The vast size of these industrial forces demanded an equally vast harvesting and transformation of resources for producing and, more importantly, for powering the war fighting machines.

The machines of military forces followed the same arc as the machines of national character in resources required to both build and power the new weapons of war. World War II Germany illustrates the requirements of industrialized military forces. Between 1933 and 1938, the German agricultural workforce declined thirteen percent while the industrial workforce increased twenty-six percent.[48] Additionally, from 1933 to 1943, the import and production of iron ore tripled, the production of steel rose by fifty percent, raw steel doubled, and electrically smelted steel, fuel and oil increased over ten-fold.[49] As highlighted by the Rommel quote at the beginning of the chapter, industrialized military forces required the production of guns, ammunition, and fuel to fight. When properly equipped and supplied, however, the forces of the Industrial Revolution wrought previously unheard of destruction.

The ends of industrialized military forces were massive, specialized, and standardized forces centrally managed by large bureaucracies. Those bureaucracies controlled vertically integrated and horizontally coordinated applications of people and products to extend man's ability to go farther, faster, and more powerfully. Similar to the origins of national wealth creation, the increased capabilities of industrialized military forces hinged on new forms of motive power and the resources powering them, initially coal and steam, then increasingly oil and the internal combustion engine. It was the ends

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[45] See Jonathan Bailey in Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 150–153.
[46] Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 169.
[47] Overy, *The Air War, 1939-1945*, 150.
[48] J. Adam Tooze, *The Wages of Destruction: The Making and Breaking of the Nazi Economy* (New York: Penguin USA, 2008), 263.
[49] Tooze, *The Wages of Destruction*, 228, 680–681.

of these machines and the steel, oil, and industry on which they relied that led to the Industrial Revolution's character of war.

Unweaving the Industrial Fabric: Shifts in the Character of War

The nature of war may be immutable, but the character of war evolves along with the participants of war. War during the Industrial Revolution occurred among and between both agrarian non-industrial nations and industrial nations. Although many of the wars, such as colonial wars, occurred between industrial and non-industrial nations, the experiences of wars among industrial nations would define the character of war in the Industrial Revolution, indelibly etching themselves into the national and institutional memories of the states and militaries participating in them.

The era of the Industrial Revolution began and ended with great wars that redefined the scope and limits of warfare. The American Revolution and Napoleonic War occurred just as the Industrial Revolution was beginning in England. While not influenced greatly by the industrialization of the nation, military, or war, these two great wars marked the beginning of the rise of the nationalism and its impact on the expansion of war to the entire population of the nation-state.[50]

The Franco-Prussian War and the American Civil War both mark the middle of the Industrial Revolution. Warfare still predominantly resembled pre-industrialization at the tactical level, but the importance of industrial production, wealth, and transportation capabilities became more strategically important. The Prussian use of the railroad was essential to their initial rapid mobilization and deployment, although provided little additional capability once those forces began to engage the enemy and rapidly acquire territory.[51] In the United States, the industrialization of the North, as well as the railroad system it used to move troops and supplies, aided in the defeat of the South.[52] While

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[50] For descriptions of the effects of nationalism on warfare, especially in Europe, see Knox in Knox and Murray, *The Dynamics of Military Revolution, 1300-2050*, 57–73., as well as Michael Howard, *War in European History*, Updated ed (New York, NY: Oxford University Press, 2009), 75–93.
[51] Van Creveld, *Supplying War*, 250.
[52] Parker, *The Cambridge History of Warfare*, 223–225.

industrialization of national character aided in victory during the nineteenth century, it was not until the great wars of the twentieth century that the Industrial Revolution would define the character of war.

World War I, already noted as the turning point in the character of military forces, was also the turning point in the character of war. Previously, as Clausewitz noted, defeating the men of the armed forces was often the primary objective of war, since the men were the primary means with which nations fought.[53] However, the introduction of rapid fire-machine guns and artillery and the supplies necessary to feed them, made a nation's industry and working population an even higher priority. On the Western Front, where neither side could hope to defeat the enemy's forces through battle or territorial conquest, the ways to win the war shifted either to exhausting the opponent of means, either men or the industrial resources required, or to breaking his will.[54] Although Germany's adoption of storm trooper tactics generated tactical and territorial gains, and predicted the development of combined-arms maneuver warfare, both sides discovered that the winner was the side whose national character could provide the most enduring means in both men and resources to the war.[55]

As the stalemate on the Western Front continued, both sides searched for ways to end the fight victoriously. Germany turned to submarine interdiction warfare to cut-off supplies from America as well as bombing London, hoping to break the will of the British people or at least to decrease their industrial output supplying the war.[56] England turned to its industrial ingenuity and created tanks in order to extend the infantry's ability to penetrate the layered defenses characteristic of trench warfare. Both sides turned to aircraft to see and strike beyond the range of ground forces, as well as chemical warfare to penetrate the trenches. Although industrial machines appeared in greater number and importance in World War I, it was less what they accomplished in the war and more the

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[53] Carl von Clausewitz, *On War*, ed. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1984), 90.
[54] Howard, *War in European History*, 114.
[55] Tim Travers, *The Killing Ground* (Pen and Sword, 2009), 259–260.
[56] James S. Corum, *The Luftwaffe: Creating the Operational Air War, 1918-1940*, Modern War Studies (Lawrence: University Press of Kansas, 1997), 34–40.

hopes attached to how they might avoid a repeat of the war's slaughter that made World War I the bridge between pre-industrial war and the fully matured industrialization of the character of war in World War II.

World War II was the apogee of industrial war. The lessons derived from the experiences of World War I and their implications on the means, ways, and ends of war defined its character. Military forces provided the means of war, while how they organized and trained provided the ways. The ends aligned with Clausewitz's spectrum of objectives to disarm the enemy. In the case of World War II, the character was as near to theoretical absolute war as mankind has ever seen.

Military forces determined the means and ways of industrial war. The means consisted of the mass produced, conscripted, and trained men-at-arms and the mass produced, supplied, and powered machines they operated. These military forces, with the exception of Germany's integrated combined-arms forces early in the war, were specialized, standardized, and centrally controlled. The *Wehrmacht's* combined-arms forces garnered significant tactical advantage early in the war by decentralizing and integrating, but decreased in efficacy as other nations adapted similar organizational schemas and tactics.[57] The losses of trained personnel and poor practices in training new recruits to replenish those losses compounded the decreased efficacy of both German and Japanese military forces as the war progressed.[58] Eventually, the better training habits and sheer size of Allied forces enabled by effective industrial harmonization overwhelmed the Axis powers.

The Allied forces that invaded continental Europe, as well as those who had been flying missions over Europe and sailing, flying, and fighting in the Pacific harmonized with the specialization, standardization, and centralization of the Industrial Revolution. In Europe, the extensive combined bomber offensive and naval Battle of the Atlantic preceding the Normandy invasion did not necessitate significant integration among

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[57] Max Boot, *War Made New: Technology, Warfare, and the Course of History, 1500 to Today* (New York: Gotham Books, 2006), 224–235.
[58] For an account of the struggles of Axis air powers during World War II due to ineffective training mechanisms, see Overy, *The Air War, 1939-1945*, 68–69, 144–145.

specialized services.[59] The need for fighter escorts for bombers eventually materialized and was met, but mostly through parallel efforts of specialization coordinated in time and space, vice actual integration.[60] Operational coordination in lieu of actual integrated training and operations among forces required an effective bureaucracy to manage the vast numbers and types of forces employed in proximate time and space.[61]

Those nations most effective at harmonizing the industrialized bureaucracies of the nation and the military forces were most successful at generating the strategic effects necessary to win industrialized war. The United States leveraged its vast automobile industry and its associated "very large production installations, skilled workers, and a large supply of tools for conversion to war purposes" to rapidly expand its fledgling air force into the largest and most powerful in the world.[62] On the other hand, Germany failed to fully mobilize its industrial resources until far too late in the war, after the tide of the ground war turned against them in the east and the British and American strategic bombing offensive was growing in fury.[63] Harmonizing the national character with military forces created the appropriate means and ways, in type, quality, and quantity, to harmonize with the ends of industrialized war.

The ends of the Industrial Revolution aligned with industrialized versions of Clausewitz's objectives of military, country, and will, which became the centers of gravity against which the means and ways concentrated. Strategies to attack the enemy's will grew out of the musings of interwar air power theorists such as William "Billy" Mitchell and Giulio Douhet who believed the war could be ended most swiftly by

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[59] The Army Air Force and Royal Air Force conducted the bombing offensives over Europe while the United States and British navies fought the Battle of the Atlantic, and their respective armies expended and trained for the eventual continental invasion.
[60] See Biddle, *Rhetoric and Reality in Air Warfare*, 164–170, 226–227., for a narrative of the detrimental effects of specialization in fighter escort development.
[61] Boot, *War Made New*, 302–303.
[62] See Overy, *The Air War, 1939-1945*, 164.
[63] Overy, *The Air War, 1939-1945*, 165–166., and Tooze, *The Wages of Destruction*, 667–671.

breaking the national will through aerial bombardment.[64] Along with the lessons of World War I, the airpower visionaries' words inspired Air Marshal Arthur "Bomber" Harris to create the British Royal Air Force's strategic bombing offensive, centered on breaking Germany's will through bombardment of urban centers and industrial cities.[65] Contrary to early post-war reports, most historians now agree that the strategic bombing of cities did not have the deleterious effects desired and may have increased resolve instead.[66]

Germany fared no better with their attempts to attack the enemy's will through strategic bombing against the United Kingdom during the Battle of Britain or in subsequent V-1 and V-2 rocket strikes.[67] Early in the war, Germany successfully compelled the Netherlands to surrender after five days of demonstrating their combined-arms warfare, later given the name *Blitzkrieg*, in conjunction with the devastating aerial bombardment of Rotterdam and occupying a large portion of the country.[68] The success of *Blitzkrieg*, as its name implies, however, was the speed with which Germany's forces could rapidly strike and maneuver at the tactical and operational level to take advantage of its enemies' vulnerabilities and destroy their military forces.[69] The character of German warfare was successful in the confines of continental Europe where the lightning-paced tactical gains of *Blitzkrieg* translated into strategic effect, but failed miserably when confronted by nations more effectively resourced and harmonized with the Industrial Revolution.

The United States ideally harmonized its national character and military forces for the character of World War II. Being relatively safe behind two vast oceans, with the

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[64] William Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power--Economic and Military* (Tuscaloosa, AL: University of Alabama Press, 2009), xii., and Giulio Douhet, *The Command of the Air*, Fire Ant Books (Tuscaloosa, AL: University of Alabama Press, 1998), 96.
[65] Biddle, *Rhetoric and Reality in Air Warfare*, 176–178.
[66] Overy, *The Air War, 1939-1945*, 207.
[67] Overy, *The Air War, 1939-1945*, 34–35, 80–81.
[68] "1940 Invasion - Timeline Dutch History - Explore the Collection," *Rijksmuseum*, accessed May 11, 2015, https://www.rijksmuseum.nl/en/explore-the-collection/timeline-dutch-history/1940-invasion.
[69] Boot, *War Made New*, 233–239.

exception of the attack on Pearl Harbor, geography afforded the United States time to build up its forces within a sanctuary. Simultaneously, US investments in medium- and long-range bombers and the ability to base those bombers in range of Germany and eventually Japan, allowed the Allies to strike the Axis powers' ability to create and supply their own forces.[70] The United States' Air Corps Tactical School developed "industrial-fabric" theory of targeting during the interwar years that evolved into the United States' initial strategic bombing plan.[71] The theory proposed that destroying a nation's industrial heart, and therefore its economy, would cause society, or at least its ability to supply the means of military forces, to unravel and fail.[72]

Although a logical end based upon the characters of industrialized nations and militaries, strategic bombing lacked the efficacy promoted by air power visionaries. The US strategic bombing effort never successfully unraveled the industrial fabric, but it significantly diminished industrial capabilities in both Japan and Europe. The US strategic bombing effort reduced Japanese production in 1945 to 35 percent of its wartime peak, stalled German industries' recovery and growth under Albert Speer, and forced Germany to produce fewer and lower quality aircraft, tanks, and munitions than it would have if not bombed.[73] When the Allies could not destroy the enemies' industry before it created the means of war, the United States and other allied powers disrupted the ways of nations to supply the means to their industrial character or the military forces they supported.

