Complexity and Innovation:

Army Transformation and the Reality of War

A Monograph
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14. ABSTRACT

On 12 October 1999, the U.S. Army began a journey down a new path to innovation, when General Eric Shinseki presented his vision of Army Transformation at the 45th annual meeting of the Association of the United States Army. In this speech, General Shinseki described the Army as an organization consisting of heavy forces with excellent staying power but poor strategic responsiveness, light forces with excellent responsiveness but poor staying power, and a logistics system with an excessively large footprint. His proposed solution, a comprehensive change of the Army resulting in full-spectrum dominance and strategic responsiveness, would occur so quickly as to "be unnerving to some." While this prediction has turned out in many ways to be true, it is not necessarily the speed of change that is unnerving to many of the people studying Army Transformation. This study's research question is, "Does Army Transformation embody the concepts of complexity theory as applied to organizational design?" Because Army Transformation lacks a clearly articulated theoretical framework, seeking to develop a Future Force in the absence of a specific operational design and supporting doctrine, the process is subordinated to the whims of Army culture and parochial bias. Complexity science is one possible source of sound theoretical principles that could provide a guiding framework to the transformation process. The study demonstrates that Army Transformation is in conflict with all of the major principles of dynamic systems, complex networks, chaos, and complexity theory. Several recommendations are provided in Chapter six. These recommendations focus on culture, by attempting to influence discourse so that it is at less risk of severe divergence with the reality of the complex world. In order to bring Army Transformation in line with CRP theory, the Army should: (1) facilitate emergence by encouraging the innovative efforts of change agents distributed throughout all levels of the Army; (2) modify education and training systems to promote adoption of a complexity CBM; and (3) abandon the speculative pursuit of the "Information-RMA" and its associated technological panaceas.

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Abstract

COMPLEXITY AND INNOVATION: ARMY TRANSFORMATION AND THE REALITY OF WAR by MAJ Mark T. Calhoun, U.S. Army, 85 pages.

On 12 October 1999, the U.S. Army began a journey down a new path to innovation, when General Eric Shinseki presented his vision of Army Transformation at the 45th annual meeting of the Association of the United States Army. In this speech, General Shinseki described the Army as an organization consisting of heavy forces with excellent staying power but poor strategic responsiveness, light forces with excellent responsiveness but poor staying power, and a logistics system with an excessively large footprint. His proposed solution, a comprehensive change of the Army resulting in full-spectrum dominance and strategic responsiveness, would occur so quickly as to "be unnerving to some." While this prediction has turned out in many ways to be true, it is not necessarily the speed of change that is unnerving to many of the people studying Army Transformation.

This study's research question is, "Does Army Transformation embody the concepts of complexity theory as applied to organizational design?" Because Army Transformation lacks a clearly articulated theoretical framework, seeking to develop a Future Force in the absence of a specific operational design and supporting doctrine, the process is subordinated to the whims of Army culture and parochial bias. Complexity science is one possible source of sound theoretical principles that could provide a guiding framework to the transformation process. Chapter one serves as an introduction to the problem. Chapter two describes the study's methodology. Chapter three introduces several concepts of culture as it applies to warfare and the military, demonstrating the need for a foundation in scientific theory to shift Army culture toward more beneficial patterns of change. Chapter four reviews complexity theory and describes the recent advances of Complex Responsive Processes (CRP) theory, demonstrating how complexity can provide a Common Body of Metaphor (CBM) to guide innovation processes. Measures of merit derived from established concepts of CRP theory facilitate the determination of a yes or no answer to the research question.

The study demonstrates that Army Transformation is in conflict with all of the major principles of dynamic systems, complex networks, chaos, and complexity theory. Several recommendations are provided in Chapter six. These recommendations focus on culture, by attempting to influence discourse so that it is at less risk of severe divergence with the reality of the complex world. In order to bring Army Transformation in line with CRP theory, the Army should: (1) facilitate emergence by encouraging the innovative efforts of change agents distributed throughout all levels of the Army; (2) modify education and training systems to promote adoption of a complexity CBM; and (3) abandon the speculative pursuit of the "Information-RMA" and its associated technological panaceas.

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CHAPTER ONE

INTRODUCTION

On 12 October 1999, the U.S. Army began a journey down a new path to innovation, when General Eric Shinseki presented his vision of Army Transformation at the 45th annual meeting of the Association of the United States Army. In this speech, General Shinseki described the Army as an organization consisting of heavy forces with excellent staying power but poor strategic responsiveness, light forces with excellent responsiveness but poor staying power, and a logistics system with an excessively large footprint. His proposed solution, a comprehensive change of the Army resulting in full-spectrum dominance and strategic responsiveness, would occur so quickly as to "be unnerving to some."[1] While this prediction has turned out in many ways to be true, it is not necessarily the speed of change that is unnerving to many of the people studying Army Transformation.

WHAT IS ARMY TRANSFORMATION?

The process of Army Transformation that General Shinseki described, and more fully developed in the "Transformation Campaign Plan" and "White Paper; Concepts for the Objective Force," centered on a strategy of moving from today's Army, the "Legacy Force," through an "Interim Force" that would provide some of the desired innovations relatively quickly, culminating in the "Objective Force" as the ultimate realization of the transformation ideal. The Objective Force would possess several key capabilities that would make it ideally suited to operate in the "emerging operational environment," adapt to the "evolving conduct of war," and conduct "full spectrum operations." At the operational level, the Objective Force would conduct "operational maneuver from strategic distances," capable of "early arrival in a crisis…decisively attacking and defeating the center of gravity of any adversary," retaining initiative through its "continuous and non-contiguous nature." At the tactical level, Objective Force units would " *see*

first, understand first, act first and finish decisively as the means to tactical success (emphasis in the original)." These tactical capabilities would be provided by "unprecedented intelligence, surveillance and reconnaissance capabilities," and "instantaneous dissemination of commander's intent coupled with broad access to the Common Operating Picture (COP) on a non-contiguous battlefield." As a result of these new capabilities, the resulting Objective Force would be responsive, deployable, agile, versatile, lethal, survivable and sustainable.[2]

FROM THE OBJECTIVE FORCE TO THE FUTURE FORCE

Army Transformation has changed in the period since General Eric Shinseki's retirement, but its major principles have remained constant. Instead of the Objective Force, we are now headed for the Future Force, in recognition that military change is an ongoing process, rather than a path to a clearly definable, final objective. Nevertheless, the key concepts forming the basis of the process remain the same.

General Peter Schoomaker, the recently appointed Army Chief of Staff, described his vision of the Army's future in a speech to the Association of the United States Army on 7 October 2003. Rather than describing any specific changes to Army Transformation, General Schoomaker pointed out the need to modernize the Army while continuing operations in the war against terrorism. He emphasized the need to develop "joint interdependence," and mentioned a recent senior leader assessment of fifteen areas of immediate focus that will be used to determine "where we are and where we need to go." Specific areas identified in this assessment include: a "move toward modular capabilities-based unit designs nested within the joint network and enabled by a joint and expeditionary mindset;" a "move towards a concept of unit manning;" "balance between the active and the reserve components;" the need for the Combat Training Centers (CTCs) and the Battle Command Training Program (BCTP) to "adapt to the future

[1] Eric Shinseki, "Address to the Eisenhower Luncheon" (Address presented to the 45th annual meeting of The Association of the United States Army in Washington, D.C., 12 October 1999).

challenges;" and a revitalization of our installations in order to achieve a robust information infrastructure and "sufficient bandwidth to enable true 'Reach-Back' capabilities."[3] General Schoomaker's most recent initiatives have focused on adjustments to Army force structure to better accommodate commitment levels associated with the war on terrorism, but his emphasis remains "an Army that can operate globally, with much more agility and flexibility than in the Cold War when we had a different enemy and mission."[4]

Army Transformation has taken on a slightly different character since the recent change in Army Chief of Staff, but the underlying concepts and systems procurement programs--many of which display great potential to benefit the Army--remain the same. In General Schoomaker's words: "As long as the United States Army has existed we have transformed--and we always will. For four years under General Shinseki our Army has asked hard questions and made tough choices. We will continue to go where the answers to those questions take us. Our azimuth to the future is good. The Army must remain relevant and ready."[5]

THE PROBLEM WITH ARMY TRANSFORMATION

Unfortunately, certain aspects of Army Transformation have sparked debate and consternation among both Army personnel and civilian defense analysts. This section will briefly address three key areas of concern: Future Force procurement and design parameters; the Army's need for "full-spectrum" capability; and the concern that Army Transformation relies too much on the hoped-for capabilities of future technologies.

Much debate has focused on one of the fundamental goals of Army Transformation:

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[2] All text quoted in this paragraph may be found in the United States Army White Paper, "Concepts for the Objective Force."
[3] Peter Schoomaker, "Address to the Eisenhower Luncheon" (Address presented to the 49th annual meeting of The Association of the United States Army in Washington, D.C., 7 October 2003).
[4] Joseph Galloway, "An Interview with General Peter J. Schoomaker, Army Chief of Staff," *Knight Ridder Newspapers* 16 January 2004 [on-line]; available from http://www.realcities.com/mld/krwashington/news/special_packages/galloway/7729126.htm; Internet; accessed 5 February 2004.
[5] Peter Schoomaker, Arrival Message upon appointment as Army Chief of Staff, August 2003.

> According to *Concepts for the Objective Force,* the Army goal is deploying "a brigade combat team anywhere in the world in 96 hours after liftoff, a division on the ground in 120 hours, and five divisions in theater in 30 days. This will drive system and capability parameters." While this requirement suggests a major redesign of maneuver formations, there is no compelling basis for this principle force design metric. There is a case for a rapidly deployable expeditionary force, but why a brigade in 96 hours? The Army must make difficult tradeoffs in its design parameters (force lethality, mobility, and sustainability) to meet these extremely demanding and seemingly arbitrary deployment timelines.[6]

This observation demonstrates the problem inherent in stringent design parameters imposed in an arbitrary manner, rather than theoretically supported requirements of a clearly described and tested operational design. New technologies and equipment designs must be integral components of the doctrine within which they will be implemented. A military reformer must first develop a generally accurate picture of the essential dynamics of anticipated future warfare, then determine the operational concepts that will lead to victory in this environment, and finally translate these concepts into a clear and effective doctrine. This doctrine then serves as "the conceptual core around which decisions must be made concerning how the force should be organized, trained, and equipped to win the next war."[7]

The important question to ask is whether these seemingly arbitrary design parameters are truly arbitrary, or whether they are an integral component of a viable future doctrine. One possible explanation for the emphasis on deployment speed and the resulting decisions to reduce the weight of our mechanized vehicles (by reducing armor protection, a survivability reduction that will be offset by technologies still in development) can be found in the last sentence of General Schoomaker's quote above, describing the Army's need to remain relevant. The requirement to ensure the future relevance of the Army was a constant theme in Army Transformation throughout General Shinseki's tenure as Chief of Staff, and it remains a central theme under General Schoomaker. Relevance, as it applies to military innovation in an

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[6] Andrew F. Krepinevich, JR., "The Army and Land Warfare: Transforming the Legions." *Joint Forces Quarterly* (Autumn 2002): 80.
[7] Harold R. Winton and Davie R. Mets, eds., *The Challenge of Change* (Lincoln, NE: University of Nebraska Press, 2000), xii.

environment of competing priorities and limited resources, means dollars and force structure. If another service can provide a necessary capability better or faster than the Army, we lose relevance. Thus, the process of transformation is largely guided not by sound principles of military innovation, but service parochialism and competition for limited resources.