Rommel attested that without industrial supplies, especially ammunition and oil, military forces of the Industrial Revolution cease to function.[74] Successful bombing raids on oil refineries, such as Ploesti, decreased the availability of oil to fielded forces and greatly diminished the speed, availability, and effectiveness of German forces, especially

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[70] Overy, *The Air War, 1939-1945*, 82–83, 194.
[71] Biddle, *Rhetoric and Reality in Air Warfare*, 140–141.
[72] See Biddle, *Rhetoric and Reality in Air Warfare*, 161–164., and Overy, *The Air War, 1939-1945*, 107–108.
[73] See Overy, *The Air War, 1939-1945*, 119–126., and Tooze, *The Wages of Destruction*, 593–598.
[74] Rommel, *The Rommel Papers*, 328.

the *Luftwaffe*.[75] Additionally, the Allied interdiction campaign to disrupt German attempts to reinforce the western front against the onslaught of ground forces during and after the Normandy invasion was pivotal to the success and rapid progress of the invasion forces.[76] In the Pacific, the US Navy's mining of key Japanese ports, and the ability of the US submarine force to destroy Japanese merchant vessels weakened and isolated Japanese forces on islands throughout the Pacific, making the defeat of Japanese forces more tenable and occasionally unnecessary.[77]

The reduction of German national and military capability through deliberate and effective attacks on oil, the vital resource needed to supply industrial forces, as well as roads and railroads, the lines of communications needed to move those forces and their supplies, led to the degradation and eventual succumbing of German military forces to the Allies. In the Pacific, the Japanese military forces suffered a similar fate, but the nation was prepared to engage in a population-wide insurgency against any invasion of the mainland of Japan. The use of two nuclear bombs in August of 1945, in addition to the previous year of urban firebombing, finally broke the national will of Japanese leaders and avoided the insurgency. The nuclear weapons that broke Japan's will were the apex of the Industrial Revolution and the culmination of three centuries of industrialization that opened to humankind the ability to reach so far, so fast, and so powerfully that we could destroy not only our enemies, but extinguish our entire species.

The character of war in World War II, the seminal struggle of the Industrial Revolution, approached Clausewitz's conception of absolute war, the ends of which aligned well with the objectives of military forces, country, and will. Nations attacked an enemy's country by cutting it off from needed industrial resources, such as oil and steel, while attempting to cripple the nation's industrial capability to use what resources it

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[75] See Biddle, *Rhetoric and Reality in Air Warfare*, 236–245., and Tooze, *The Wages of Destruction*, 648–649.
[76] See Tooze, *The Wages of Destruction*, 650., and
[77] See Boot, *War Made New*, 296–297., Mark R Peattie, *Sunburst: The Rise of Japanese Naval Air Power, 1909-1941* (Annapolis, Md.: Naval Institute Press, 2001), 193–195., and Eric M Bergerud, *Fire in the Sky: The Air War in the South Pacific* (Boulder, Colo.: Westview, 2001), 664–671.

could acquire. Nations attacked enemies' armed forces by eschewing frontal assaults and attempting to maneuver around front-line units and cut them off from necessary industrial supplies via mobile combined-arms warfare, in the case of the Germans, or aerial and naval superiority, in the case of the Allies. Lastly, nations attacked each other's wills through direct bombardment of the populations responsible for supporting and producing the industrial means of war, with only the Allies finding success through the advent and application of the nuclear bomb.

Given these ends, the character of war in the Industrial Revolution focused less on effective combat between military forces than it did on disconnecting the ends of national wealth production with the means of fielded military forces. The most successful nations were those most capable of creating strategic harmony among the nation, its military, and war while generating significant discord for their enemies.[78] Effective industrial bureaucratization of the nation, military forces, and war achieved this harmony.

Lessons of Industrial Harmony and Discord

Throughout the Industrial Revolution, and especially in World War II, the winning side was the one most effective at integrating national commercial industrialization with the creation of military forces and their application in the character of war. After Pearl Harbor, the United States turned its already robust commercial industrial base into a centralized war-producing machine. Neither Germany nor Japan ever accomplished this, partly because they faced constant disruption and pressure from Allied bombing, naval interdiction, and ground combat, initially, in the case of Germany, from the Soviets in the east, then increasingly from the Allies and from every direction.

Within the United States, World War II cemented the pathways of success in national and military institutional memory, organization, and equipment. These institutional lessons endured through the post-war drawdown and into the Cold War build up. Effective military forces consisted of raising and training vast quantities of men to operate the mechanized means of war in standardized ways. Creating more machines that

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[78] Boot, *War Made New*, 301–304.

could reach farther, faster, and more powerfully than the adversary was a vital element of war. Coordination among specialized assets provided enough effectiveness for success. Centralized control of numerous vertical hierarchies was necessary and sufficient to ensure efficient coordination among specialized forces. Attacking the enemy's industrial resources, production, and supplies is an effective route to victory, by unweaving their industrial fabric of by bombing the enemy into submission. Such were the lessons learned by the US military forces of World War II.

Many of these lessons were to be tempered or proven false by the revolution brought on by the development and creation of the nuclear weapon. First, the nuclear weapon limited the likelihood of the character of war escalating to its absolute form among nuclear-capable adversaries. Second, the computing technology created to develop and test nuclear weapons would lead to the Information Revolution, irrevocably changing the national character, the character of war, and the military forces they demanded in ways unforeseen.

Chapter 5

Information Dissonance

Data was no longer regarded as static or stale, whose usefulness was finished once the purpose for which it was collected was achieved … Rather, data became a raw material of business, a vital economic input, used to create a new form of economic value. In fact, with the right mindset, data can be cleverly reused to become a fountain of innovation and new services. The data can reveal secrets to those with the humility, the willingness, and the tools to listen.

—Viktor Mayer-Schönberger and Kenneth Cukier
Big Data

World War II indelibly etched the essence of the Industrial Revolution into the national and military characters of the United States. Simultaneously, two major technologies emerged from World War II that would instantly change the character of war and modify the national character and, to a lesser extent, military forces more slowly over time. Nuclear weapons changed the character of war, perhaps permanently, following their use in Hiroshima and Nagasaki at the end of World War II. Computers, developed initially to break German encryption codes and later to perform the calculations necessary for atomic weapon development, have less quickly but more profoundly changed the character of nations, militaries, and war by triggering the Information Revolution.

From Factories to Facebook: National Character in the Information Revolution

The Information Revolution is in the process of reshaping the ends, means, and ways of the character of national wealth production. The ends of national character are transitioning away from the mass production of standardized goods to the tailored production of individualized goods shaped by the market of individuals through information feedback processes. Means are shifting to cross-specialized individuals and small groups valued not for their ability to perform standardized physical functions like cogs in an industrial machine, but for the ways in which their unique experiences and expertise reshape the processes that produce wealth. The knowledge-laborers of the Information Revolution, still reliant on the industrial age resources of steel, coal, and oil,

add the greatest value to national ends through the knowledge and processes they create using the key resource of information and the electronic devices that store, process, and communicate it. The nature and speed of the information resource demand the ways of national character be more adaptive and responsive by being organizationally flatter, more cross-functionally integrated, more communicative, more decentralized, and more individually empowered.[1] Nations whose wealth-producing corporations harness these ways most effectively will most profitably translate means to generate the ends of the Information Revolution.

Informationization, the Information Revolution equivalent of industrialization, is changing the ends of national character from the value added by the production of things to the value added by knowledge and process improvement of how those things are researched, designed, advertised, financed, and moved.[2] In the United States' economy, advanced business services, the functions providing those knowledge and process improvements, equated to $10.6 *trillion* of productivity in 2007 with a $153.5 billion trade surplus.[3] During the same period, US manufacturing production amounted to only $1.95 trillion with an $882 billion trade deficit.[4]

The US economy is the vanguard of information economies that "are increasingly dependent upon the application of science and technology, as well as upon the quality of information and management, in the processes of production, consumption, distribution, and trade."[5] These dependencies create a "shift in advanced capitalist societies, from material production to information-processing activities, both in terms of proportion of [Gross National Product] and in the proportion of the population employed in such

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[1] Martin Carnoy, ed., *The New Global Economy in the Information Age: Reflections on Our Changing World* (University Park, Pa: Pennsylvania State University Press, 1993), 5.
[2] Peter Dicken, *Global Shift: Mapping the Changing Contours of the World Economy*, 6th ed (New York, NY: Guilford Press, 2011), 58.
[3] Dicken, *Global Shift*, 23, 37.
[4] Dicken, *Global Shift*, 23, 36.
[5] This is Manuel Castells' first of five fundamental features of informational economy in Carnoy, *The New Global Economy in the Information Age*, 15.

activities."[6] The shift to information-based activities and workforce transforms the ends of the national character away from machines and products that assist humankind in doing more, farther and faster, to information processes, storage, and communication that allow humankind to learn, think, and influence globally in real-time.

The outputs of the informationized national character revolve around processes and information. As such, the outputs are more cognitive, flexible, and additive than industrial outputs. The rapid growth of information, the networks on which it moves, and the processes that transform it into wealth shift value from muscle to mental, from mass to flexibility, and from destructive to constructive ends and require significant alterations in the means and ways of national character.

Evolving ends of informationized national character are caused by and causal to the shifting means. The explosive growth of information as a means of value creation is linked inextricably with the rapid increase in wealth generated through processes to communicate, analyze, and adapt based on that information, much like the intertwined industrial growth of machines and coal, iron, and oil. Unlike the resources of the Industrial Revolution and the mechanical products they fueled and created, information is a constructive vice destructive material that can travel speeds and distances unrivaled by any means or product of industrialization.[7] The very nature of information, the primary non-human resource of informationized nations, profoundly shapes the human means, the ways, and the ends of national character.

Data, information, and knowledge often are considered distinct concepts, but this paper shall use them interchangeably as each contributes to the shifting ends, means, and ways of national character.[8] Alvin and Heidi Toffler describe ten key differences that

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[6] Castells' second fundamental feature in Carnoy, *The New Global Economy in the Information Age*, 17.

[7] For a thorough exploration of the value of data and its constructive nature, see Viktor Mayer-Schönberger, *Big Data: A Revolution That Will Transform How We Live, Work, and Think*, First Mariner Books edition (Boston: Mariner Books, Houghton Mifflin Harcourt, 2014), 98–122.

[8] Many authors explore the concepts of data, information, and knowledge. Some expand the concepts further to include understanding and wisdom, such as Russell L. Ackoff, *Ackoff's Best: His Classic Writings on Management*, 1 edition (Wiley, 2008), 175–178.

separate knowledge from historical economic resources as a means of national character.[9] While all ten are important, the elements of information causing the most significant changes are that it is non-rival, non-linear, relational, and mates with other information. The value of information is non-linear because a small amount of data can create disproportionate returns on investment, such as when Google's founders created the PageRank function in their search engine, BackRub, which would later become the premier Internet search engine and propel Google into the forefront of the Information Revolution.[10] Non-linearity is what makes information-based activities more valuable than industrialized activities, and is the result of the other characteristics of information.

The non-rival, relational, mating, and proliferating aspects of information are what make it non-linear. A non-rival resource is equivalent to a constructive resource in that it is not destroyed when used to create value.[11] Unlike oil, coal, or metal, one can use a set of information to create value on its own, combine the set with other information, or analyze the set in a different way and create entirely new value.[12] The ability to compare information in one area with information from another to create new added value is what makes data relational and mating. The non-destructive nature of information and the speed at which it travels over the modern data infrastructure of the

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Also, see M. Boisot and A. Canals, "Data, Information and Knowledge: Have We Got It Right?"," *Journal of Evolutionary Economics* 14, no. 1 (2004): 43–67.

[9] Alvin Toffler and Heidi Toffler, *Revolutionary Wealth*, 1st ed (New York: Knopf, 2006), 100–101. They use knowledge synonymously with data, information, and knowledge. The Tofflers' ten properties of knowledge include: 1) it is non-rival, 2) intangible, 3) non-linear, 4) relational, 5) mates with other knowledge, 6) is more portable than other products, 7) is compressible into symbols or abstractions, 8) can be stored in smaller and smaller spaces, 9) can be explicit or implicit, expressed or not expressed, shared or tacit, and 10) it proliferates.

[10] Google, "Google: Our History In Depth," *Google: Company*, accessed May 19, 2015, http://www.google.com/about/company/history/.

[11] Toffler and Toffler, *Revolutionary Wealth*, 102–104.

[12] See three types of option value of information, reuse, recombinant, and extensible data in Mayer-Schönberger, *Big Data*, 104–110. Also, Charles Duhigg, "How Companies Learn Your Secrets," *The New York Times*, February 16, 2012, sec. Magazine, http://www.nytimes.com/2012/02/19/magazine/shopping-habits.html.

Internet allow information to rapidly proliferate.[13] This process of quickly generating value-upon-value from information drives non-linearity and the desired skills and traits of the workers who enable it.

The movement of the ends of national character from industrial- to information-based shifts the skills and traits of desired workers away from the ability to perform standardized, specialized, and compartmentalized tasks that linearly add value to a physical product. Instead, the Information Revolution "requires well-trained, adaptable workers with authority to make their own decisions."[14] Information Revolution workers are still specialized, but the nature of information as a resource differentiates the usefulness of informationized specialization from its industrial purposes. Instead of compartmentalized and standardized specializations meant to send physical products in a linear vertical supply chain to add value, information specialization requires unique worker knowledge and horizontal networks of data sharing to create non-linear value growth. Information Revolution companies value specialists for their ability to add unique insight and values either by being cross-disciplinary specialists on their own or by participating on teams of specialists whose summed knowledge is greater than its parts.[15] Leveraging this knowledge requires corporations to decentralize and reverse Industrial Revolution's ways of centralization, bureaucratization, and vertical hierarchies.[16]

The nature of information and the changes it creates in the means and ends of national character shifts the ways of effective wealth production from mass production, standardization, vertical integration, and large-scale organizations to flexible, customizable production, and horizontal networks among economic units where the most

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[13] Toffler and Toffler, *Revolutionary Wealth*, 101.
[14] Tim Harford, *Adapt: Why Success Always Starts with Failure* (New York: Picador, 2012), 82.
[15] On the topic of cross-disciplinary innovators, see Toffler and Toffler, *Revolutionary Wealth*, 147–148. On the need for groups of ever-growing knowledge breadth, see Harford, *Adapt*, 99–100.
[16] James Surowiecki, *The Wisdom of Crowds* (New York, NY: Anchor Books, 2005), 71–72.

essential assets are flexibility and adaptability.[17] Flexibility and adaptability are terms often used, rarely defined, and occasionally synonymous. The terms, however, each have unique characteristics that help illuminate differences between industrialized and informationized systems.

Flexibility is the ability to adjust the current system to a changing environment. Industrialized institutions, centralized and standardized, could be very flexible, such as by increasing the production output of a desired product or by allowing the interchangeability of parts.[18] Adaptability, on the other hand, is the ability to change the system itself to evolving environments. Industrial institutions, such as the centrally planned Soviet economy, remain much less successful at adapting because of the very processes they created to be more flexible.[19] Informationized systems, the value of which resides in information, a more fungible resource than traditional physical ones, have the capacity to be both flexible and adaptable.[20]

Flexibility and adaptability are made essential by the expansion of a global economy enabled by the connectivity of the Information Revolution layered upon the motive capability of the Industrial Revolution.[21] Global markets increase opportunities for innovative market challengers and require better adaptability to remain competitive.[22] A global economy also presents a more diverse set of markets, each requiring local knowledge and flexibility to which industrial centralization is ill-suited, driving the need for decentralization and flatter bureaucracies.

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[17] This shift in organizational structures is Castells' third fundamental property of an information economy in Carnoy, *The New Global Economy in the Information Age,* 18.
[18] See David Alberts and Richard Hayes, "Power to the Edge. Command...Control...in the Information Age" (Office of the Assistant Secretary of Defense (OASD), Command & Control Research Program (CCRP), 2003), 105, 107–127, http://www.dodccrp.org/files/Alberts_Power.pdf. Alberts and Hayes use interoperability and agility, which map to the concepts of flexibility and adaptability, to describe two key attributes of Information Revolution systems.
[19] Harford, *Adapt*, 25.
[20] Carnoy, *The New Global Economy in the Information Age*, 2–5.
[21] Global markets is Castells' fourth fundamental in Carnoy, *The New Global Economy in the Information Age*, 18–19.
[22] Harford, *Adapt*, 81–82.

Flatter hierarchies improve information flow within organizations both vertically and horizontally.[23] Reduced layers between front-line workers and executives reduce the filtering process that often prevents truthful and valuable information from reaching the executives who need it. Additionally, the more rigidly vertical the hierarchy, the more seams it creates, limiting the opportunities and desire for horizontal communication and integration vital to effectively growing knowledge value. Decentralization of authority further aids the information flow by reducing the requirement to vertically communicate to request approval for action, freeing time for lateral coordination and integration.[24] Decentralization also allows empowered groups to respond to changing local conditions and markets through information-enabled feedback systems, essential given the pace and globalization of economies in the Information Revolution.[25] Those corporations able to embrace informationized ends, means, and ways and the nations from which they operate prosper.

The United States, its riches made through the auspices of the Industrial Revolution and the aftermath of its culmination in World War II, faltered in the 1970s and early 1980s because it failed to assess and adapt to the changing environment of the Information Revolution.[26] The United States prospered because "mass production was the greatest production system in the history of the world. It won the war; and by dissolving social conflicts in a rising tide of consumer goods; it won the peace. It catapulted America into a unique position of overweening economic, military, political, and cultural power. It had, however, its weaknesses. It was terribly inflexible."[27]

While the United States rested on its industrial accomplishments, new challengers in the global economy, Japan and Germany, were leveraging information-based feedback to adapt to local consumer desires. In the case of Japan, car manufacturer Toyota began

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[23] See Surowiecki, *The Wisdom of Crowds*, 201–211., for an account of the value of informationized organizational structures over industrial.
[24] Surowiecki, *The Wisdom of Crowds*, 214–217.
[25] Amazon's ability to correlate various user's future desires based upon past purchases is an exemplar of informationized feedback in Mayer-Schönberger, *Big Data*, 51–52.
[26] Surowiecki, *The Wisdom of Crowds*, 206–207.
[27] Stephen Cohen in Carnoy, *The New Global Economy in the Information Age*, 109–110.

producing smaller runs of higher quality vehicles at less cost by making quick die changes instead of relying on more expensive capital investments in large-run machine tooling.[28] Toyota also empowered any line worker to halt the line if they detected an error in the manufacturing process, lowering the cost, and improving the quality of their vehicles. These early information-based changes gave Toyota a marked advantage over US companies still clinging to their Industrial Revolution successes. The US automakers' disadvantage illustrates the results of operating in dissonance with the changing character of the automotive industry, the ramifications of which continue to today.[29] While many in the United States commercial sector have adapted and harmonized with the changing national character, the military forces continue to lag, reminiscent of the failings of the US auto industry circa 1970.

Changing Technologies, Stagnant Organizations: Military Forces in the Information Revolution

The character of the United States' modern military forces is based on Information Revolution technological means layered on the industrialized ways that proved so effective in World War II and were reinforced in the early post-war environment. Nuclear weapons and the digital computer, developed out of World War II, shaped the character of military forces and war during the Information Revolution. Digital information networks derived from advances in computer systems offered the means to harmonize with the changing national character of decentralization, flexibility, adaptability, and local adaptation to feedback. Unfortunately, the stagnant organizational and doctrinal ways of US military forces remain in discord with these informationized ways, leaving America vulnerable to those who adapt more effectively. The invention of nuclear weapons looms largest over changes in military character,

The detonation of the atomic weapons on Hiroshima and Nagasaki cemented the means and ways of industrialized military forces within the US military. Nuclear weapons, coupled with the intercontinental ballistic missile (ICBM), were the military

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[28] Cohen in Carnoy, *The New Global Economy in the Information Age*, 110–115.
[29] Dicken, *Global Shift*, 344–354.

culmination of the Industrial Revolution, reaching father, faster, and more powerfully than humankind ever had before.[30] The USSR scrambled to catch up to American atomic might, eventually spawning an arms race that evolved into a complex strategy of deterrence and mutually assured destruction (MAD).[31] Recognizing the capabilities of the Soviet and American arsenals to destroy humanity, the United States instituted centralizing command and control measures to further prevent inadvertent nuclear war.[32]

The importance of assessing Soviet nuclear capabilities also drove centralization of reconnaissance assets such as the U-2 spy plane and surveillance satellites.[33] These systems formed the early means of a growing Intelligence, Surveillance, and Reconnaissance (ISR) complex, especially within the Air Force, that would hold primary responsibility for the collection, communication, and analysis of information produced by the military forces.[34] Satellites, the rockets that launched them, and nuclear weapons were all possible because of the invention of the digital computer, the other major effector on the means of military forces.

British code breakers developed Colossus, the "world's first digital, programmable computer," at Bletchley Park in order to crack Nazi ciphers during World

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[30] For President Dwight Eisenhower's response to the Soviet attainment of ICBMs and the impact on United States military planning, see Campbell Craig, *Destroying the Village: Eisenhower and Thermonuclear War* (New York: Columbia University Press, 1998), 54–55.

[31] For a synopsis of deterrent strategy development, see Bernard Brodie, *Strategy in the Missile Age*, New RAND ed (Santa Monica, CA: Rand Corp, 2007), 390–409. For a brief discussion on the development of MAD, see David E. Hoffman, *The Dead Hand: The Untold Story of the Cold War Arms Race and Its Dangerous Legacy*, 1st Anchor Books ed (New York, NY: Anchor Books, 2010), 16–17.

[32] Hoffman, *The Dead Hand*, 36–40, 44–45., illustrates the progression of nuclear command and control and the Single Integrated Operations Plan (SIOP) under President Ronald Reagan's administration.

[33] The need for surveillance of Soviet nuclear capabilities during the Cold War, see Dino A. Brugioni, *Eyes in the Sky: Eisenhower, the CIA, and Cold War Aerial Espionage* (Annapolis, MD: Naval Institute Press, 2010), 130–134, 387–391.