The influence of service parochialism is further demonstrated in the growing popularity of the notion of a current Revolution in Military Affairs (RMA). There was a growing consensus in the 1990s among military analysts that an RMA was emerging, but the Army initially failed to join the other services in claiming that its in-progress plans, programs and budgets already embodied this revolution. Rather, at this stage the Army's position was that the existence of an RMA had not yet been definitively demonstrated. It was only after a decade of experimentation and restructuring of its transformational plans that the Army no longer treated the RMA as a hypothesis. The result, in one analyst's view, was a failure on the Army's part to assert its rightful jurisdiction over land combat as technologies and organizations changed. Rather than ensuring "full and final jurisdiction, one profession *winning at the expense of all others"* (emphasis added), the Army left itself vulnerable to the challenge presented by the other services over its "traditional occupational exclusivity."[8] Thus is revealed the influence of service parochialism, and the thinly veiled emphasis on plans, programs and budgets that advance one service's priorities over what is best for the nation's defense. While a competitive inter-service environment is natural (and to a certain degree productive), the resulting quest for relevance must be balanced with sound theory and operational design to achieve beneficial innovation.

Official publications describing Army Transformation often refer to “full-spectrum dominance.” Nevertheless, in practice the process focuses rather narrowly on those capabilities in which the U.S. Army is already the world’s most capable military, and neglects those capabilities that in recent years have proven to be problematic. In Haiti, Bosnia, Kosovo, Somalia and most recently in Iraq, the Army’s greatest challenges were not related to war fighting capability; rather

they were the challenges related to peacekeeping, stability and support, and nation building operations. In the words of General (Retired) Anthony Zinni, “What strikes me is that we are constantly redesigning the military to do something it already does pretty well…. If we're talking about the future, we need to talk about not how you win the peace as a separate part of the war, but you've got to look at this thing from start to finish. It's not a phased conflict; there isn't a fighting part and then another part."[9] If Army Transformation is going to be truly full-spectrum, it must begin with a thorough analysis of the roles and missions the Army will be expected to perform in the future, and a determination of the capabilities and organizational structure the Army will require in order to fulfill those expectations.

In describing the Army's purpose, *Field Manual 1* states: "The Army's nonnegotiable contract with the American people is to fight and win our Nation's wars."[10] Nevertheless, recent historical events do not support the common assumption (and typical training strategy) that proficiency at decisive combat operations necessarily leads to proficiency in stability and support operations. This is clearly demonstrated in the Army's recent experiences both in Operation Enduring Freedom in Afghanistan, and in Operation Iraqi Freedom. In both of these operations, technological superiority enabled the Army to made relatively quick work of defeating enemy combat forces. However, upon the conclusion of decisive combat operations, problems in the Army's ability to conduct stability and support operations while opposed by insurgents and guerillas became clear. The likelihood of encountering this type of resistance in the future is clearly demonstrated by a review of history, which demonstrates that a less advanced enemy either quickly makes up the technological disparity, or "tends to adopt guerilla techniques."[11] Throughout history, victory in the decisive combat phase of an operation is incomplete if the peace cannot be sustained post-conflict, and winning the war does not automatically lead to

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[8] Lloyd J. Matthews, ed., *The Future of the Army Profession* (Boston, MA: McGraw-Hill, 2002), 104-106.
[9] Anthony Zinni, "Address by General Anthony Zinni, U.S. Army (Retired)." (Address presented to The Marine Corps Association and U.S. Naval Institute Forum 2003, 4 September 2003)
[10] Department of the Army, *Field Manual 1*, *The Army* (Washington, D.C., 2001), 21.

securing the peace. Any Future Force design must ensure the capability to conduct both of these missions equally well.

A logical inconsistency exists in the shift toward a lighter, more deployable force and the resulting decrease in armor protection of the Army's future mechanized vehicles. This tradeoff of mobility for armor protection will be overcome by advanced technology that will provide survivability by enabling the vehicle to destroy any enemy before it can get close enough to engage the vehicle. The result will be a weapon system ill suited for operations requiring close interaction with a local populace that may conceal an isolated terrorist or insurgent threat: "If the systems cannot survive on their own in the presence of enemy forces, if they can survive only by killing everything that might harm them, then they cannot play their necessary role in operations other than war, including those supporting the transition from war to peace."[12]

This problem is further evidenced in Army Transformation's high degree of reliance on solutions to be provided by future technologies:

> The emphasis throughout this vision is on standoff capabilities. The situation will be developed "out of contact," that is, by satellite and airborne sensors rather than by the armed reconnaissance of ground elements. Yet one of the advantages of using ground forces to conduct reconnaissance is that the very presence of such forces compels the enemy to react. In this way it is possible to gain an understanding not only of where the enemy is, but also of how he is likely to behave when the attack begins. Long-range sensors cannot discern these characteristics of an enemy force because frequently the enemy does not know how he will react until he is actually confronted with a particular situation. It is clear that "developing the situation" has come to mean, even for the Army, simply identifying targets.[13]

It is apparent that the current approach to Army Transformation may not lead the Army to a force ideally suited to provide the unique capabilities for which it is historically called upon. Killing the enemy at great distances with precision munitions is a capability that already exists in the Air Force and the Navy. It is both the ability to close with and destroy a determined enemy, *and* the ability to closely interact with a local populace during stability and support operations,

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[11] Christopher Bellamy, *The Evolution of Modern Land Warfare* (New York, NY: Routledge, 1990), 34.
[12] Frederick W. Kagan, "War and Aftermath." *Policy Review* (August-September 2003): [on-line]

that have traditionally been the defining roles of the Army; and these are capabilities any Future Force must possess.

The reliance on technological solutions is similarly evident in claims that information technology and a "global information grid" will reduce uncertainty in war.[14] In the decade following the 1991 Gulf War, increasingly widespread belief in American technological superiority led many to believe the "information revolution" would soon lift the fog of war. In the words of H.R. McMaster: "The belief that industrial age warfare had been supplanted by yet-to-be-defined information age warfare gained wide acceptance."[15] By the late 1990s, business information management practices were seen as potential military solutions, as described in books such as *Network Centric Warfare.* In 2002, the U.S. Air Force published its "Air Force Transformation Flight Plan" in which "predictive battlespace awareness" was put forward as a future capability that would "anticipate our adversary's next move before he makes it" and "eliminate surprise."[16] As described above, recent Army Transformation documents display a similar reliance on information superiority to overcome the reduced survivability of the lighter combat vehicles of the future. What is particularly troubling about this trend is that it not only dominates future vision, but it has migrated to the present, where it is shaping current Army doctrine. This can be seen both in recent doctrinal publications including the Interim Brigade Combat Team's tactical doctrine and *Field Manual 1,* as well as the manner in which recent joint experiments such as Millennium Challenge 2002 are scripted to validate concepts of dominant battlespace knowledge and predictive intelligence. [17]

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[13] Ibid.
[14] JV2020, 12. While this is a study of Army Transformation, the process is a subset of Department of Defense Transformation. Therefore, Joint Transformational and operational concepts shed light on the Army's innovation process.
[15] H.R. McMaster, "Crack in the Foundation: Defense Transformation and the Underlying Assumption of Dominant Knowledge in Future War," [Online] available from http://carlisle-www.army.mil/usacsl/publications/S03-03.pdf, accessed 30 December 2003, 11.
[16] Air Force Transformation Flight Plan, as quoted in McMaster, 24-5.
[17] McMaster 40-1 and 61-3.

Paradoxically, the very emphasis on technology that leads some to believe precision-guided munitions will reduce the need for sizeable ground forces has created the opposite situation in recent combat experience: "Ever-more lethal precision engagement technology is driving our opponents increasingly into cover and increasingly into complex terrain--and these are the postures that demand the largest proportion of dismounted strength in the American combined arms mix. Hence the demand for dismounted infantry in Army combat units is likely to rise over time."[18] It is interesting to note the shift in the most recent version of Joint Vision 2020 away from the technological emphasis of earlier Department of Defense transformation documents: "We must also remember that information superiority neither equates to perfect information, nor does it mean the elimination of the fog of war. Information systems, processes, and operations add their own sources of friction and fog to the operational environment." This is a promising shift, but it is inconsistent with other portions of the same document that continue to emphasize the information revolution and the profound changes it will cause in military operations. After more than a decade of ever-increasing claims of the advantages provided by information technology, "caveats could not overcome the momentum behind the belief that technology would lift the fog of war."[19]

TRANSFORMATION: A CONCEPT IN SEARCH OF A THEORY?

These and other logical inconsistencies in our current concept of transformation point to a key underlying issue: Army Transformation lacks a clearly stated theoretical basis. The most important purpose of a body of knowledge, embodied in the form of a theory, is to provide a sense of understanding. This sense of understanding can only exist if the causal mechanisms that link changes between dependent and independent variables are fully described. This is necessary to instill confidence among all members of the interested community that the causal relationships

[18] Stephen Biddle, "Afghanistan and the Future of Warfare," [Online] available from http://www.carlisle.army.mil/ssi/pubs/2002/afghan/afghan.pdf, accessed 5 February 2004, 57.
[19] McMaster, 38.

described in a theory are true.[20] In other words, if future roles, missions or the environment of conflict (the independent variables) change, we must change the Army in certain ways (the dependent variables) to meet the resulting challenges. This clear description of the linkage in causal relationships can be difficult to develop and articulate, but without such a theoretical framework, innovation is mere speculation. Without a basis in theory, change processes are often steered less by an objective optimization of the organization for future realities than a collection of culturally biased, parochially motivated measures.

In the case of Army Transformation, the lack of an explicitly stated theory as a basis for change is evident in several characteristics of the process: the top-down, leader-directed nature of Army Transformation, in which key leaders dictate concepts of change to be executed by the force rather than seeking out and instituting emergent innovations based upon objective experimentation; the absence of a clearly defined operational design for the future force; the vagueness of the perceived roles and missions of the Future Force; the reliance on immature technological solutions to the problems inherent in conceptions of the Future Force; and the lack of empirical testing of experimental Army doctrine, organization and equipment at the joint operational level to ensure its effectiveness in realistic scenarios--before procurement and fielding begin. This paper will describe the cultural sources of these factors, illustrate the dangers inherent in these cultural tendencies through historical examples, and propose a scientific model that can provide guiding principles for a clearly defined theory of Army Transformation.

[20] Paul Davidson Reynolds, *A Primer in Theory Construction* (Boston, MA: Allyn and Bacon, 1971), 7-9.