[34] Department of Defense, "Joint Publication 2-0: Joint Intelligence" (Department of Defense, October 22, 2013), ix, http://www.dtic.mil/doctrine/new_pubs/jp2_0.pdf.

War II.[35] Across the ocean, US scientists and engineers created ENIAC, a digital computer designed to speed up artillery table calculations for the proliferating variety of artillery pieces and munitions employed in the war.[36] After the war, many of those same engineers adapted ENIAC to perform the necessary calculations that allowed for the development of the hydrogen bomb.[37] Initially the size of buildings, digital computers rapidly evolved from Colossus and ENIAC, the total computing power of which now fits on a chip inside a greeting card that plays "Happy Birthday" when it is opened.[38]

The invention of the computer allowed humans to more effectively manipulate numbers and symbols, expanding the value of information in ways previously unimaginable. The miniaturization of computing capability allowed humans to move information processing from centralized computing facilities of the Industrial Revolution to distributed locations, and decentralize some aspects of feedback and decision making by enhancing or replacing human cognitive capabilities with computer-based ones. Although precision-guided munitions (PGMs) predated the digital computer, the miniaturization of computing capabilities, especially solid-state technologies greatly enhanced the accuracy and lethality of PGMs.[39] The accuracy of PGMs gave their user the ability to hit and destroy even the most hardened facility conventionally, that is

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[35] John Jackson, *Code Wars: How "Ultra" and "Magic" Led to Allied Victory* (Barnsley, UK: Pen & Sword Military, 2011), 164.
[36] George Dyson, *Turing's Cathedral: The Origins of the Digital Universe*, First Vintage Books edition (New York: Vintage Books, a division of Random House, Inc, 2012), 70–80.
[37] Dyson, *Turing's Cathedral*, 206–216.
[38] Michio Kaku, *Physics of the Future: How Science Will Shape Human Destiny and Our Daily Lives by the Year 2100* (New York: Doubleday, 2011), 22–24.
[39] Both the German and US navies employed guided munitions during World War II, although they were limited to mechanical guidance systems, vice ones involving elements of digital computers. After World War II, the United States pioneered the development of PGMs, achieving great success (although in limited numbers) with the Paveway I laser-guided bomb (LGB), and after with the AIM-7 Sparrow air-to-air missile. See Barry Watts, "Six Decades of Guided Munitions and Battle Networks: Progress and Prospects" (Center for Strategic and Budgetary Assessments, March 1, 2007), 1–12, http://csbaonline.org/publications/2007/03/six-decades-of-guided-munitions-and-battle-networks-progress-and-prospects/.

without the massive blast associated with nuclear weapons.[40] This destructive potential redefined the concept of mass in warfare, allowing fewer combat systems to achieve greater strategic effect than previously required by relatively inaccurate unguided conventional weapons.[41] The very precision on which PGMs rely, however, requires accurate information to either guide the munitions to impact or to at least point them in the right direction. Without a significant network infrastructure on which to communicate the necessary information, PGMs would be little more precise than their unguided predecessors.[42]

The information networks that sense, communicate, process, and provide the information to enable PGMs is the third technical means of the informationized military force. From employing network-guided or enhanced weapons on the front edge of the battlefield, to communicating and processing information into intelligence, to controlling remotely piloted vehicles (RPV) via satellites, to the everyday tasks of checking email, the United States military relies on networks of sensors, people, computers, and weapons.[43] Without these networks and the information and processes residing on and connected by them, the United States could not wage modern warfare. Although

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[40] Watts, "Six Decades of Guided Munitions and Battle Networks: Progress and Prospects," x.

[41] See Watts, "Six Decades of Guided Munitions and Battle Networks: Progress and Prospects," 258–265. Watts describes the change from the days of industrialized unguided bomb, when military planners had to determine the number of aircraft sorties needed to destroy a target, to the number of targets a single sortie could destroy in the informationized PGM era.

[42] See Keith L. Shimko, *The Iraq Wars and America's Military Revolution* (New York, NY: Cambridge University Press, 2010), 122., and Watts, "Six Decades of Guided Munitions and Battle Networks: Progress and Prospects," 28–32.

[43] For Global Positioning System (GPS)-guided bombs see "Boeing: Weapons," accessed May 22, 2015, http://www.boeing.com/defense/weapons/. For air-to-air data-linked missiles see Raytheon Corporation, "Latest AMRAAM Variant Achieves Program Milestone," *Raytheon*, 9 Apr 15, http://raytheon.mediaroom.com/2015-04-09-Latest-AMRAAM-variant-achieves-key-program-milestones. For ISR processing networks see Raytheon Corporation, "Distributed Common Ground System (DCGS)," *Raytheon*, accessed May 21, 2015, http://www.raytheon.com/capabilities/products/dcgs/. On vulnerability of RPV satellite datalinks and reliance of military on commercial electricity and communication networks, see Shane Harris, *@WAR: The Rise of the Military-Internet Complex* (Boston: Houghton Mifflin Harcourt, 2014), 57, 140.

essential to modern operations, military networks, especially at the front edge of the battlefield, are often sourced by individual branches of service or mission function, a legacy process from the compartmentalization of the Industrial Revolution, and are rarely compatible with each other.[44] While the means of computers and networks have increased in numbers and importance, the ways of organizing them remain as they were in industrial warfare.

United States military forces remain mired in the ways of centralized bureaucratic control of vertically integrated organizations. Fear of nuclear escalation stemming from tactical mistakes generating strategic blunders drove civilian leadership to not only sustain, but also accentuate these industrial tendencies.[45] This fear extended beyond the centralized control of nuclear forces to similar measures over conventional forces to avoid a potential nuclear conflict. During Vietnam, the US civilian leadership centralized control of the air war in the Oval Office under President Lyndon Johnson, and continued similar, albeit reduced, levels of centralization under President Richard Nixon.[46] America's Vietnam experience also highlighted fissures between services and the resultant vertical integration, and consequentially minimizing lateral coordination. The route package system that geographically separated Navy and Air Force airspace responsibilities exemplifies these fissures.[47] The ossifying ways of industrialized organizations persist to the present.

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[44] DOD's doctrine on joint communications provide an illustration of these disparate systems that share information vertically to be integrated, potentially, at locations away from the battlefield, Department of Defense, "Joint Publication 6-0: Joint Communications System" (Department of Defense, June 10, 2010), II–4–II–6, www.dtic.mil/doctrine/new_pubs/jp6_0.pdf. Also, for an overview of the challenges associated with integrating disparate tactical data links, see Northrop Grumman, "Understanding Voice and Data Link Networking: Northrop Grumman's Guide to Secure Tactical Data Links." (Northrop Grumman, December 2013), 9–1 – 9–5, http://www.northropgrumman.com/Capabilities/DataLinkProcessingAndManagement/Documents/Understanding_Voice+Data_Link_Networking.pdf.

[45] Craig, *Destroying the Village*, 54–55.

[46] Mark Clodfelter, *The Limits of Air Power: The American Bombing of North Vietnam* (Lincoln, NE: University of Nebraska Press, 2006), 84–88, 118–119, 163–166.

[47] For a discussion of the disconnect between the strategic bombing air war and the air power supporting ground forces see Donald J. Mrozek, *Airpower and the Ground War in*

The ways of operational planning and command and control, DOD's Joint Staff doctrinal organization, and the vertically-aligned intelligence collection, analysis, and dissemination process illustrate the enduring presence of vertically integrated, centralized industrial processes within the US defense establishment. The failures of the route package system in Vietnam contributed to the design of the USAF's the Joint Air Operations Center (JAOC) and its associated 72-hour Air Tasking Order (ATO) cycle, both aimed at centralizing control of theater air assets as part of a broader joint planning and execution process.[48] The JAOC, under the auspices of the Joint Forces Air Component Commander (JFACC), is responsible for collecting the relevant intelligence to direct theater air operations, planning, and developing the ATO, and assessing the results of daily air operations.[49]

The JAOC predicates its process on the tenet of "centralized control, decentralized execution."[50] While good in theory, especially assuming industrial concepts of coordinated specialization of physical capabilities, this precept ignores the realities of information networks. By centralizing intelligence, control, planning, and assessment, the JAOC process forces vertical information exchanges from the front lines to the centralized JAOC for processing, followed by vertical distribution of command and control information back to the battlefront via the ATO process.[51] Additionally, within the JAOC, and the armed services in general, information and the forces primarily

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Vietnam. (Maxwell AFB, AL: Air University Press, 1988), 69–72, 118. For route package details see Clodfelter, *The Limits of Air Power*, 220.

[48] The JAOC was previously called just the Air Operations Center (AOC), followed by Combined AOC (CAOC) until 2014 when it was doctrinally renamed the JAOC. For a description of the elements and processes of the CAOC in Operation IRAQI FREEDOM, see Benjamin S. Lambeth, *The Unseen War: Allied Air Power and the Takedown of Saddam Hussein* (Annapolis, MD: Naval Institute Press, 2013), 207–220.

[49] Department of Defense, "Joint Publication 3-30: Command and Control of Joint Air Operations" (Department of Defense, February 10, 2014), II–2, II–3, http://www.dtic.mil/doctrine/new_pubs/jp3_30.pdf.

[50] Department of Defense, "Joint Publication 3-30: Command and Control of Joint Air Operations," I–3.

[51] Department of Defense, "Joint Publication 2-0: Joint Intelligence," I–1 – I–6., describes the vertical intelligence process. Also, Lambeth, *The Unseen War*, 214–215., highlights the slow and laborious reactive targeting process due to centralization.

responsible for the collection, processing, and communication of it play a supporting role to the operators and their physical operations, establishing the primacy of industrial systems, people, and processes over informational ones.[52] Doctrinal Joint Staff organizational structure contributes to the discord between the value of information in military forces and the lack of effective integration of information processes, especially laterally at the operational edge.

The Joint Staff organization structure, mirrored by service and geographic command structures, creates vertically integrated separations of information and network systems that are only integrated, if ever, at the very top of the structure.[53] Organizational doctrine divides information collection, usage, communication, and processing functions into three separate directorates: J-2 Intelligence, for collection and processing; J-3 Operations. for using information to create physical effects; and J-6 Command, Control, Communications, and Computers (C4) and Cyber, for creating the networked infrastructure through which it and the other directorates operate.[54]

The segregated responsibility and vertical information flows within each directorate inhibit the organizational flattening, horizontal integration, and local reaction to feedback vital to successful organizations within the national character of the Information Revolution.[55] Legacy organizational structure and concepts of an industrialized military force sabotage flexibility and adaptability, the two key features of

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[52] Stephen Peter Rosen, *Winning the next War: Innovation and the Modern Military* (Ithaca: Cornell University Press, 1991), 104., and Lambeth, *The Unseen War*, 215.
[53] Surowiecki, *The Wisdom of Crowds*, 69., highlights the centralizing reaction of the interagency Intelligence Community to the failures of disparate agencies to prevent the terrorist attack of 11 September 2001. Unfortunately, this centralization does nothing but exacerbate lateral information sharing at the edge of the information front, but hopes that effective aggregation and analysis can solve the failures of the past.
[54] Department of Defense, "Joint Chiefs of Staff: Joint Staff Structure," *Joint Chiefs of Staff*, accessed May 22, 2015, http://www.jcs.mil/Leadership.aspx.
[55] Martin Van Creveld, *Command in War* (Cambridge, Mass: Harvard University Press, 1985), 259, 268–269. Also, for an analysis of the detrimental effects of vertical hierarchies and inefficient information exchange, see Alberts and Hayes, "Power to the Edge," 174–177.

informationized organizations.[56] Modern US military forces' training of recruits parallels this legacy.

The human means of military forces are themselves products of the changing national character. The ways of informationized value creation demand workers who are specialized in knowledge, exhibit variation in thought, and possess either experience across multiple disciplines or are capable of being unique contributors to and associative thinkers in multi-disciplinary teams.[57] Unfortunately, the US military continues to condition its forces for standardization, through initial drill and training, ubiquitous standard operating procedures, and career advancement for conformity.[58] The passing over for promotion of then-Colonel H. R. McMaster in 2006 and 2007 is an illustrative example of the military forces punishing non-standardization.[59] These training and promotion processes condition out innovative behavior or remove from service those who evince such behavior.[60] Those who remain often lack the opportunity for cross-functional growth or multi-disciplinary integration, except at the top of the centralized bureaucracy due to the vertical organizational structure of the military forces.

Discord results when the standardized industrial mindset of the military force the people, raised in an informationized national character, to reshape their behavior in order to succeed. The military loses out on the innovative gains realized by commercial

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[56] Toffler and Toffler, *Revolutionary Wealth*, 27.

[57] Reference this paper's earlier discussion on the human means of informationized national character. Also, for the importance of associative thinking and other elements of innovative thinking, see Jeff Dyer, Hal B. Gregersen, and Clayton M. Christensen, *The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators* (Boston, Mass: Harvard Business Press, 2011), 3.

[58] For standardization of procedures, reference the Army's 7-step Military Decision Making Process in Department of the Army, "ADRP 5-0: The Operations Process" (Headquarters, Department of the Army, May 17, 2012), 2–11 – 2–12, http://armypubs.army.mil/doctrine/DR_pubs/dr_a/pdf/adrp5_0.pdf. Also, for promotion pathways and resistance to change, see Rosen, *Winning the next War*, 19–21.

[59] Harford, *Adapt*, 83–86. Colonel McMaster previously proved his operational and academic acumen in DESERT STORM and OIF and authoring the book, *Dereliction of Duty*. He was later promoted to Brigadier General thanks to General David Petraeus.

[60] Clayton M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Boston, Massachusetts: Harvard Business Review Press, 2013), xxii–xxiii, 176–181.

entities that encourage, rather than condition out through training the ability of informationized workers to make cross-functional knowledge connections and act on them at the local level.

While the means of military forces have adapted with the Information Revolution, many of its ways remain mired in the specialization, standardization, and centralization of a previously successful industrialized character.[61] The United States' military is able to collect, communicate, and analyze more information than any other nation. Organizing the processes of information flow around industrialized structures and concepts fails to effectively leverage the national character or the inherent advantages of informationized operations. The resultant discord has led to a number of military setbacks for the United States since World War II as the nation's military forces have failed to adapt to the Information Revolution's shifts in the character of war.

From the Industrial Fabric to the Web of Humans: Character of War in the Information Revolution

The United States emerged from World War II as one of the two dominant world powers. The United States, rivaled only by the Soviet Union, dwarfed the rest of the world economically and militarily, initially with conventional and then increasingly, nuclear forces. After the fall of the Soviet Union and the end of the Cold War, the United States remained the sole military superpower, unrivaled conventionally by all and only by the post-Soviet Russian Federation in nuclear capability.

Since World War II, however, the United States' strategic military performance was a mixture of resounding victories, questionable successes, and arguable failures. America owes this varied record to the discord created in the character of war between the industrial ways and ends the military forces brought to the fight with the ways and ends dictated by the changing character of war. The inability of the United States to attack the industrial objectives for which it had harmonized its means and ways, either because the opponent lacked such industry or the threat of nuclear escalation prevented it,

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[61] Max Boot, *War Made New: Technology, Warfare, and the Course of History, 1500 to Today* (New York: Gotham Books, 2006), 434–436.

created some of this discord.[62] Adversaries employing means, ways, and ends more effectively harmonized with their national character and informationized warfare accentuated America's discord. The United States was only truly successful when fortunate enough to face opponents against whom the legacy industrial ways and ends of war harmonized.

Nuclear weapons shaped the character of war by bounding post-industrial conflict through fear of escalation. Threat of nuclear weapons moved most wars farther away from Clausewitz's absolute war, a war that promised a high likelihood of national annihilation.[63] Although the threat of escalation limited the nuclear nations participating in post-World War II conflict, the proxies through whom they warred often suffered and fought from a perspective of absolute war.[64] The dominant nuclear and conventional capabilities of the US forces converged with the proliferation of Information Revolution means and ways to shift the ends that American adversaries sought in informationized war.

In Vietnam, the need to avoid overt involvement by the Soviet Union and potential nuclear escalation such involvement brought with it restricted the effectiveness of the United States' industrial character of war.[65] Initially, the United States increasingly escalated conventional force in an unsuccessful attempt to compel Ho Chi Minh and his forces to cease supporting an insurgency in South Vietnam.[66] Unlike successful US efforts to remove a direct threat to North America from Soviet nuclear weapons during the Cuban missile crisis, the adversary in Vietnam was not convinced of American resolve, and also was committed to an absolute struggle for national

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[62] Conrad C. Crane, *American Airpower Strategy in Korea, 1950-1953*, Modern War Studies (Lawrence, KS: University Press of Kansas, 2000), 114–131., provides a somber reminder of the destruction wrought by industrial warfare practices against North Korea during the final two years of the war in an effort to reach a satisfactory armistice.
[63] See Craig, *Destroying the Village*, 68–69., for Eisenhower's assessment of the impact of nuclear weapons on the character of future wars.
[64] Mrozek, *Airpower and the Ground War in Vietnam.*, 166–169.
[65] Clodfelter, *The Limits of Air Power*, 42–43.
[66] Clodfelter, *The Limits of Air Power*, 44.

liberation.[67] As frustration and costs mounted, the United States conducted industrial-style war against elements of North Vietnam, but could not adequately stem the tide of militarily necessary supplies to communist units operating in South Vietnam or break the will of such a determined foe.[68] While the United States unsuccessfully employed industrial warfare against North Vietnam, Ho Chi Minh leveraged new means and ways of the Information Revolution to attack America's will, one of the classical Clausewitzian ends of war.

Changing means of informationized warfare opened the opportunity to spread a local narrative on the global information network in order to shape world opinion in the hopes of influencing the adversary nation's will to fight. Throughout the conflict, the North Vietnamese Politburo carefully calculated many of their strategic moves for maximal propaganda effect on US domestic support.[69] In the end, Hanoi's strategy was successful, accelerating the withdrawal of American forces from South Vietnam, opening the opportunity for reunification, and reshaping American culture.[70] Although the experiences of Vietnam changed American culture, they failed to create equivalent adjustments in the how US military forces approached the character of informationized war.

The United States attempted to harness information means and ways to the character of war in Vietnam, but only succeeded in warping the information means around industrial ways. Through massive accumulation of data and statistics on the performance and efficiency of US forces, the administration, led by President Johnson and Secretary of Defense Robert McNamara believed they could control warfare and

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[67] Thomas C. Schelling, *Arms and Influence* (New Haven, CT: Yale University Press, 2008), 166–169.
[68] For Rolling Thunder's ineffectiveness to achieve stemming the logistical flow of resources to the Vietnam insurgency, see Clodfelter, *The Limits of Air Power*, 83–84, 134.
[69] Stephen P. Randolph, *Powerful and Brutal Weapons: Nixon, Kissinger, and the Easter Offensive* (Cambridge, MA: Harvard University Press, 2007), 28–29.
[70] Mrozek, *Airpower and the Ground War in Vietnam.*, 156.

approach it as a rational extension of game theory.[71] The vertical communication requirements of this centralized approach to gathering and disseminating information created severe bottlenecks and false reporting of data, even though one third of all major items brought into Vietnam were electronic communications gear and American forces inaugurated the use of satellite communications.[72] The precepts of centralized information and decision control and the vertical data flow necessitated by such control were failed industrial ways to use information means. The lessons the United States may have drawn from failures in Vietnam were soon erased by the resounding success sixteen years later against Iraq.

During the sixteen years between the end of Vietnam and the opening of Operation DESERT STORM (ODS) the United States greatly improved its means of informationized war, including PGMs, information networks, the global positioning system (GPS), and stealth aircraft. The improved means were sufficient to thoroughly defeat Iraqi forces of comparable size that lacked the informationized effectiveness of the US forces in ODS, wiping clean the lessons of Vietnam and stunting the institutional learning process.[73]

The large size, industrial character, and vulnerable information systems of Iraqi forces perfectly suited the industrially harmonized US military forces. The limited networking the Iraqis possessed among their leadership, forces, and integrated air defense system (IADS) were the primary targets of an early US aerial bombardment that combined stealth and PGMs that rendered the system ineffective within the first hour and non-operational within 36 hours.[74] This left the Iraqi army and air forces in a pre-informationized state and entirely vulnerable for eventual decimation by coalition

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[71] Antoine J Bousquet, *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity* (New York: Columbia University Press, 2009), 153–155.
[72] Bousquet, *The Scientific Way of Warfare*, 156.
[73] On the harmonization of American forces and the character of war in Iraq, see Bousquet, *The Scientific Way of Warfare*, 160. At the outset of the fight, Iraq had the world's fourth largest army, against the United States' third, and the sixth largest air force, see Shimko, *The Iraq Wars and America's Military Revolution*, 55.
[74] Benjamin S. Lambeth, *The Transformation of American Air Power* (Ithaca, N.Y: Cornell University Press, 2000), 113.

forces.[75] This lopsided victory, owing much to the convenient harmonization of military forces and the character of war, convinced US military forces that Vietnam was an anomaly. The conflict bolstered the belief that investments made in informationized means of PGMs, stealth, air power, and vertically integrated information technologies were sufficient to create a revolutionary change in the effectiveness of military forces even absent any significant shifts in the ways of organizing or training.[76]

Operations ENDURING FREEDOM (OEF) in Afghanistan and IRAQI FREEDOM (OIF) in Iraq made apparent the fault lines between effective means and effective ways of informationized war. After a successful opening in both wars, the United States became mired in counter-insurgency struggles for which it was ill prepared and ill-suited to adapt to quickly.[77]

Early success in OEF exemplified effective means and ways of informationized wars. US Special Operations Forces (SOF), decentralized and empowered to react to changes in local circumstances, embedded with anti-Taliban forces. SOF integrated through digital networks with PGM-equipped aircraft to help indigenous forces oust the Taliban government and to track down al Qaeda terrorists.[78] American SOF have flatter organizations, empower their forces for local operations, train and organize for laterally-integrated operations at the lowest level, and minimize the necessity for vertical centralization of command and control during operations.[79] Although successful against

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[75] For discussion of John Warden's five rings model, and the importance of dislocating the center ring of leadership, consisting of military command and control in Operation Desert Storm, see John Andreas Olsen, *John Warden and the Renaissance of American Air Power*, 1st ed (Washington, D.C: Potomac Books, 2007), 146–148. On the implications of this destruction on Iraq's ability to wage effective informationized war, see Alvin Toffler and Heidi Toffler, *War and Anti-War* (New York: Warner Books, 1995), 70.

[76] Shimko, *The Iraq Wars and America's Military Revolution*, 79–89.

[77] Shimko, *The Iraq Wars and America's Military Revolution*, 203.

[78] Stephen Biddle, "Afghanistan and the Future of Warfare," *Foreign Affairs*, March 2003, https://www.foreignaffairs.com/articles/afghanistan/2003-03-01/afghanistan-and-future-warfare.