CHAPTER TWO

METHODOLOGY

This study's research question is, "Does Army Transformation embody the concepts of complexity theory as applied to organizational design?" Complexity theory gained notoriety in the early 1990s as a representation of insights gained into the function and significance of complex systems and dynamical processes. It built on earlier studies in chaos and catastrophe theory, providing detailed understanding of concepts including self-organization, emergence and the theory of Complex Adaptive Systems. It is a theory that has been studied for more than a decade by some of science's leading minds, at colleges and institutes around the world, including the prestigious Sante Fe Institute. Complexity science has been applied in many fields including economics, evolutionary theory, physics, computer science, and organization design. Complex Responsive Process (CRP) theory is perhaps the most recent advance in the study of complexity in organizations. CRP theory moves beyond the notion that human organizations should be viewed as mechanical systems, emphasizing the unique scientific nature of human interaction as a source of key insights into the manner in which organizations best achieve truly novel change.

This study’s hypothesis is that the application of complexity theory to organization design provides concepts that could significantly improve the way the Army is currently seeking to innovate. Because Army Transformation lacks a clearly articulated theoretical framework, seeking to develop a Future Force in the absence of a specific operational design and supporting doctrine, the process is subordinated to the whims of Army culture and parochial bias. Complexity science is one possible source of sound theoretical principles that could provide a guiding framework to the transformation process. Chapter four will review complexity theory and describe the recent advances of CRP theory, demonstrating how complexity can provide a Common Body of Metaphor (CBM) to guide management and innovation processes. Measures of merit derived from established concepts of CRP theory will facilitate the determination of a yes or no answer to the research question.

MEASURES OF MERIT

The use of complexity theory as a guiding framework for organization design is only one of a large and diverse range of applications of the theory, but it continues to gain momentum and general acceptance within the scientific community. The topic is addressed in numerous books, studies and scientific journals, and case studies abound that demonstrate the increased effectiveness of organizations that incorporate concepts derived from complexity theory into their operations. This study will utilize measures of merit derived from several principles of CRP theory. These principles present several challenges to the universal prescriptions of mainstream thinking about stability and change in organizations, and the manner in which organizations innovate. They include the recognition that: (1) predictability in the evolution of complex organizational processes is severely limited; (2) self-organizing interaction is the central transformative cause of emergent new directions in the development of an organization; (3) individual choice is limited; (4) stability in organizations does not derive from control; (5) diversity and difference are vital to creativity; and (6) the ability to design and plan is limited.[21]

These principles of CRP theory provide the following measures of merit: *Prediction*, defined as the reliance on highly specific, predictive models of the future; *Control*, defined as the reliance on top-down, hierarchical control and consensus building; and *Stability*, defined as the attempt to reduce redundancy, inefficiency and difference. These measures of merit and the principles upon which they are based will be described in greater detail in chapter four. They will serve as a lens through which to view the three case studies presented in chapter five. This analysis of military innovation processes in the Napoleonic era, the German Army between 1870 and 1939, and the U.S. Army during the interwar period, will demonstrate alternatives to the Army's current approach to transformation, and determine whether establishing CRP theory as the intellectual foundation of Army Transformation would improve the process. This evaluation

according to the study's measures of merit will both support the analysis of the Army's current innovation process, and provide the framework by which to answer the research question.

SIGNIFICANCE

The process of innovation is constant in a military organization. Its inherent difficulties are compounded by the fact that it is generally undertaken in an environment of limited budgets and an unclear future. While change is a universal constant in any military organization, Army Transformation is a process that is unique in the Army's history. This is because the Army is being directed toward a radically different Future Force design, requiring significant changes in organization, doctrine and equipment, in the absence of a looming major conflict and the corresponding increase in resources that would result. Historically, truly dramatic, sweeping changes in military organizations usually occur rapidly only during those brief periods when an impending major confrontation places national survival at stake, or some intellectual spark ignites a dramatic conceptual leap in military doctrine or organization. The lack of a specific threat, the scarcity of resources, and the absence of any demonstrable conceptual advances (unfounded assertions of the proponents of the I- RMA aside) make the Army's current attempt to achieve radical change especially problematic.

History abounds with examples of the failure to effectively innovate. The dangers are evident--procurement programs are expensive and lengthy, and once a major force redesign is adopted, it will take many years and a great deal of money to change course if the chosen path is fundamentally flawed. The leadership-driven approach of Army Transformation ensures the stakes are even higher. Consciously or not, little effort is currently being made to elicit emergent innovation from within the Army--rather, the Army's senior leadership determines the general and specific components of the process, and directs its implementation. This top-down approach is

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[21] Ralph D. Stacey, Douglas Griffin and Patricia Shaw, *Complexity and Management: Fad or Radical Challenge to Systems Thinking?* (New York: Routledge, 2000), 123-5.

not without precedent, and is not necessarily destined to fail. However, the radical nature of the changes the Army is currently trying to achieve, and the questionable justification for such an extreme adjustment to the current force, begs the question whether a top-down approach is necessary or wise: "The lesson may well be that if you are right, top-down leadership will allow you to get it very, very right. If you get it wrong, however, you will get it very, very wrong."[22]

[22]Williamson Murray and Allan R. Millett, *Military Innovation in the Interwar Period* (Cambridge, UK: Cambridge University Press, 1996), 308.

CHAPTER THREE

WAR AND CULTURE

Armies may fight the way they train, but they train the way they think.[23]

John A. Lynn

The nature of warfare at any given time in history is a direct reflection of the cultures of the antagonists. Similarly, the change processes that armies undergo between and during wars are influenced by culture: both that of the organization itself, and the society of which it is a part. Military evolution must be based on a logical assessment of the nature of future warfare and the necessary requirements for waging it. This assessment must be articulated in a sound theoretical framework and embodied in a clearly defined operational design. Otherwise, innovation becomes the product of an attempt to shape the reality of future war to fit a culture's current discourse on war, rather than the result of a theoretically sound process that prepares the society's army for the likely reality of future warfare. Without a clear understanding of the impact of culture and discourse on perceptions of war in the future, the Army may encounter the unfortunate situation of being prepared to fight one type of war, but finding itself in another.

According to the *Merriam-Webster Dictionary*, culture is "...5a: the integrated pattern of human knowledge, belief, and behavior that depends upon man's capacity for learning and transmitting knowledge to succeeding generations; b: the customary beliefs, social forms, and material traits of a racial, religious, or social group; c: the set of shared attitudes, values, goals, and practices that characterizes a company or corporation."[24] Williamson Murray defines military culture as "the sum of the intellectual, professional, and traditional values of an officer corps; it plays a central role in how that officer corps assesses the external environment and how it analyzes the possible response that it might make to 'the threat'."[25] A military organization's culture influences its perceptions and interactions in the same way as a society's; similarly, a

[23] John A. Lynn, email to Mark T. Calhoun, 5 September 2003.
[24] Merriam-Webster Online Dictionary, available from http://www.m-w.com/, accessed 22 February 2004.

society's culture and that of its military, while different, are inextricably linked--each influences and responds to the other. Military innovation is a process that is inevitably subject to the influence of cultural bias; but a foundation in theory, development of a clearly articulated operational design, and adoption of a guiding CBM will minimize that effect. A clear understanding of the influence of culture and its potential pitfalls will serve to emphasize the need for a theoretical grounding of Army Transformation, and a focus on a clearly described operational design.

DISCOURSE AND REALITY

In his recent book *Battle*, John A. Lynn presents a cultural model of war that describes the interaction between a society's discourse on war and its experience of the reality of war:

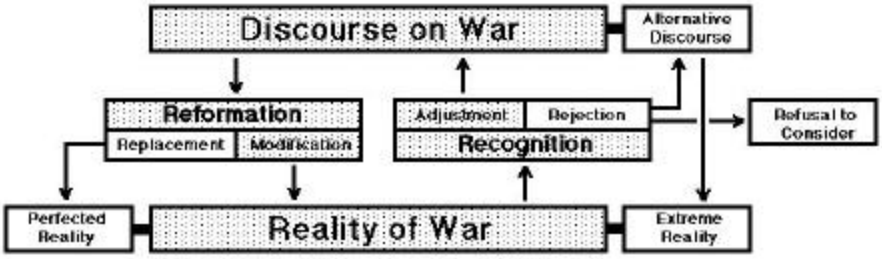

Figure 1 - John A. Lynn's Cultural Model of War[26]

This model provides insight into the influence of cultural perceptions and discourse on Army Transformation. All societies, and the armies that are a subset of their societies, engage in conversations and debate concerning their mental image of what war is or will be, and how or why it should be undertaken. These ideas are embodied in the society's "Discourse on War," directly impacting military innovation by shaping the organization's perceptions of the nature and environment of future conflict. When innovative processes are guided by specificity--provided by

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[25] Murray and Millett, 312-3.
[26] John A. Lynn, *Battle* (Boulder, CO: Westview Press, 2003), 332. The version presented here is an updated one, provided by Dr. Lynn to the author by email on 9 December 2003.

a clear, well-understood threat like the Soviet Union during the Cold War--discourse tends to remain closely tied to reality. In periods of uncertainty or disunity, discourse can diverge from the reality of war through the process of "Reformation," (the imposition of discourse on reality) leading to an attempt at "Modification" of the nature of warfare. The resulting modification can occur in a number of ways, including changes in military organization and equipment, or social and political initiatives to rethink the ethics and policy of waging war. In extreme cases, it may be impossible to modify the nature of warfare to the degree desired. When this occurs, "Replacement" may result in the creation of a "Perfected Reality" such as the medieval tournament, invented to satisfy the chivalric ideals of the time that stood in stark contrast to the brutal realities of actual warfare.

An army discovers to what degree its attempts at modification were effective upon encountering the "Reality of War." To some degree, deficiencies in organization, doctrine, or equipment are inevitably revealed in combat, resulting in a process of "Recognition," (the imposition of reality on conception), leading to "Adjustment" of the discourse on war. In situations where the degree of divergence from reality is excessive, the high degree of required adjustment places the Army in a position of disadvantage that can lead to a minor setback--or a major catastrophe. In extreme cases, the reality of warfare is so divergent from a society's discourse that the required adjustment is simply unacceptable; in this case, the result is "Rejection," leading to an "Alternate Discourse" that prepares the society for an "Extreme Reality" of warfare. An example of this process is the exceptionally brutal nature of the fighting between Japanese and American soldiers in the Pacific during World War II. [27]

The final branch of the cultural model, "Refusal to Consider," is an addition to the version published in *Battle.* In Dr. Lynn's words, "...it seems to me there is another form of

[27] Ibid., 331-41. One recent example of a major breakdown between discourse and reality is the administration's assumption that it would face a "liberation" scenario in Iraq after defeating Hussein's military forces, only to find itself engaged in a protracted counterinsurgency. See Record, "Bounding the Global War on Terrorism," 39.

rejection, and that is simply the refusal to consider the rejected form of violence at all." Various statements of personnel involved in recent military operations in Iraq demonstrate that in many soldiers' minds, the activities following the end of major combat operations in Iraq do not fit their definition of war: "Something that is simply not considered as war is going to find a hard time working itself into doctrine."[28] This pathway in Dr. Lynn's model highlights a key component of the Army's discourse: the Army's cultural perception, expressed in *Field Manual 1*, that its central purpose is fighting and winning the nation's wars. Despite historical evidence that most of the Army's effort will be directed toward Stability and Support Operations (SASO), the cultural mindset remains focused on major combat operations. This results in a widespread refusal among Army personnel to accept SASO as war, and leads to ongoing debates concerning how the Army should train and organize to handle these types of operations, or whether they should be handed over to a separate peacekeeping force.[29] The "Refusal to Consider" pathway lends additional insight into the question whether Army Transformation is truly full-spectrum focused.

CASUALTY AVERSION

One example of the interrelationship between the Army's and American society's discourse on war is the perception within the Army that American society is "casualty averse." This perception--a phenomenon of recent limited war experiences and the corresponding political debates over U.S. involvement in these types of wars--has significant implications for the conduct of Army operations. The reality is that strong evidence exists both that senior military leaders believe the American public is casualty averse, and that this belief is simply incorrect. One study asked senior military leaders and members of the general public how many casualties they believed would be reasonably justified in various military intervention scenarios. In cases such as

[28] John A. Lynn, email to Mark T. Calhoun, 9 December 2003.
[29] Kenneth O. McCreedy, "Planning the Peace: Operation Eclipse and the Occupation of Germany" (Monograph, School of Advanced Military Studies, Fort Leavenworth, KS, 1995). This paper demonstrates the same reluctance among planners in post-World War II Germany to assume military responsibility for stability operations --"refusal to consider" has a long-standing historical precedent.

stabilizing the Congo or preventing development of Iraqi weapons of mass destruction, the public expressed the willingness to accept many times more casualties than the senior military leaders.[30] Recent analysis demonstrates that it is the senior military leadership, not the general public that tends to be casualty averse. "...most Americans are willing to tolerate substantial casualties if they believe in the cause for which they are incurred and see visible policy progress."[31]

While it is self-evident that military leaders can and should attempt to minimize casualties, an excessive preoccupation with casualty avoidance can adversely impact the planning process by limiting possible military options, or by creating an occupational tendency to unconsciously subordinate mission accomplishment to self-preservation. The casualty aversion phenomenon is an example of the influence of society's discourse (in this case, as modified by the impact of mass media) on the military's conception of war, and the resulting attempt by military leaders to shape the reality of war through the process of Reformation and Modification to fit cultural perceptions of what they believe it should be. If, in a future war, vital national interest precludes withdrawal and operational characteristics result in significant loss of life, a costly Recognition and Adjustment process could be necessary to modify military leaders' perceptions of the operational methods considered acceptable in order to achieve victory.

REVOLUTION IN MILITARY AFFAIRS?

The current debate over the question of a Revolution in Military Affairs (RMA) sheds further light on the influence of cultural discourse on the process of military innovation. While historians still argue the existence of an RMA during various periods in military history, the Army has acknowledged the current existence of an RMA, relying on the promise of immature

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[30] Charles K. Hyde, "Casualty Aversion: Implications for Policymakers and Senior Military Officers" in *Chairman of the Joint Chiefs of Staff Strategy Essay Competition: Essays 2000* (Washington, D.C.: National Defense University Press, 2000), 1-16.

[31] Jeffrey Record, "Bounding the Global War on Terrorism," [Online] available from http://www.carlisle.army.mil/ssi/pubs/2003/bounding/bounding.pdf, accessed 5 February 2004, 37. See also Richard H. Shultz Jr., "Showstoppers," *The Weekly Standard* (January 26, 2004), [Online] available

revolutionary technologies as the conceptual foundation of Army Transformation. According to one definition, a revolution is "A sudden, radical or complete change."[32] This definition reveals a logical inconsistency in the claim that we are currently involved in an ongoing RMA. Because the suddenness or momentousness of the resulting change can only be determined after that change has occurred, by comparison to the previous state of affairs, one cannot tell if change is truly revolutionary until after the fact.[33] An analysis of several hundred years' history reveals that every significant Western military revolution was "uncontrollable, unpredictable and unforeseeable."[34] While it may be desirable to seek innovations that will provide significant advantage over an adversary, it is questionable whether one should declare that an RMA is currently in existence, because this can distort cultural perceptions and set unrealistic expectations regarding the efficacy of the hoped-for "revolutionary" innovations.

The implicit acceptance of an RMA, commonly ascribed to modern advances in information technology, lends a perhaps undeserved credibility to claims of future technologic superiority, often referred to as "information dominance." The RMA culture heavily influences the discourse on war, encouraging the adoption of transformation programs bearing a strong resemblance to technologic opportunism. Historically superior methods of military innovation generally center on doctrinal and organizational changes, not technological advances. Reliance on technology to gain advantage over an enemy is expensive, and typically only results in a temporary advantage before the enemy finds some creative way to regain parity. Even the most significant technologic advances are only truly effective as a complement to doctrinal or conceptual innovation: "The key to technological exploitation became not so much the

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from http://www.weeklystandard.com/Content/Public/Articles/000/000/003/613twavk.asp, accessed 5 February 2004, 30.

[32] Merriam-Webster Online Dictionary, accessed 22 February 2004.

[33] The lively debate and voluminous literature arguing whether an RMA existed between the 17th and 19th centuries serves to demonstrate the difficulty of proving any innovation is revolutionary, even given decades to reflect on the question. See Clifford J. Rogers, ed. *The Military Revolution Debate: Readings on the Military Transformation of Early Modern Europe* (Boulder, CO: Westview Press, 1995).

revolutionary character of inventions and processes, but creation of a management and logistical system that made the *application* of technological advantage possible."[35] In the Future Force, the application of advantages provided by anticipated revolutionary technological advances would be ensured by more technology, from space-based, network-centric battle command systems that will provide near-real time intelligence and information dominance, to systems that will be easier to support logistically because of lower fuel consumption, greater reliability and new methods of power generation. Technology will be exploited by more technology.[36]

One alternative to the RMA paradigm is the concept of "punctuated equilibrium." Originally presented by Stephen Jay Gould and Niles Eldredge as a modification to the traditional view of biological evolution, punctuated equilibrium describes long periods of near stasis, interrupted by sudden "punctuations," or periods of dramatic change. While this theory does not replace the concept of gradual, evolutionary change, it does supplement it by accounting for occasional periods of sudden, revolutionary change. This concept provides a viable alternative to the evolution versus revolution argument that typically surrounds perceptions of military change processes. As demonstrated by Mr. Rogers, military change throughout history generally follows a pattern of gradual, evolutionary progress with occasional punctuations; or individual, revolutionary developments.[37] While brief periods of revolutionary change do occur, they are momentary, generally unforeseen, and are quickly met with corresponding developments that bring a return to military parity.

What is the significance of the evolution or revolution debate? To quote Clifford Rogers: "It might be argued that, so long as we all know what we are talking about when we say 'Military Revolution,' my objections are mere quibbling, only a question of semantics. But, as George

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[34] Williamson Murray and MacGregor Knox, eds., *The Dynamics of Military Revolution, 1300-2050* (Cambridge, UK: Cambridge University Press, 2001), 6-7.
[35] Murray and Millett, 348.
[36] Department of the Army, *Concepts for the Objective Force*, White Paper (Washington, D.C.: 2001), 9-16.

Orwell showed so effectively in *1984*, words shape ideas, and ideas shape the world."[38] The tendency to look for short but dramatic periods of innovation is only a component of modern scientific method: "Reductionism was the driving force behind much of the twentieth century's scientific research. To comprehend nature, it tells us, we first must decipher its components.... Today we recognize that nothing happens in isolation. Most events and phenomena are connected, caused by and interacting with a huge number of other pieces of a complex universal puzzle."[39] Significantly, the tendency to take the reductionist view of technology as the panacea-like source of innovation is nothing new. General Westmoreland, in a 1969 address to the Association of the United States Army, claimed "the Army has undergone in Vietnam a quiet revolution in ground warfare..." leading to "...an entirely new battlefield concept" which he called the "...automated battlefield."[40] Unfortunately, the surveillance and information technologies with which General Westmoreland was so enamored failed to overcome much deeper cultural realities that significantly hindered U.S. Army operations in Vietnam. This begs the question whether the current fascination with the I-RMA concept is only more of the same.

As the concept of military revolution establishes itself in the Army's conception of war, discourse begins to shape reality: Reformation leads to attempts at Modification. Unproven technologies and untested concepts gain an implicit legitimacy as components of the RMA, because of an implied teleological unity that may not exist. Expectations change based on potentially exaggerated claims of the effectiveness of anticipated innovations, and the anticipated inability of future enemies to cope with them. These altered perceptions become part of the transformation process, and unless refuted through objective analysis and experimentation they permanently alter its course. Even worse, future vision becomes current doctrine in anticipation

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[37] Clifford J. Rogers, ed. The Military Revolution Debate: Readings on the Military Transformation of Early Modern Europe (Boulder, CO: Westview Press, 1995), 76-7.
[38] Ibid., 77.
[39] Albert-Laszlo Barabasi, *Linked* (New York: Plume, 2003), 6-8.
[40] Loren Baritz, *Backfire* (New York, NY: William Morrow and Company, 1985), 50.

of the hoped-for advantages of future technologic advances that may, like General Westmoreland's "automated battlefield," fail to deliver on their promises.

SUMMARY

Culture is a critical component of the way a society, and that society's army, views war. The cultural view is modified through a discourse-reality cycle in which perceptions change and can potentially diverge dangerously from reality. Discourse is generally influenced by the language and attitudes, or cultural norms, through which it takes place. This chapter has demonstrated some of these recent cultural norms, embodied in the technology-centric mantra of the RMA. Recent trends in transformation concepts and related doctrine such as Information Superiority, Rapid Decisive Operations (RDO), Effects Based Operations (EBO) and the various anticipated capabilities of the Future Force all reflect the language of the RMA culture. While the RMA means different things to different people, and it certainly does not meet the definition of a theory, it is apparently substituting as one in its role as the guiding cultural discourse in Army Transformation. The next chapter will describe complexity science, and present concepts from complexity theory that could serve as a Common Body of Metaphor (CBM) to ground the Army's transformation plans in theory and enable the Army to avoid a serious discourse-reality breakdown in the future.

CHAPTER FOUR

COMPLEXITY

> Even a few years ago, a physicist asked about what is known and what is not known would have answered that the real problems were only at the frontiers of our universe at the level of elementary particles and at the level of cosmology. In contrast, he or she would have asserted, the basic laws that are relevant on our macroscopic level were well known. Today, a growing minority of scientists would question that optimistic view. Even at our real-world level, we see that some of the basic questions remain largely unanswered.[41]
>
> Ilya Prigogine

Simply put, complexity is the science of nonlinear systems that are composed of very large numbers of interconnected parts, or agents. Complexity reached its zenith of public popularity in the 1990s, but its role as the guiding force behind the last decade's most remarkable discoveries among the scientific community has steadily grown. Since the time of Galileo and Newton, scientific endeavor has been characterized by reductionism (the process of breaking down complex systems into component parts to study them individually--a process that only works well in linear systems), and the belief that all natural processes are inherently time-reversible. Complexity theory has reversed that trend:

> Even the most hard-boiled, mainstream scientists are beginning to acknowledge that reductionism may not be powerful enough to solve all the great mysteries we're facing: cancer, consciousness, the origin of life, the resilience of the ecosystem, AIDS, global warming, the functioning of a cell, the ebb and flow of the economy....What makes all these unsolved problems so vexing is their decentralized, dynamic character, in which enormous numbers of components keep changing their state from moment to moment, looping back on one another in ways that can't be studied by examining any one part in isolation. In such cases, the whole is surely not equal to the sum of the parts. These phenomena, like most others in the universe, are fundamentally *nonlinear*.[42]

Recent discoveries by complexity scientists have demonstrated that the principles of both Newtonian physics and quantum mechanics are far from universal; rather, they exist in the realm

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[41] Ilya Prigogine, *The End of Certainty* (New York: W.H. Freeman and Company, 1989), 2. Prigogine won the Nobel Prize for chemistry in 1977 for his work on non-equilibrium thermodynamics, particularly the theory of dissipative structures. The new ideas embodied in his work and that of other complexity scientists point to "the beginning of a new scientific era." (Prigogine, *The End of Certainty*, 7)

[42] Steven Strogatz, *Sync* (New York: Hyperion, 2003), 285-6.

of special cases. Scientists have gradually come to recognize that the world is dominated by complex, dynamic processes that cannot be understood through linear, reductionist methods. The scientific truism of the past few centuries--that all scientific processes are deterministic and time-reversible, and it is only the flawed process of human observation that implies irreversible time and requires probabilistic analysis--is fundamentally flawed. This is because complex dynamic systems, even when governed by simple rules of interaction, demonstrate a type of order that is inherently unpredictable and is without question governed by the "arrow of time."[43] Even today, some complexity researchers are merely merging these new ideas with the fundamental Newtonian or quantum model, but a growing number of scientists see complexity as nothing less than the foundation of an entirely new conception of science.