[79] Shimko, *The Iraq Wars and America's Military Revolution*, 135, 137., and Benjamin Lambeth in John Andreas Olsen, ed., *A History of Air Warfare*, 1st ed (Washington, D.C: Potomac Books, 2010), 277.

an over-matched adversary, even these ways fell prey to the American forces' industrial age penchant for centralization, bureaucracy, and vertical information flows.

Once again, the centralized leadership structure of US military forces skewed means of networks for information control through vertical integration. Even though advanced global information networks and ISR fusion capabilities could reduce the sensor-to-shooter data times to single digit minutes, the bureaucratic demands for centralized approval by General Tommy Franks, the US Central Command commander, often impeded improved informationized ways, missing opportunities to eliminate certain Taliban leaders, some of OEF's key objectives for strategic effect.[80] General Franks' centralized intervention owes its roots to the effective leveraging of informationized ways by Hanoi during the Vietnam War to degrade international support and American resolve. Franks, along with President George W. Bush, was "determined to avoid any untoward occurrence that might even remotely suggest that the campaign was an indiscriminate war against the Afghan people or against Islam."[81] However, this risk-averse centralization of control failed to stymie determined and adaptive adversaries who, lacking the means of US forces, incorporated the ways of informationized war far more effectively, nearly handing America twin strategic defeats.

Insurgents and terrorists throughout time have employed available information means and ways to further their cause.[82] The means, ways, and ends of the character of war afforded by the Information Revolution harmonize especially well with insurgents' preferred methods. These unconventional forces cannot hope to compete with an industrial nation, such as the United States, in attaining Clausewitz's objectives of defeating an opponent's military forces or disconnecting the ability of the country to supply them. The unconventional force's only hope is to survive while fighting an

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[80] Lambeth in Olsen, *A History of Air Warfare*, 273.
[81] Lambeth in Olsen, *A History of Air Warfare*, 273.
[82] Roger Trinquier, *Modern Warfare: A French View of Counterinsurgency*, Praeger Security International (PSI) Classics of the Counterinsurgency Era (Westport, CT: Praeger Security International, 2006), 23, 32, 51. Trinquier recognized that the guerilla has the knowledge advantage and that precision information provides significant advantage in insurgencies.

information battle to influence the adversary's will to fight. The insurgent's goals are to isolate the opponent internationally by attacking their legitimacy on the world stage while attempting to dissolve support for the opponent's action locally and within the opponent's own country.

The means and ways of the Information Revolution affords unconventional forces opportunities to accomplish these goals. Global and local digital networks, along with social media, allow terrorist organizations to decentralize within extremely flat organizational structures while still creating strategic effects to further their ideological ends.[83] This decentralized structure helps ensure strategic survival by making the broad organization resilient to individual and small-group losses, while also offering a level of deniability that can be used as propaganda on the world stage to accuse aggressors of atrocities.[84] In the globally connected world, international isolation, especially if it comes with economic sanctions, can be powerful influencers against any nation, while national guilt associated with atrocities can be especially devastating for liberal democracies like America.[85] Fighting information-empowered unconventional forces requires adoption of decentralized, flattened, and locally integrated ways enabled by Information Revolution means.

In Iraq, when the US forces empowered lower-level units to operate from small outposts within the community instead of from large and remote garrisons, the units could gather and react to local information feedback by building trust on a local level.

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[83] Scott Atran, *Talking to the Enemy: Faith, Brotherhood, and the (Un)Making of Terrorists*, 1 edition (New York: Ecco, 2010), 50.

[84] For a phenomenal account of the informal networks involved in the Arab Uprising, see David Kilcullen, *Out of the Mountains: The Coming Age of the Urban Guerrilla*, 1 edition (Oxford ; New York, NY: Oxford University Press, 2013), 179–219. For accounts of the global character of informationized wars, see Emile Simpson, *War From the Ground Up: Twenty-First Century Combat as Politics* (Oxford ; New York, NY: Oxford University Press, 2012), 6–7, 12, 228.

[85] Reference impact of Abu Ghraib on American morale, Shimko, *The Iraq Wars and America's Military Revolution*, 182–183.On effects of international economic sanctions in response to military action, see Priyanka Boghani, "What's Been the Effect of Western Sanctions on Russia? – Putin's Way," *FRONTLINE*, accessed May 23, 2015, http://www.pbs.org/wgbh/pages/frontline/foreign-affairs-defense/putins-way/whats-been-the-effect-of-western-sanctions-on-russia/.

Consequently, disparate units could test out various operational and tactical options to find the most successful approach within the environment.[86] One example of testing out a unique information process for significant gain was when US Army Lieutenant Bob Stasio devised a method of using informationized means to infiltrate Iraqi insurgent networks in order to map the web of terrorists and insurgents for detention and questioning or imprisonment.[87] Adoption of similar principles and processes throughout Iraq and Afghanistan harmonized the national character of the United States and the local population as well as the character of informationized war, turned around flagging efforts in both OIF and OEF, created positive strategic effects, and led to the best chance the United States had for exiting both conflicts victoriously. Unfortunately, informationized ways of decentralization, flattened organizations, and horizontal integration still run counter to the industrialized organization and training of American military forces, potentially condemning the lessons of OIF and OEF to the same fate as those of Vietnam.[88] Continuing down this path would also condemn the United States to strategic discord in the Information Revolution.

Strategic Discord and Ominous Threats

United States' experiences in OIF and OEF hint at the future character of informationized war. The means will continue to evolve, but still rely on the people, products, and networks the national character shapes and produces. The ends, their upper limit still bounded by nuclear weapons, will still focus on influencing the national leadership's will through precision strikes and an international narrative shaping and isolating fielded forces by interrupting their networks of coordination and integration with each other and with higher leadership, especially when the forces are vertically

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[86] Harford, *Adapt*, 57–60.
[87] Harris, *@WAR*, 12–17.
[88] Coming out of OIF and OEF, DOD published the 2014 Budget Priorities document including a section of supporting Full-Spectrum Training that reads as equating to traditional industrial warfare principles, Department of Defense, "Defense Budget Priorities and Choices Fiscal Year 2014" (Department of Defense, April 2013), 8, http://www.defense.gov/pubs/DefenseBudgetPrioritiesChoicesFiscalYear2014.pdf.

organized. Advantage will be gained or lost by adapting ways of military forces that harmonize national character, military means, and the character of war. The United States has spent most of the Information Revolution in a stagnant state of strategic discord because of the military forces' inability to overcome the institutional inertia etched into their ways of industrial organization and training by the cauldron of World War II.

Fortunately, although the radical Islamic militants' adoption of harmonized Information Revolution ways posed a threat to US interests abroad and domestically, the United States' overwhelming means and late-adapting ways overcame the threat in OIF and OEF. Of much larger concern is the re-emergence of Russia and China as the United States' major state competitors for global influence and international system shaping. Not only are both nations nuclear powers and industrially strong, but more importantly, they have shown the investment in and willingness to use digital information network capabilities, often referred to as cyber capabilities, to gain strategic advantage.

Russia employed cyber attacks against Estonia in 2007 to demonstrate political resolve and Georgia in 2008 to isolate the country's leadership from domestic and international information flows as part of a broader land invasion.[89] Meanwhile China has stolen billions of dollars of intellectual property and military technology by exploiting vulnerable US government contractors' systems.[90] Both of these nations pose a threat to the United States due to its discord between national character and military forces.

American military forces continue to focus on the industrial war, investing too little in informationized warfare and leaving the cyber security of the nation to private individual or corporate entities.[91] Although private entities will be involved in whatever

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[89] Jason Healey, ed., *A Fierce Domain: Conflict in Cyberspace, 1986 to 2012* (Washington, DC: Atlantic Council, 2013), 70–72.

[90] Reference Thomas Rid, *Cyber War Will Not Take Place* (New York, NY: Oxford University Press, 2013), 154–155., on China's secretive cyber unit 61398. Also, Richard A. Clarke, *Cyber War: The Next Threat to National Security and What to Do about It*, 1st ed (New York, NY: Ecco, 2012), 237.

[91] Department of Defense, "Defense Budget Priorities and Choices Fiscal Year 2014," 8. On the inability of government to provide cyber security, see P. W. Singer and Allan

security arrangement the US government eventually makes, the fact that private corporations are more effective at combating these threats illuminates one more element of the strategic discord between national character and military forces.[92]

Given the growing capabilities of China and Russia and the apparent inability of US military forces to harmonize in the Information Revolution, both countries pose a grave danger if they harmonize the ways of their nation and military forces with the informationized character of war. The United States, currently operating in discord, must adapt the means and ways of its military forces to harmonize and operate in the changing character of war in the Information Revolution.

Friedman, *Cybersecurity and Cyberwar: What Everyone Needs to Know* (New York, NY: Oxford University Press, 2014), 193–211.

[92] See Harris, *@WAR*, 171–177., for an account of Google making public policy by detecting, tracking, and publicly announcing Chinese espionage attempts on Google's and others' systems.

Chapter 6

Orchestrating Change

> *Complex systems: a system in which large networks of components with no central control and simple rules of operation give rise to complex behavior, sophisticated information processing, and adaptation via learning or evolution.*
>
> —Melanie Mitchell
> *Complexity: A Guided Tour*

Now is the time to harmonize. The convergence of more powerful and adaptive threats, exponential growth in data and ways to create value from the data, and emerging modes of chaotic and complex thought presents opportunity and advantage to those who harmonize the means and ways of military forces with the national character and potential conduct of war. Harmonization requires the US military to invest in the means of ubiquitous horizontal information flows, to train and empower the multi-functional groups that emerge from the horizontal network environment by decentralizing command and control authorities, and to reorganize the industrial structure of the military writ large so that a flatter, informationally-empowered system can emerge that is more flexible, adaptable, and harmonized with the national character.

Convergence of Opportunity

The time is right for US military forces to harmonize means and ways with the informationized national character. The adversaries—real and potential—threatening the United States and its interests continue to adapt and become more capable. The insurgencies in Iraq and Afghanistan and the continuing struggle to tamp down global terror networks provide a window of insight to potential adversaries on the weaknesses of the industrial ways of American military forces. China's growing economy, increasingly capable military, willingness to use and effectiveness of informationized means against the United States to garner advantage illuminate the potential risks of not harmonizing. Although Chinese culture may be less inclined to the decentralized ways of the

informationized character of war, the risk of the Chinese nation harmonizing while the United States persists in ossified industrial structures is too great not to change.[1]

Re-emergent Russia produces similar risks. Although the Russian economy and military lack China's vitality, Russia proved willing and capable of launching information attacks in conjunction with physical territorial conquest. Similar information attacks, directed at the centralized, vertically integrated information flows and command and control structures of the US military could prove devastating in conjunction with physical attacks against American allies and interests abroad.[2]

Converging in time with the increased threat is the exponential increase of information production and the knowledge tools available to generate value from that increase. Currently 42.3 percent of the world population connects to the Internet, a 741 percent increase since 2000, while the amount of data communicated over the Internet has grown and will continue to grow exponentially.[3] The exponential data increase, while important, pales in comparison to the value created by the analytic tools and algorithms that create value from the information.[4]

Gary King, a Harvard Professor in the Institute for Quantitative Social Sciences and a leading figure in big data analytics, presented a case study in the important of analytic knowledge tools for creating value King noted that Moore's Law suggests a doubling of computational power every 18 months, whereby using the same computational methods to solve a complex information problem should take half the time

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[1] Qiao Jie, "Lectures on the Science of Campaigns {zhanyi Xue Jiaocheng}," November 2012, 283–285., from the People's Republic of China Military Science Press, wrote about the importance of informationized warfare as the "prerequisite key to winning war."
[2] Richard A. Clarke, *Cyber War: The Next Threat to National Security and What to Do about It*, 1st ed (New York, NY: Ecco, 2012), 93.
[3] Miniwatts Marketing Group, "Internet World Stats," *Internet World Stats*, February 27, 2015, http://www.internetworldstats.com/stats.htm., and "Cisco Visual Networking Index: Forecast and Methodology, 2013–2018," *Cisco*, accessed February 26, 2015, http://cisco.com/c/en/us/solutions/collateral/service-provider/ip-ngn-ip-next-generation-network/white_paper_c11-481360.html.
[4] Gary King, "Big Data Is Not About the Data!," (Slides, New England Artificial Intelligence Meetup, May 14, 2013), http://gking.harvard.edu/files/gking/files/evbase-neai_0.pdf.