COMPLEX ADAPTIVE SYSTEMS

Describing complexity science eleven years ago, M. Mitchell Waldrop wrote: "If the field seems poorly defined at the moment, it's because complexity research is trying to grapple with questions that defy all the conventional categories." Theoreticians had begun to recognize that many perplexing questions from a diverse range of disciplines shared four common characteristics. First, these questions concerned systems that could be described as complex, meaning they have a large number of agents that interact with each other in a large number of ways. Second, in addition to being complex, these systems demonstrate the ability to self-organize, meaning that in the absence of a managing or controlling function they spontaneously develop collective properties and elaborate organizations. Third, these complex, self-organizing systems demonstrate the ability to adapt, or actively evolve in response to their environment. Fourth, they demonstrate the ability to avoid either excessive stability or disorder, existing instead at the "edge of chaos," a balancing point between stability and change where the system does not remain static, but also does not devolve into complete disorder. It is at the edge of chaos that a

[43] Prigogine, The End of Certainty, 3-7.

complex system can achieve a paradoxical kind of harmony in which both self-organization and truly novel change can occur.[44] Complex dynamic systems are ubiquitous in nature, but until recently most scientists have avoided studying them, because non-linear systems are counterintuitive to the way we view the world: "Virtually all the major unsolved problems in science today have this intricate character....The richness of the world around us it due, in large part, to the miracle of self-organization. Unfortunately, our minds are bad at grasping these kinds of problems."[45]

Central to complexity theory is the Complex Adaptive System (CAS). One way to illustrate the key features of a CAS is to review Stuart Kauffman's study of Boolean Networks. Kauffman began his study of complex systems in an attempt to discover the source of spontaneous order in the complex world. He could not accept the Darwinian concept that natural selection through the process of gradualism could adequately account for the evolution life: "In some complex systems, any minor change causes catastrophic changes in the behavior of the system. In these cases...selection cannot assemble complex systems."[46] While many of Kauffman's specific conclusions regarding evolutionary theory remain controversial, his study of complex networks illuminates many of the key principles of complexity theory.

In *At Home in the Universe*, Kauffman describes a simple Boolean network consisting of an array of three light bulbs (see Fig. 2), in which each bulb can have one of two states, on ("1") or off ("0"). Once every second, each light bulb observes the state of the two adjacent to it, and adjusts its state according to their input. This change is regulated by Boolean logic rules; either an "and" function (both of the adjacent bulbs must be lit for the bulb to light), or an "or" function (if either adjacent bulb is lit, or both adjacent bulbs are lit, the bulb will light).

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[44] M. Mitchell Waldrop, *Complexity* (New York, NY: Touchstone, 1992), 9.
[45] Strogatz, 34.
[46] Stuart Kauffman, *At Home in the Universe* (New York, NY: Oxford University Press, 1995), 151-2

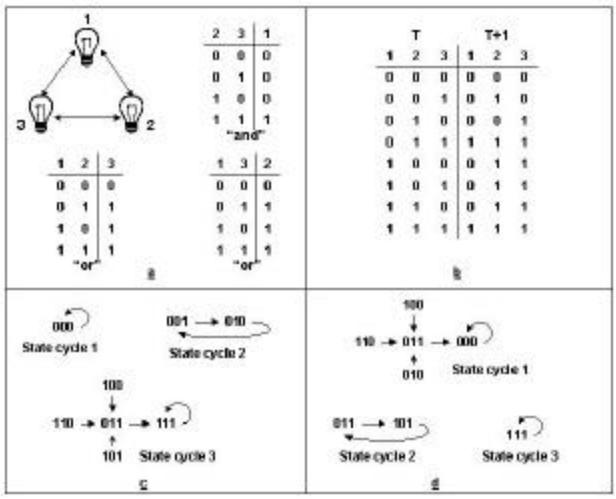

Figure 2 - Boolean Network[47]

In this network, bulb "1" is assigned an "and" function, and bulbs "2" and "3" are assigned "or" functions. Fig. 2a depicts the network and the functions associated with each bulb. In the tables depicted in Fig. 2a, the right hand column indicates the bulb receiving input from the other two bulbs, represented by the left and middle columns. For example, the only state that will cause bulb "1" to switch on is an "on" input from *both* bulbs "2" and "3" (the bottom set of numbers in the "and" table). In contrast, bulbs "2" and "3" will switch on if *either* or *both* bulbs are on (bottom three lines of the "or" tables). Combining these tables, Fig. 2b presents all eight possible states of the network (at time "T"), as well as the resulting state of the network one second later (at time "T+1"), based on each bulb's Boolean rule. Fig. 2c presents the "trajectories," or sequences of network states, that will result based on various initial configurations, once the network begins its 1-second cycles (for comparison, Fig. 2d depicts the

[47] Ibid., 76. This chart is an exact reproduction of the example presented by Kauffman in *At Home in the Universe*. Research on these types of networks appears to have originated with Stanislaw Ulam, who began working with Cellular Automata in the late 1940s. John Casti continued in this vein with his computer modeling of housing pattern distributions in 1967 (see Casti, *Complexification*, 213-23).

cycles that would result if bulb "2" was given an "and" rule, instead of an "or" rule). The state cycle trajectories demonstrate a key point about complex self-organizing systems: given a finite number of possible states (in this case eight, or 2^3), the network will eventually return to a state it has been in before, and then repeat the cycle.[48] As depicted in Fig. 2c, this could result in various situations: "State cycle 1," in which the starting configuration causes the network simply to maintain its initial state; "State cycle 2," in which the network cycles back and forth every second between only two states; or "State cycle 3," in which several initial states all follow trajectories leading the network to an unchanging cycle. An observer of this simple network will quickly see it achieve the state cycle resulting from its initial conditions, indicated by the lighted bulb pattern that develops.

It is important to note that if it takes a particularly long time for a Boolean network to achieve a state cycle, it will be unpredictable in any practical sense. In Kaufmann's words: "Now imagine a larger network, with 1,000 bulbs and thus $2^{1,000}$ possible states. If the network were on a state cycle passing through every one of this hyperastronomical number of states, and if it took a mere *trillionth of a second* per state transition, we could never in the lifetime of the universe see the system complete its orbit."[49] This is significant because most systems in nature display these extreme degrees of complexity, but nevertheless do display patterns, or order. In other words, they achieve state cycles much faster than would be expected without some form of self-organization occurring within the system. The source of self-organization in these highly complex systems is the presence of "attractors."

Attractors determine those states that a dynamic system will tend to adopt over time. The simple three-bulb network described above assumes the depicted steady states due to the system's attractors. Depending on the system's initial conditions, it will proceed along a specific trajectory to the resulting stable state cycle. It is the presence of attractors in a system that enables its self-

[48] This demonstrates the key difference between chaos theory, which describes the erratic behavior of small systems, and complexity, which describes the organized behavior of large systems.

organization and orderly, rather than purely random, behavior. There are three basic types of attractors, and their differences are directly observable in the behavior of the system. The first two are "point" and ”limit cycle" attractors:

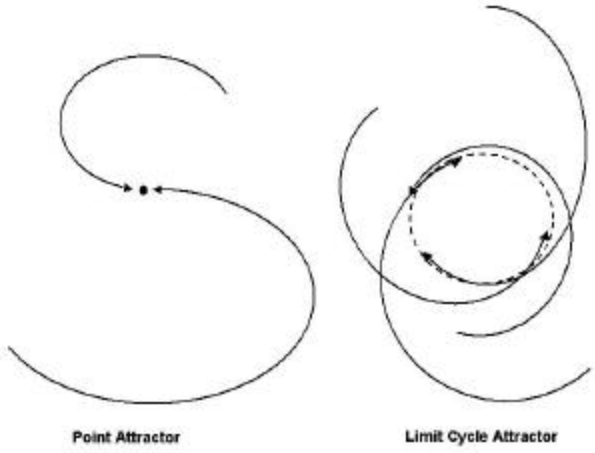

Figure 3 - Point and Limit Cycle Attractors

A point attractor exists where one or more trajectories leads to a specific network state, where system activity comes to a halt. State cycles 1 and 3 in Fig. 2c are examples of point attractors. A limit cycle attractor exists where trajectories converge on a steady state cycle, where activity continues around the same series of points indefinitely. State cycle 2 in Fig. 2c is an example of a limit cycle attractor. Both of these types of attractors lead to fairly simple behavior, in which a system progresses to some state and then stops moving, or becomes trapped in an endless, repetitive cycle of behavior. A network made up of a large number of interacting agents can contain many attractors, but if they are point or limit cycle attractors they will lead to behavior that is simple and predictable, and they will cause the network to achieve an orderly state much more quickly than one would expect if the network's interactions were purely random.

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[49] Ibid., 77-8.

For example, a pendulum's motion is driven by gravity and friction to a point attractor at the pendulum's resting point.

The strange attractor results in much more complex (and interesting) behavior, and perhaps counter intuitively, it the most common type of attractor found in nature: "systems with strange attractors are the rule, not the exception."[50] Edward Lorenz discovered one of the most famous strange attractors while working on a method of modeling the atmospheric conditions that result from various patterns of jet stream activity. Lorenz plotted the possible configurations of three weather system variables in three dimensions, ending up with the graphical depiction in Fig. 4. The two "wings" of this system's state space graphically represent two predominant global weather patterns; the left wing that of unsettled weather patterns, the right wing that of fair summer but foul winter weather patterns.[51]

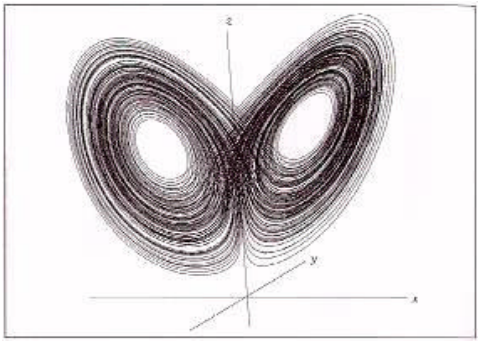

Figure 4 - Lorenz Attractor[52]

The image that emerged as Lorenz plotted his data reveals several key characteristics of strange attractors: they lead to a much more complex form of order than point and limit cycle attractors; different trajectories within the state space of a single attractor may lead to more than

[50] Casti, Complexification, 37.
[51] Ibid., 96.
[52] Fig. 4. Lorenz Attractor. Reprinted, by permission, from: Susan Stepney, Professor of Computer Science, University of York, UK, "Nanotechnology and complexity: consequences for computing" [on-line]; available from http://www-users.cs.york.ac.uk/~susan/complex/nanotalk.htm ; Internet; accessed 4 December 2003.

one possible form of orderly behavior; and most significantly, dynamical systems containing strange attractors are highly sensitive to initial conditions. This final characteristic is often referred to as the "butterfly effect" (note the shape of the Lorenz attractor), describing the effect of a butterfly flapping its wings in Brazil, thereby setting off a tornado in Texas.[53] This sensitivity to initial conditions is a central feature of chaotic systems and strange attractors. To visualize this sensitivity to initial conditions, one need only imagine pairs of adjacent points beginning to move along trajectories on the Lorenz attractor. It can be readily seen that depending on where they begin their movement, adjacent points can follow trajectories that will take them both to a pattern of activity on the left wing of the attractor, both to a pattern of activity on the right wing of the attractor, or each to separate patterns of activity on opposite wings of the attractor. These patterns of activity are not limit cycles. The wings of the butterfly are thin, but they each contain an infinite number of points. The weather characteristics get "trapped" on one wing of the attractor or the other, therefore displaying order, but each can occupy any of an infinite number of states on the wing where it is trapped, resulting in unpredictability: "This infinite of complex surfaces--the strange attractor--embodies a new kind of order. Though the trajectory's motion is unpredictable in detail, it always stays on the attractor, always moves through the same subset of states. That narrowness of repertoire accounts for the order hidden in chaos and explains why its essence never changes."[54] This key characteristic of strange attractors explains a fundamental trait of complex systems--despite the fact that they are governed by only a few simple, deterministic rules, they display behavior that is orderly, yet unpredictable. This is contrary to the deterministic, time-reversible Newtonian view in which natural processes can be explained by a theory that provides accurate predictions as long as precise information is available regarding initial conditions.

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[53] Edward N. Lorenz, *The Essence of Chaos* (Seattle: University of Washington Press, 1993), 14.
[54] Strogatz, 192.

To apply these ideas to adapting, self-organizing living systems, one can view the state space of a complex system as a "fitness landscape" made up of many trajectories and containing some number of strange attractors. Because it is a complex system, it will consist of an infinite number of possible states, but because it will self-organize, it will display orderly behavior. By mathematically depicting this complex system as an "NK" model--where "N" represents the number of interacting system components, "K" represents the number of inputs each component of the system receives, and each system state is randomly assigned a "fitness value" representing its relative adaptive advantage--one arrives at a graphical representation like that presented in Figure 5. The ruggedness of the landscape, or the relative number and height of the peaks, is directly proportional to the values of "N" and "K." As the number of system components and the number of their interactions increase, the landscape becomes correspondingly more rugged. As this complex, living system seeks optimal adaptations (to be achieved through mutations in the population), it can be thought of as navigating this landscape, climbing the various "peaks" in search of the most beneficial adaptive state or highest peak.[55]

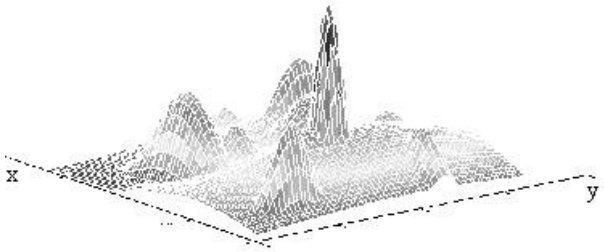

Figure 5 - Fitness Landscape[56]

[55] Kauffman, At Home in the Universe, 163-9.
[56] Fig. 5. Fitness Landscape. Reprinted, by permission, from: Frank Vavak and Ken Jukes, UK Napier University, Edinburgh, UK. "Adaptive Combustion Balancing in Multiple Burner Boiler Using a Genetic Algorithm with Variable Range of Local Search" [on-line]; available from http://ingenet.ulpgc.es/functional/databases/ceani/authors/inringtfogarty/res/1/burners_d1.html ; Internet; accessed 4 December 2003.

To make his research more relevant to actual living systems, Kauffman applied his ideas to "correlated" fitness landscapes, in which the fitness values of various states were not randomly assigned, but interrelated. This is necessary because the various possible adaptive characteristics in a natural complex system are not independent, but linked. For example, an adaptation leading to denser, heavier bones may make a leg stronger, but this same adaptation may be disadvantageous because of its adverse impact on running speed, if the environment is one in which speed is more important than strength for survival. Because the adaptations in a biological system (or "agents" in a complex system) are interdependent, the resulting fitness landscapes are both structured and proportionately more complex. [57]

Kauffman's research illustrates the concept of a CAS as a system in which a large number of agents interact in a large number of interdependent processes, adapting through a mechanism of self-organization. What he discovered was the surprising fact that adaptation is optimized when the system exists at the "edge of chaos," the boundary between highly orderly and highly chaotic states. The edge of chaos is analogous to the scientific phenomenon of the phase transition--the point at which a system transitions from one state to another (i.e. water transitions from liquid to gas at the boiling point temperature). Much like the balanced state a system occupies when undergoing a phase transition, Kauffman believes "Networks in the regime near the edge of chaos--this compromise between order and surprise--appear best able to coordinate complex activities and best able to evolve as well."[58]

One particularly significant characteristic of the edge of chaos is the fact that not only do systems achieve optimum adaptability there--they tend to evolve there on their own. Complex adaptive systems achieve a state of "self-organized criticality" discovered by Danish physicist Per Bak in 1986. Bak illustrates the concept through the metaphor of a pile of sand, created by pouring a steady stream of sand onto a tabletop. As the amount of sand on the table increases, it

[57] Ibid., 26.
[58] Ibid.

forms a pile that gets taller and wider until sand begins to fall off the sides. At this point, the sand pile has achieved self-organization, in that it has reached a steady state without anyone consciously directing it; and the pile has reached criticality, in that it is just barely stable, with any further addition of sand having the potential to cause a cascade of falling sand, a trickle, or no effect at all. The reaction that occurs when sand is added to the pile after it has reached criticality occurs according to a power law distribution, meaning there are a small number of large events (cascades of falling sand), and a large number of small events (trickles of falling sand). Most importantly, this self-organized criticality occurs on its own, whether in an actual pile of sand, a computer simulation or a natural complex system.[59]

Recent research demonstrates that even the Internet has evolved to a state of connectivity that conforms to a power law distribution. Put simply, the Internet contains a very small number of web pages with very many connections or links, and a great many web pages with almost no links. The Internet evolved to this power law distribution on its own, just like other complex systems, living or non-living; and this characteristic results in the existence of major vulnerabilities in the network. Because only a tiny fraction of web sites have a high degree of connectivity, their loss can be highly disruptive. Network robustness provides the ability to overcome connection problems through redundant linkages, but at the same time results in "extreme exposure to attacks."[60] This should give pause when considering the true benefit of the future global information grid in facilitating network-centric warfare.

Over a period of a few decades, a large group of researchers from many disciplines, including computer science, economics, physics and biology, discovered the basic characteristics of the CAS. They found that the CAS is a system made up of a large number of agents, each behaving according to its own rules or principles in response to local interactions with other system agents. Even when the governing rules or principles are deterministic, the behavior of the

[59] Waldrop, 304-5. In evolutionary terms, system changes represented by sand falling off the edge of the table are referred to as "extinction events."

system is unpredictable--patterns emerge from the interactions of the agents in the manner associated with strange attractors. The system achieves a state of self-organized criticality without a blueprint or control mechanism, evolving to the edge of chaos where change occurs according to a power law distribution. At the edge of chaos, the system is optimized for adaptation; the number of interactions is great enough that truly novel change can occur, but the system does not become totally unstable.

Many of the earliest complexity theorists were experts in the physical sciences and mathematics, but it was not long before social scientists and other theorists began to study the applicability of CAS theory to human organizations. Many of these researchers quickly recognized that human organizations possessed unique characteristics that required new ways of looking at complexity. While some writers today still apply CAS theory to human organizations in mechanistic terms, a growing field of theorists is expanding our understanding of complexity in the unique human environment.

EMERGENCE

Put simply, emergence is "overall system behavior that comes out of the interaction of many participants--behavior that cannot be predicted or even envisioned from a knowledge of what each component of the system does in isolation."[61] Tap water serves as a simple metaphor of this emergent behavior. Although it is made up of hydrogen and oxygen--both flammable gases--water is liquid and inflammable. These are properties one would never expect from a simple examination of water's molecular components. For the purpose of this study, emergence refers to complexity in human organizations:

> When it comes to thinking about organizations, be they countries, clubs, corporations, or the military, we tend to see them as defined by their structure. This leads to a mental picture of an organization as an elaborate diagram outlining the hierarchical chains of command and control within the

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[60] Barabasi, 109-22.
[61] Casti, *Would-be Worlds* (New York, NY: John Wiley, 1997), 82.

> organization.... However, there is another way to think about an organization: It is a collection of processes.[62]

By viewing an organization as a unified framework of its interrelated structure and function, one begins to perceive the emergent behaviors that lead to unexpected outcomes: "microlevel interactions between individual agents and global, aggregate-level patterns and behaviors mutually reinforce each other."[63]

Complexity science provides insight into the difficulties of management in an environment of ill formulated problems, confusing volumes of information, complex interactions between many agents, and significant yet unpredictable ramifications in the system. While it may not yield clear answers to these difficult issues, complexity can provide a source of metaphor through which to change the language of management, enabling a new conception of the organization and opening up new possibilities for action:

> Complexity science words and models give new tools to business leaders. By actively seeking to guide language choice, managers can influence the perceptions and actions of the remaining members of the organization. Leaders' effectiveness lies in their ability to make activity meaningful for those they lead. They do this not by changing behavior, but by giving others a sense of understanding about what they are doing. In this sense lie the potential strengths of complexity as a management tool.[64]

The implication is that while social systems cannot be viewed in the mechanistic terms applied to physical systems, managers can provide a greater sense of understanding by grounding the member's actions in a CBM based on the science of human interaction and culture.