18 months from now than it does today. On the other hand, King's students were able to develop an algorithm in two hours that computed in twenty minutes what previously would have taken a $2 million computer significantly longer.[5]

King is not alone in creating knowledge tools, information processes that act on and in information to create value. IBM Research, an arm of International Business Machines (IBM), researches and creates cognitive computing tools to improve synaptic processing in digital systems, create new visualization tools to better help humans perceive and comprehend big data, and create more efficient human-computer interaction systems.[6] These tools, interacting with the explosive growth of the harvesting and movement of information, are on the cusp of accelerating the Information Revolution in much the same way the Industrial Revolution expanded exponentially at the convergence of railroad expansion, increased resource extraction, and improvement in machine tools. However useful these tools may become, much of the value will be lost without new ways of thought to make sense of and harness the tools.

The emerging schemas of chaos theory and complexity generate modes of thinking to manage and harness the incredible opportunities of information networks and emerging knowledge tools. Chaos theory describes the tendency of many natural systems to exhibit long-term non-linear behavior, implying that the ability to predict future states of a system are nearly impossible because minor changes in initial conditions vastly change long-term behavior.[7] Due to this non-linearity, it is very difficult, if not impossible, to control chaotic systems in the mechanistic, industrial ways desired by centralized military forces. Complex systems theory offers solutions for coping with chaos.

Complex systems theory, also known as complexity sciences, investigates systems that appear to cope with chaotic behavior and environments to create order from

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[5] Jonathan Shaw, "Why 'Big Data' Is a Big Deal," accessed May 22, 2015, http://harvardmagazine.com/2014/03/why-big-data-is-a-big-deal.
[6] "Cognitive Computing: Artificial Intelligence Meets Business Intelligence," CT400, (April 1, 2015), http://www.research.ibm.com/cognitive-computing/index.shtml.
[7] Antoine J Bousquet, *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity* (New York: Columbia University Press, 2009), 164–173.

chaos. A complex system "exhibits nontrivial emergent and self-organizing behavior."[8] The complex behavior of these systems emerge from the *interactions* of a multitude of less sophisticated parts through *signaling and information processing* that create very *adaptable* systems whose capabilities far exceed the sum of their parts.[9] Military forces must allow complex behavior to emerge, but can only do so through "decentralised [*sic*] and distributed network relations and positive feedback [that] allow for bottom-up emergence and evolution of complex systems [since] complexity and adaptability are greatest at the 'edge-of-chaos' where systemic structure can be retained but is also at its most flexible and creative."[10] United States military forces must change the means, but more importantly the ways, that they organize, train, and equip to create complex systems that harmonize with the national character and the way of war in the Information Revolution.

Orchestrating Harmony

Harmonizing US military forces with the informationized characters of the nation and war demands a three-step process. First, US forces must invest in the network mesh that connects people and systems at the edge of the battle space. Second, the military must train and empower the networked individuals and groups at the edge of the battle space to horizontally share information, reconfigure themselves to solve problems, and adapt to local circumstances. Third, once the emerging systems of networked people prove capable of efficacious complex behavior, eliminate the bloated and unnecessary bureaucracy that stifles complex emerging behavior by demanding vertical information integration in an effort to control the chaos of war that refuses to be controlled.

Creating robust, resilient, interoperable networks is the first step to harmonizing. One such network already exists in the World Wide Web and its Internet Protocols (IP).[11]

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[8] Melanie Mitchell, *Complexity: A Guided Tour* (New York, NY: Oxford University Press, 2009), 13.
[9] Mitchell, *Complexity*, 12–13.
[10] Bousquet, *The Scientific Way of Warfare*, 183.
[11] David Alberts and Richard Hayes, "Power to the Edge. Command...Control...in the Information Age" (Office of the Assistant Secretary of Defense (OASD), Command &

Military forces could generate a similar network architecture among all systems and people by establishing standard communication protocols, via translators or meta-data tagging, among their various networks to allow for interoperable data sharing.[12] Retired US Air Force Lieutenant General David Deptula has coined the term "combat cloud" to describe such a system, while early visions of DOD's Global Information Grid (GIG) attempted to actualize certain elements of the system.[13] Continued proliferation of network connectivity into everyday devices illustrates the ability to create a robust network to connect all present and future military systems.[14] While the technology exists to create the network, how military forces use the network determines its usefulness.

Information, as a resource, is additive and non-linear in its value. Contrary to standard military security procedures, the nature of information demands more access to relevant information in order to maximize its value.[15] Traditional military culture and structure tends to hoard information as a form of institutional leverage and over classification for security purposes. This culture runs counter to harmonizing informational ways with the national character. Technical workarounds exist to strip information of source metadata while still providing the requested information to the end user.[16] Training and empowering a workforce to share information and capitalize on the knowledge network will realize its value.

Luckily for US military forces, America's informationized national character has prepared most recruits for the potential to operate in these networks. As of 2014, almost

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Control Research Program (CCRP), 2003), 82, http://www.dodccrp.org/files/Alberts_Power.pdf.

[12] Alberts and Hayes, "Power to the Edge," 189.

[13] See David Deptula, "A New Era for Command and Control of Aerospace Operations," *Air & Space Power Journal*, August 2014, 11–12. Also, see Alberts and Hayes, "Power to the Edge," 189–198.

[14] Cisco, "Internet of Things (IoT)," *Cisco*, accessed May 25, 2015, http://www.cisco.com/web/solutions/trends/iot/overview.html. The website highlights that internet-enabled devices now outnumber humans 1.5 to 1.

[15] Alberts and Hayes, "Power to the Edge," 72–73.

[16] John Andreas Olsen, *John Warden and the Renaissance of American Air Power*, 1st ed (Washington, D.C: Potomac Books, 2007), 190–191.

87 percent of the US population used the Internet.[17] After growing up in a world of information sharing, including personal details on social networking sites, and self-forming groups to solve problems, the population of potential military recruits is primed to participate in a military information network. US forces must harness this cultural character by bounding, shaping, and educating it for military operations. The training process must avoid standardization of thought, but should encourage variation of perspectives while imbuing the trainees with necessary military discipline. It is the variation and randomness that accompanies it that allows complex systems to evolve and adapt to ever changing environments.[18]

US military forces will garner significant advantage and harmonization by creating a robust network that affords lateral information exchanges at the edge of the battle space and filling those networks with a population primed for its structure. This network "implies a decentralized, open, and adaptable form of organization, naturally best suited to adjusting to a rapidly changing environment through the self-organising [sic] and emergent properties of the network."[19] The success of this network lies "in embracing uncertainty and designing a resilient and flexible military that is capable of adapting to the unforeseen and contingent."[20]

The US Army's mission command concept is an example of a step in the right direction. Mission command is "the exercise of authority and direction by the commander using mission orders to enable disciplined initiative within the commander's intent to empower agile and adaptive leaders in the conduct of unified land operations."[21] Although mission command intends to decentralize initiative and adaptation, it relies on the "science of control to manage information."[22] This "science of control" centralizes information flows back to the commander, creates the same vertical information

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[17] Miniwatts Marketing Group, "Internet World Stats."
[18] Mitchell, *Complexity*, 181–182.
[19] Bousquet, *The Scientific Way of Warfare*, 205.
[20] Bousquet, *The Scientific Way of Warfare*, 222.
[21] Department of the Army, "ADRP 6-0: Mission Command" (Headquarters, Department of the Army, May 17, 2012), 1–1, http://armypubs.army.mil/doctrine/DR_pubs/dr_a/pdf/adrp6_0.pdf.
[22] Department of the Army, "ADRP 6-0: Mission Command," 2–12 – 2–13.

structures antithetical to complex systems, and fails to effectively create a decentralized network.[23]

One criticism leveled at decentralized networks that exhibit emergent behavior is that such systems do not establish a line of accountability for who must ensure the system works and who is to blame if it fails. This criticism is flawed in two ways. First, the critique assumes that emergent behavior is leaderless. This assumption is false as emergent behavior, while complex and chaotic, is lead by an emergent leader, who is chosen by the complex system because he or she is the most appropriate to lead the behavior given the present conditions.[24] Second, if the failure was not due to the emergent leader's actions, but because of the system that chose or enabled that leader, then the commander who oversaw the development and operation of the emergent system could be held accountable.[25] In both cases, the institution upholds the standards of accountability, under different norms and expectations, while creating a flexible and adaptable network. If US military forces desire to create such a network to strategically harmonize, they must get out of their own way by eliminating the ossified industrial organizational structure that inhibits the decentralized, emergent behavior so beneficial to complex systems.

America's military force structure, harmonious and advantageous during the Industrial Revolution, is now detrimental, potentially even debilitating, in the midst of an

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[23] See Bousquet, *The Scientific Way of Warfare*, 220–233., for a similar criticism of network-centric warfare (NCW). Although NCW and mission command are vastly different, both rely on centralization of knowledge to create a common operating picture from which uncertainty and the forces operating within uncertainty can be controlled.

[24] Alberts and Hayes, "Power to the Edge," 184–186., describe how emergent leadership arises. Also Mitchell, *Complexity*, 215–220., discusses Robert Axelrod's cooperation experiment under conditions of evolution with normative and meta-normative reprisals. The experiment suggests, as applied to accountability in emergent leadership, that a culture of appropriate behavior, which is the desired end of accountability. Ones create this culture by establishing a normative system whereby supporting actors in the emergent system are held accountable and punished for not correcting or changing the emergent leader's inappropriate behavior. In a decentralized system, creating a culture of people who do not tolerate others doing the wrong thing is more powerful than creating a culture in which we hope no individual does the wrong thing.

[25] Alberts and Hayes, "Power to the Edge," 209–210.

ever-expanding Information Revolution. First, DOD should rework the Joint Staff structure to eliminate fissures between intelligence, operations, and communication infrastructure and cyber. Information intertwines these facets of military operations so deeply that the artificial organizational separation is anathema to efficacious informationized military operations. Although the Goldwater-Nichols Act of 1986 created the Joint Staff system to bridge the parochial fissures that had developed between the services, it succeeded only in creating a new level of bureaucracy on top of the current service structure and doctrinally cemented the chasms between the functional components of intelligence, operations, and C4 and Cyber.[26] The provisions of the Act to encourage inter-service understanding and promote joint behavior are insufficient to create the level of integration at the edge of the battle space required by informationized warfare.

In the process of organizational adaptation, the US military must rework or eliminate the current concept of intelligence. The notion of information processing in support of the operational commander breeds centralization and vertical information integration. Although context application and information processing functions of intelligence are important, in a decentralized network environment, the raw data and its processed form are relevant to all, not just a central figure.[27] Current ISR systems, whether on or in the ground, sea, air, and space, must post their data on the network before layering vertical processing on it to create traditional intelligence products. Once military forces begin fusing operations and information across all domains, the next logical step is to adapt the structure of the services or the very concept of distinct services.