The role of culture in organizations was discussed in the previous chapter of this paper. An article by Nicholas C. Peroff, published in the inaugural issue of *Emergence*, provides a better understanding of how this cultural effect should be viewed and influenced. Peroff writes that any effort to apply a scientific theory to the management of human organizations must confront a central question: is management an art, or a science? As Peroff points out, Edward O. Wilson

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[62] Casti, Complexification, 192.
[63] Ibid., 195.

provides key insight into this question when he differentiates between the creative arts and science. Wilson argues that all natural phenomena, from the level of galaxies down to that of subatomic particles and including both natural and social sciences, are based on material processes that can be explained by a small number of fundamental natural laws. In contrast, he describes the creative arts as beneficial to humans, but nonscientific: rather, they are based on the "epigenetic rules" that govern human behavior.[65] These epigenetic rules are hereditary predispositions that result when natural selection favors beneficial behaviors, such as taboos against incest and the tendency to invest in our children and protect our territory. In the same way that these genetic predispositions lead us to behaviors that are beneficial, they guide us to creative arts that are useful and necessary in our quest for knowledge--but they nevertheless perform merely a "primal function."[66] While Wilson believes the consilience or "jumping together" of scientific knowledge may someday explain art, he minimizes the contribution that art (such as the art of organization management), can make to the body of scientific knowledge.

Peroff argues Wilson's goal of consilience cannot encompass the management of human organizations unless it includes recognition of the scientific influence of art and culture. Management clearly consists of principles derived from both art and science. While the process of managing an organization requires grounding in scientific research and physical processes, it also encompasses human processes and interactions that "cannot be dissected and reassembled to explain how an organization works."[67] The concept of emergence recognizes this duality in organizations, and proposes complexity science as a source of metaphor to serve as an alternative means by which scientific rigor can be applied to the art of management: "If a consilience of the art and science of management is to happen, it will require a greater general willingness to think

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[64] Michael R. Lissack, "Complexity, the Science, its Vocabulary, and its relation to Organizations," *Emergence* I, no. 1 (1999): 122-3.
[65] Toby Lester, "All for One for All," *The Atlantic Online* 18 March 1998, [Online] available from http://www.theatlantic.com/unbound/bookauth/ba980318.htm, accessed 26 November 2003.
[66] Edward O. Wilson, *Consilience* (New York, NY: Vintage Books, 1999), 246.

about organizations as complex, nonlinear human systems, and it will require an open-minded exploration of the as yet unproven explanatory power of metaphor as a theoretical concept."[68]

In his description of emergence, Peroff takes issue with Wilson's proposition that any unified theory of all natural phenomena, to include human interaction and processes, must be based on material processes that are ultimately reducible to the laws of physics. While he recognizes the importance of culture and its influence on art, writing that culture "expands like a growing organism into a universe of seemingly infinite possibility,"[69] Wilson argues that art is the antithesis of science because it has no scientific meaning or value.[70] Nicholas Peroff, writing in the first issue of the journal *Emergence,* disputes this assertion by grounding the cultural aspect of human organizations and the art of management in the mechanism of a Common Body of Metaphor (CBM): "Through metaphor, our understanding of things is acquired, defined, and organized in terms of our existing knowledge of things already retained in our minds as remembered images, ideas, symbols and stereotypes.... In more conventional terms, an organization's CBM is comparable to its culture."[71] The presence of a CBM in human organizations both provides a scientific foundation for the understanding of the influence of culture, and distinguishes human organizations from other complex systems. A CBM provides a source of "memes," or self-replicating patterns of thought that spread throughout the agents of a complex system,[72] serving as the psychological equivalent of the human gene.[73] Because "an organization is more than physical phenomena and causal relationships,"[74] it will never be fully explained in a consilience restricted by Wilson's refusal to ascribe any scientific value to the influence of art and culture. Similarly, the insistence that these phenomena have no scientific

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[67] Nicholas C. Peroff, "Is Management an Art or a Science? A Clue in Consilience" *Emergence* I, no. 1 (1999): 100.
[68] Ibid.
[69] Wilson, 243.
[70] Ibid., 238.
[71] Peroff, 101-2.
[72] Kauffman, At Home in the Universe, 300.
[73] Strogatz, 261.

validity hinders our ability to approach key aspects of organization management from a foundation in scientific theory. Complexity science, as expressed in the concept of emergence, recognizes the significance of metaphor in both the art and the science of management. This recognition points to a means by which the Army can view culture from a scientific perspective, and influence its culture by incorporating the language of complexity science in its CBM. Military historians have long recognized the influence of culture in patterns of military thought, and John A. Lynn has recently provided a model that explains the process by which this occurs. Complexity forms the scientific basis of this process.

Emergence highlights the importance of culture, the debate over the usefulness of culture in a scientific study of society, and the usefulness of metaphor as a possible foundation on which to base the study and influence of culture. The connection between this train of thought and this paper's previous chapter on culture and war is clear. The primary influence on culture is a society's (and its military's) discourse--and the primary way to influence discourse in a constructive way is through the use of metaphor. A CBM serves as the script or program that drives human agent-level behavior, in the manner of a meme propagating itself in self-organizing patterns of thought and language. This script or program provides the frame of reference in which innovation occurs, and determines the level at which the change agents exist. Complexity science, provides a source for this guiding CBM--one that places the change agents at the lowest levels within the organization, generating change in the form of emergent innovation. Recognition of human organizations as complex adaptive systems provides a framework within which this emergent innovation can occur.

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[74] Peroff, 102. Art implies an intuitive understanding of science, such as shooting an arrow or throwing a curveball. Scientific knowledge and the creative arts are fundamentally linked.

ORGANIZATION AS COMPLEX ADAPTIVE SYSTEM

The conceptual foundation of the self-organizing networks upon which CAS theory was built can be easily translated to organizational structure and processes. This effort has led to a new paradigm in which the principles of CAS theory are adapted to the unique nature of the interactions of system agents in human organizations. In the generally accepted view of this new paradigm, three factors are considered necessary conditions for self-organization: (1) A "Container," (2) "Significant Differences," and (3) "Transforming Exchanges."[75] This section will describe these conditions, and discuss the role of change agents as key participants in the evolutionary process of organization change.

The Container can be thought of as the boundary within which change will occur. This boundary can be physical (a building), organizational (a department), behavioral (culture) or conceptual (rules and procedures). The container acts as a cohesive force, both drawing agents into the system and constraining the change process. Significant Differences directly influence change processes by shaping the patterns that emerge. Agents may differ in level of expertise, education, or power; or they may hold differing views on cost versus quality or other organizational process concerns. The group focuses on these significant differences as the source of emerging patterns. Transforming Exchanges are the connections between system agents. These can be viewed as messages delivered in meetings, by E-mail or telephone, or even through financial transactions. As one system agent changes, the messages he sends to nearby agents change, generating a response. It is this exchange of messages between transforming agents, much like the input from nearby light bulbs in the Boolean network, that results in the emergence of self-organizing patterns of change in the organization.[76]

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[75] Edwin E. Olson and Glenda H. Eoyang, *Facilitating Organization Change* (San Francisco, CA: Jossey/Bass-Pfeiffer, 2001), 11.
[76] Ibid., 11-15.

The change agent's role is to cause shifts in the Container, Significant Differences and Transforming Exchanges, and then observe the system's response, implementing a series of such interventions as a means to influence the process of change:

> Change agents are "system agents who consciously influence the self-organizing process toward new and more adaptable patterns of relationship and behavior. They may be external or internal consultants, formal or informal leaders, or individual contributors to the work of the system.[77]

The change agent must recognize the interrelationship of the self-organizing conditions, because an intervention in one condition will affect all three. This process of assessing, intervening and evaluating the conditions of self-organization is viewed as "the most effective method for a change agent to influence the paths and products of self-organization in human systems."[78]

This brief description of the conditions for self-organization, and the change agent's role in manipulating them to guide organization change, represents the current mainstream application of complexity theory to organization management. These views represent a great deal of progress in moving beyond mechanistic, Newtonian approaches to management. Yet this basic model is essentially a systems theory approach, dressed up with the language of complexity science.

COMPLEX RESPONSIVE PROCESSES

A growing body of complexity theorists has begun to move beyond the notion that human organizations should be viewed as systems, due to the unique nature of human interactions and processes. While these researchers recognize that CAS theory provides an excellent source of metaphor to describe some of the characteristics of human organizations, its strong ties to general systems theory can lead to the misinterpretation of key facets of human interaction:

> ...humans are themselves members of the complex networks that they form and [it is impossible to stand] outside of them in order to objectify and model them. With this intersubjective voice people speak as subjects interacting with others in the co-evolution of a jointly constructed reality. These voices emphasize the

[77] Ibid., 4.
[78] Ibid., 18.

> radically unpredictable aspects of self-organizing processes and their creative potential.[79]

This view stands in contrast to the underlying premise of systems theory in which the manager or system administrator stands outside of and controls the organization, in an effort to guide it to its optimal state of maximum efficiency and effectiveness. Even in the view of the organization as a CAS, in which the top-down, control oriented approach to change is avoided by locating change agents throughout the organization, the process still generally seen as consisting of an agent observing and leveraging a system to guide it in the desired direction of change.

Peter Senge's work on the systems view of human organizations has become a nearly universal standard in business management theory. According to Senge: “business and other human endeavors are also systems.” He recognizes the influence of complexity, observing that in modern organizations “...we are becoming overwhelmed by complexity;” but he argues “systems thinking is the antidote to this sense of helplessness that many feel as we enter the ‘age of interdependence.’ Systems thinking is a discipline for seeing the ‘structures’ that underlie complex situations, and for discerning high from low leverage change.” Senge describes the organization as a mechanism, made up of structural archetypes controlled by feedback and balancing processes. The manager's job is to discern the organization's structure, understand the interrelationships within the structure and apply leverage where necessary to achieve maximum effectiveness: “Seeing the major interrelationships underlying a problem leads to new insight into what might be done.”[80]

A major flaw in Senge's systems approach is in its focus on archetypes, or generic structures making up the internal workings of most organizations, which the manager must learn to identify and manipulate. Once the self-organizing tendency of human organizations is recognized, one can identify "...several factors beyond these archetypes that should be considered

[79] Stacey, Griffin and Shaw, ix-x.

as part of any system diagnosis. These include symptoms, critical thinking, pattern recognition, and boundary conditions." In complex systems, one cannot easily find leverage to solve a problem in a single archetype, but must learn to look at a series of indicators, or symptoms. This requires critical thinking, particularly focused inward to ensure "one's own closely held premises are frequently under scrutiny and potential revision." Pattern recognition is one method that allows an antidote to reductionism. Because modern organizational problems are highly complex, simple decision-making rules only address surface elements of the problem--pattern recognition "enables the performer rapidly to perceive relevant situations and call on memory efficiently for appropriate responses stored there." Focusing on boundary conditions enables the manager or change agent to move beyond analysis of isolated internal characteristics of a system in favor of a holistic view of the interrelationship between the system and its environment. Many of today's most successful organizations have adopted a "boundaryless culture" that is less stovepiped and compartmentalized, leading to members who are more flexible, possess a wider range of skill sets and are more open to innovation. Perhaps most importantly, many complexity theorists have come to recognize that "There is nothing inherently autocratic or heroic about system thinking."[81] This points to a dramatically new role for the leader in complex organizations, and forms a key element of CRP theory.