Decentralized organizations of secure, interoperable networks fused across the front edge of the battle space suggest a diminishing desire or need for unique services. When navies primarily fought on the seas and transported armies who fought on land,

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[26] *Goldwater-Nichols Department of Defense Reorganization Act of 1986*, 1986, 1009–1011, http://history.defense.gov/Portals/70/Documents/dod_reforms/Goldwater-NicholsDoDReordAct1986.pdf.

[27] Alberts and Hayes, "Power to the Edge," 82–83, 101–102.

neither affecting the other's domain beyond limited coastal engagements, separation of services by domain was logical.[28] Even in World War II, when naval guns on battleships only ranged 24 miles and aircraft could strike deeper in enemy territory than land or sea forces, domain separations made sense.[29] However, the advent of surface-launched cruise missiles that travel over 1000 miles, aircraft that can loiter over and observe vast swathes of land and sea, and surface-to-air missiles that cover 100 mile radii, all blend the physical separations among domains.[30] The need for interoperable networks, increased information sharing, and wide-spread, multi-disciplinary integration or all-domain information and operations challenges the desire and necessity of domain-specific service delineations.

Commensurate with the dissolution of the horizontal fissures of interoperability, US military forces must reduce the hierarchical structure and bureaucratic waste layered on top of the complex system network. Bureaucracies and hierarchies developed during the Industrial Revolution in order to control and coordinate growing numbers and types of specialties.[31] Given the information architecture available during industrialization, organizing hierarchically was the most effective method of optimizing and controlling mechanistic physical systems. However, as illustrated by the progress and growth of decentralized, flatter commercial organizations, bureaucratic hierarchies are no longer necessary or desired in informationized systems and serve only to generate discord.

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[28] Julian Stafford Corbett, *Some Principles of Maritime Strategy* (Annapolis, Md.: Naval Institute Press, 1972), 11–15. Corbett discusses the limited interaction but supporting functions of armies and navies in maritime strategy.
[29] Tony DiGiulian, "USA 16"/50 (40.6 Cm) Mark 7," February 5, 2007, http://web.archive.org/web/20070205233558/http://www.navweaps.com/Weapons/WNUS_16-50_mk7.htm.
[30] GlobalSecurity.org, "BGM-109 Tomahawk," *GlobalSecurity.org*, accessed May 25, 2015, http://www.globalsecurity.org/military/systems/munitions/bgm-109-specs.htm., "RQ-4 Block 10 Global Hawk," *Northrop Grumman*, accessed May 25, 2015, http://www.northropgrumman.com/Capabilities/RQ4Block10GlobalHawk/Pages/default.aspx., and GlobalSecurity.org, "RIM-174 SM-6 Extended Range Active Missile (ERAM)," *GlobalSecurity.org*, accessed May 25, 2015, http://www.globalsecurity.org/military/systems/munitions/sm-6.htm.
[31] Alberts and Hayes, "Power to the Edge," 41–42.

The United States must harmonize the means and ways of its military forces with the national character and character of war in the Information Revolution to minimize the risks posed by emerging and capable threats and to capitalize on the opportunities afforded by the rapid growth of information generation and processing tools coupled with the concepts of complex systems theory.

Summary and Conclusion

Strategic harmonization of national character, military forces, and the character of war during socio-technological revolutions requires military forces to shed historically successful means and ways and adapt new resources and methods to harmonize with and leverage revolutionary change. The United States is in the midst of one of the most sweeping socio-technological upheavals in human history: the Information Revolution. The revolutionary repercussions span a spectrum of change with Alvin and Heidi Toffler's revolutionary wave theory describing the broad civilization changes that have occurred during transitions between agrarian, industrial, and information-based societies. Revolutionary waves transform society, but most importantly the waves shift how the societies create wealth. The changes in methods of wealth production also impact they means and ways the militaries of transforming nations fight.

MacGregor Knox and Williamson Murray's concept of military revolutions illuminate how the Toffler's revolutionary waves might reverberate through and change the organization and methods of military forces. Often forced to ride the wave of change, military forces transform along with the society from which they derive. Although smaller military revolutions occur more frequently and absent revolutionary waves, the MRs that occur concurrent with such waves are irresistible and profound. Within the MRs, smaller and more frequent revolutions occur that transform the ways militaries conduct war.

Revolutions in Military Affairs, a term made famous by Andrew Marshall and his team in the Office of Net Assessment, are the technological glue between broader MRs and the ever-changing character and conduct of war. Revolutions in Military Affairs encompass organizational, operational, and technological changes in how militaries

conduct war, and the attending effects on the adversaries and character of war. The three levels of revolutions form a structure for building a theory of strategic harmonization.

The spectrum of revolution constructs the basis for the three elements of strategic harmonization: the national character, military forces, and the character of war. Each of these three elements includes means, ways, and ends, the harmonization of which across all three elements reduces strategic risk. The national character provides the means that military forces translate into strategic effect within the character of war. National resources and the population supply the means of the national character that through wave-specific ways translate those resources into the ends of wealth production. The ends of national character provide the resources of military forces, along with the human means and their culturally formed ways.

Military forces, as the bridge between nation and war, transform the means supplied by the nation into military ends. These ends supply the means to generate strategic effect within the character of war, while the methods of organizing and training military forces also determine the ways available to military forces in war. The means and ways used by military forces in the character of war generate strategic effects to achieve the ends of war. These ends, in term, are determined by the means and ways of the adversary's national and military character. The goal of strategic harmonization is to align the national character of wealth production with the means and ways military forces use to generate strategic effect within the ever-changing character of war. US military forces strategically harmonized well during the Industrial Revolution, culminating in World War II.

During the Industrial Revolution America grew from a fledgling frontier country to the world's largest economy and possessing its most effective military force. The national character transitioned from an agrarian society relying on wind, water, wood, and rural craftspeople to an industrial society built on iron, coal, oil, and urban factory workers. Bureaucratic organizations expanded and centralized in order to coordinate and control increasingly massive production through standardization and functional specialization. The ends of industrialized society were machines that allowed humans to move farther, faster, and accomplish more wherever they went. These machines and the factory workers who built them provided the means of industrial military forces.

Industrial military forces, consisting of standardized and specialized machines and people harmonized well with the national character and the character of industrial war. Centralized hierarchies proved just as successful coordinating and controlling military forces of men and machines as they did the nation from which those resources came. Like the nations for which they fought, industrial military forces could go farther, faster, and more powerfully than ever before, and they relied on increasingly vast industrial resources extracted, produced, and supplied by their supporting nations. It was this reliance that shaped the character of industrial war.

Industrialized war approached Clausewitz's concept of absolute war almost completely, as military forces, now capable of reaching deep into an enemy's country, strove to destroy an adversary's ability to wield its military forces, to produce and supply those forces, and its will to do both. Military forces attacked these objectives through increasingly massive arsenals of specialized machines centrally coordinated and directed at destroying the adversary's ability to produce and supply their military forces. When even those objectives proved ineffective against the Japanese, US military forces resorted to attempting to break Japanese will through firebombing and delivery of two atomic weapons. The advent of nuclear weapons and the computers that made them possible ushered in the next revolutionary wave: the Information Revolution.

US national character changed slowly after World War II, but transformed with increasing speed as computers and the networks connecting them proliferated. The ends of national wealth production shifted from the mass production of standardized things to the cognitive, flexible, and additive creation of information, processes, and knowledge tools that allowed humans to expand and relocate information processing and cognition. As information became the primary means of wealth production, successful companies became flatter, decentralized, integrated, flexible, and adaptable. The companies that failed to adapt often ceased to exist. The same cannot be said of US military forces.

US military forces adopted many of the means of the Information Revolution, but without the associated ways that created so much value for the nation. Fear of accidental escalation and destructive nuclear war bears much of the responsibility for this organizational stagnation as it drove increasing centralization of control, reinforcing vertical information channels and bureaucratic hierarchies. However, even as

information means became more ubiquitous through the widespread employment of PGMs, networks, sensors, and computers, US military forces remained wedded to industrial ways and ends. The resultant discord with the nation and the character of war led to significant military setbacks and potential strategic failure.

Although the United States achieved considerable success in Operation DESERT STORM, where the character of war conveniently harmonized with US military forces, the nation struggled through three other conflicts in Vietnam, Iraq, and Afghanistan. In all three of these struggles, American military forces and the informationized character of war were in discord. While US forces perpetuated industrial ways layered on informationized means, their adversaries adapted to both the means and ways of informationized warfare by decentralizing, flattening, and harmonizing with their national characters. Although none of the adversaries faced by the United States posed an existential threat to the nation, other nations are emerging that have shown the capabilities and willingness to use information means to threaten America and its interests.

The United States must harmonize its military forces with an informationized national character and character of war. The solution proposed in this paper of investing in a ubiquitous network architecture, training and empowering the forces to become a part of a complex system at the edge of the battle space, and the elimination of wasted bureaucratic overhead and organizational barriers to integration suggests further areas for research. The GIG concept began in 2001, but has yet to materialize.[32] A fully realized GIG would go a long way to creating the type of network suggested in this paper. One could help immensely by researching the status of the GIG, why has it been delayed, modified, or has failed, and what impediment must the US military overcome to bring it to fruition.

Actualizing the solution suggested in this paper also requires research into human behavior and organizational reform. The methods of discipline and drill used to create

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[32] US Joint Forces Command, "Capstone Requirements Document: Global Information Grid (GIG)" (Department of Defense, August 30, 2001), www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA408877.

desired industrial military culture have existed for centuries, but run counter to the informationized national culture and the ways necessary for today's military forces to harmonize. A study of the methods that might be employed to foster military discipline without the standardization of thought and behavior required by traditional training techniques and ways in order to shape a military culture that allows for increase individualism, diverse cross-functional emergent group behavior, and bounded risk taking could create concrete measures to achieve this vision.

Research into how to train informationized forces as well as the best organizational structure to empower those forces will require extensive experimentation and the assumption of some tactical and operational risk. Even in the informationized national character, different organizational structures abound, including hierarchical ones similar to the US military's. However, to achieve the complex system behavior this paper describes as necessary for the current revolution, significant changes must be made to the military's structure. The details of these changes, what vertical fissures to eliminate, and how to re-organize the forces without creating new cultural seams requires further investigation.

Additionally, this paper suggests further research to explore the generality of the theory of strategic harmonization. Did similar discord occur in nations transitioning from agrarian to industrial societies, and if so, how did they re-harmonize? Stalinist Soviet Union, Maoist China, or industrializing Great Britain provide potential case studies of such forced and natural harmonization. Other nations currently transitioning from agrarian to industrial or industrial to informational societies might also be studied.

Finally, strategic harmonization of military forces is essential to efficaciously translating national character into strategic effect in war. Although the nature of war is immutable and Clausewitz's violence, reason, and chance endure, the character of the Information Revolution suggests a re-evaluation of reason's purpose. Since Clausewitz's time and through the Industrial Revolution, many have attempted to apply reason to reduce the effects of chance and the inherent uncertainty of war. Complex system theory, however, suggests that chance is not something to be reasoned away, but something to embrace and reinforce. Chance and uncertainty are not the great unknowns of war to be dominated and tamed by human endeavors. Instead chance, randomness, and uncertainty

are the creators of adaptability and evolution to be observed, nurtured, and harnessed, allowing our forces to out-change our adversaries and harmonize with the Information Revolution.

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