Leading CRP theorists argue that Senge's systems view is based on the Kantian distinction between mechanism and organism, in which different causal processes apply to nature (the system) and human action (the manager's influence). This is particularly important in the context of this study because the teleological process (causal framework) that guides the members of an organization directly contributes to their concept of innovation: "Organization of any kind, whether in nature or in human action, can be thought of as the interplay of stability and

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[80] Peter M. Senge, *The Fifth Discipline* (New York, NY: Doubleday, 1990), 69,72. Senge's work is deeply rooted in general systems theory, following Bertalanffy's assertion that man is an “active personality system.” (see Bertalanffy, *General Systems Theory*, 192)

change...the basic concerns are with continuity and with creativity, or innovation."[82] In the Kantian view, the mechanistic functioning of the organizational system follows formative teleology, in which movement is to a final form or pre-given state that is contained within the organization's structure and processes. The manager, standing outside the system, exercises rationalist teleology in which movement is toward a goal autonomously chosen by the manager, and the final unknowable form of the organization is achieved through choice. [83]

This split teleological view of organization as mechanism, and manager or change agent as a separate being standing outside of and optimizing the system, is flawed for two reasons:

> First, managers and researchers are humans participating in the very phenomenon their approach splits them off from: they cannot be objective observers in the manner of the natural scientist, but they proceed as if they can.... Second, and closely related to the first, the split locates human freedom entirely in the manager (theorist, researcher, decision-maker) and reduces other members of the organization to inhuman parts without freedom, just as Kant warned.[84]

Transformative teleology presents an alternative view of the organization's causal process. According to this view, the organization's future is unknowable, because it is constantly evolving:

> Truly novel change is possible and self-organization is a paradoxical process of repetition and potential transformation. It is emergence of identity in a transformative, self-organization process and the paradoxical experience of identity in transformation.... In other words, identity, or organization, is evolving in unknowable ways, being created as it goes along."[85]

The key problem in the split teleological view is the concept that the organization operates under one form of causality, while the manager operates under another. This limits the potential of human freedom and innovation *within* the organization, thereby hindering its ability to achieve novel change.

An analysis of the flaws in two of Senge's fundamental propositions will serve to illustrate the problems with the split teleological view of innovation in organizations. The

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[81] Dennis J. Moberg, "Diagnosing System States: Beyond Senge's Archetypes" *Emergence* III, no. 2 (2001): 20, 23, 26, 30 and 34.
[82] Stacey, Griffin and Shaw, 12. The teleological processes are summarized in Appendix A.
[83] Ibid., 38.
[84] Ibid., 58.

concepts of the "mental model" and the "learning organization" form the basis of the systems view of knowledge creation and information management in organizations. They both take the basic position that knowledge exists in two forms: tacit and explicit. According to this view, the manager must manipulate knowledge and information for the benefit of the organization by influencing mental models, and encouraging dialogue to bring important tacit knowledge to the surface so that it may be incorporated into the organization's knowledge database.

According to Senge, mental models are “deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action. Very often, we are not consciously aware of our mental models or the effects they have on our behavior”[86] He defines institutional learning as the “process whereby management teams change their shared mental models of the company, their markets, and their competitors.”[87] This view is representative of the information age-inspired belief in the ability to manage knowledge creation: because only explicit information is of value to the organization, it is up to the manager to tap into the pool of implicit knowledge contained in the minds of the organization's members. Put simply, in this view the human mind is merely another system, one more aspect of organization that is subject to the skillful manager's control. This control is extended from tasks and relationships to values, systems of belief, and learning-- Senge's learning organization is enabled through the skillful manipulation of the agents' tacit mental models.[88]

There are a number of problems with the concept of mental models. First, there is the paradoxical suggestion that the individual occupies the central role as the owner of valuable intellectual capital in his own mind, but that individual is reduced to insignificance by the manager's control of his "human capital."[89] According to CRP theory, it is impossible to measure intellectual "capital" in any meaningful way; and it is an illusion to imagine that any individual

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[85] Ibid., 38.
[86] Senge, 8.
[87] Ibid., 8-9.
[88] Ralph D. Stacey, *Complex Responsive Processes in Organizations* (NY: Routledge, 2001), 3.

can manage learning and knowledge creation because they occur within the human mind, or within human relationships, both of which are unmanageable in any real sense. Instead of trying to bring agents' tacit mental models to the surface so that they can be made explicit and manipulated for the benefit of the organization, the manager should instead focus on becoming more skillful in participating in the relationships they are already a part of.[90]

The categorization of information as either tacit or implicit, and the resulting management task of managing mental models to foster the learning organization, is flawed because it is based on the split teleological view in which one causal process regulates tacit knowledge in human minds, while another governs the manner in which it is controlled:

> The mainstream theory of learning and knowledge creation in organizations is a systems theory and like other systems theories it implicitly assumes the dual causal structure of Rationalist and Formative Teleology. The learning and knowledge creating system depicted in... [see Appendix B, Fig. 6] is basically one in which tacit knowledge already stored in the heads of some individuals, already enfolded as it were, is unfolded by processes of conversion. Mental models are already there, as are the learning models according to which they are supposed to be changed and so are the visions that are supposed to guide the learning and knowledge creation of the whole system. System archetypes (Senge, 1990) are already there.[91] (28)

The systems view is attractive to the leader who wishes to manage the knowledge and beliefs of the organization's agents by maintaining top-down control, through methods like fostering shared vision, and controlling the context of organizational dialogue. But the systems view cannot succeed in managing beliefs and knowledge, because it does not account for the manner in which they are created:

> However, by definition, this systems perspective cannot succeed on its own as an explanation of how new knowledge is created. It can only explain how already enfolded knowledge is unfolded by the system. Within its own terms this systems view does not, indeed cannot, explain how completely novel knowledge arises. It simply assumes that it arises as tacit knowledge in the heads of some individuals, or exists in a common pool of meaning, and the explanation starts from there. The same point applies to the requirement for a vision to guide the functioning of

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[89] Ibid., 4.
[90] Ibid., 8-9.
[91] Ibid., 28.

> the system. There, too, there is no explanation within systems thinking itself of how such a guiding vision is formed.[92]

The philosophical basis of CRP theory's perspective on knowledge creation and information management can be found in the work of George Herbert Mead, a social psychologist and philosopher who developed a new concept of the evolution of self that avoids the self-contradiction of split teleology and focuses on the characteristics of the mind that are distinctly human. According to Mead's view, mind and society evolved together; neither one preceded the other. It was in the interrelationship between the human mind and the social implications of human acts that the self evolved. This can be understood by considering the unique nature of the human nervous system. As a human contemplates making a gesture or message, the nervous system responds by providing a sense of the response the receiver of the message will experience. This immediate feedback, provided by the nervous system *before* the gesture or message is transmitted, enables the human to modify behavior through reflection and choice in the conscious mind. Thus arises the conception of "self." This results in a sophisticated form of cooperative interaction in which human relating is inherently pattern forming. Much like complex systems in which numerous agents adjust their states through multiple interactions to achieve self-organized criticality, the continuous circular pattern of gesturing and responding take on a fractal nature, achieving coherent patterns that display self-similarity regardless of scale. These complex, responsive processes "have the paradoxical feature of continuity and novelty, identity and difference, at the same time."[93]

This has profound meaning for the nature of human interaction, and the role of the manager in promoting organizational change:

> If one takes this view of the emergence of coherent patterns of relating in the process of relating, then there is no need to look for the causes of coherent human action in concepts such as deep structures, archetypes, the collective unconscious, transcendental wholes, common pools of meaning, group minds, the group-as-a-whole, transpersonal processes, foundation matrix, the personal

[92] Ibid.
[93] Ibid., 93.

> dynamic unconscious, inner worlds, mental models, and so on. Instead, one understands human relating to be inherently pattern forming.[94]

Knowledge, therefore, is not mysteriously formed in an individual's mind through some undefined formative process, to be mined like a resource by a manager operating in a rationalist teleologic manner. It is the product of a process in which knowledge causes itself in the local interactions between humans in the living present.[95] Because these ongoing interactions and the resulting patterns are the basis of knowledge in the organization, power relations or patterns of inclusion and exclusion become central to the process of organization change:

> The complex responsive process framework places power relations, and the ideological themes unconsciously sustaining them, at the center of the organization knowledge creation process. Power relations in organizations arise in ideologically patterned talking, creating the dynamics of who is "in" and who is "out." This is reflected in an unconscious process that distinguishes ways of talking that are to prevail.[96]

Transformation arises in the complex interactions of organizational agents. Change agents are not managers exercising top-down control, through rationalist teleology, of a process that is formative in nature. Rather change agents exist, potentially, everywhere. Cultural norms and the associated power relations determine how the agents participate in the communicative pattern forming.

By adopting complexity science as a CBM, organizations empower change agents at all levels. Managers focus on enhancing their role in participating in the pattern forming process of transformation, rather than attempting to manage and control human mind and relations, which are essentially unmanageable. They recognize that "living systems patterns and processes are running all the time in all organizations, even beneath the command-and-control patterns that we may try to impose."[97] Rather than fighting self-organization, managers empower system agents as participative members in the transformational process. Self-organizing leaders view system

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[94] Ibid.
[95] Ibid., 217.
[96] Ibid., 214.
[97] Richard N. Knowles, "Self-Organizing Leadership." *Emergence* III, no. 4 (2001): 124.

agents as sources of patterns of beneficial change to be adopted in the organizational framework as they emerge; rather than cogs in a machine, attempting to get things done in spite of the mechanistic nature of the rationalist-formative approach of the systems view of organization management.

Significantly, military leadership doctrine recognizes the existence of self-organizing processes in combat operations, in its emphasis on centralized planning and decentralized control through initiative-based execution in keeping with the commander's intent. In the language of complexity: "in an emergency [i.e. combat] there is so much that has to be done so quickly that there is no way management can exercise normal control over the situation...these processes of self-organization are natural; many of us already know how to do them."[98] It only remains for the Army to rediscover the principle, successfully adopted by some armies in the past, that successful innovation is most likely to occur in organizations that capitalize upon (rather than suppress) the natural processes of self-organization in peacetime to the same degree that they do in combat.

CRITERIA FOR GUIDING CHANGE

The view of organization change as a process of pattern forming resulting from the interactive nature of multiple, continuous human interactions--analogous to the emergence of pattern due to the strange attractors that characterize complex systems of many agents engaging in ongoing local interactions--provides the following measures of merit as a means to evaluate whether an organization change process is guided by the concepts of CRP theory.

Prediction is defined as the reliance on highly specific, predictive models of the future. Because the continuous, interactive nature of human interaction results in patterns of knowledge creation that continually self-organize in the living present, any change process that focuses on an attempt to predict the future, and conform the organization to that predictive vision through a systems-based management process, will display the flaws resulting from the split teleologic

approach to organization change. The alternative approach suggested by CRP theory engenders an environment in which change is derived from emergent patterns of thought resulting from human interactions in the local present. Truly novel change is possible, guided by patterns that arise in actual local interaction rather than efforts at predictive speculation about future realities that may never exist.

Control is defined as the reliance on top-down, hierarchical management practices that seek to impose shared vision and consensus. Organizational identity emerges in the pattern forming that occurs in local interactions; the manager cannot control the knowledge contained in these complex interactions like human capital. Rather than focusing efforts on top-down control based on the view that visionary leadership will guide transformation in the "correct" direction, managers taking the CRP view empower change agents throughout the organization, focusing their own efforts on improving the manner in which they participate in the local interactions in which they already participate. Change agents throughout the organization, operating at the same ontological level, engage in local interactions that result in emerging patterns of self-organization, paradoxically both promoting organizational stability and enabling truly novel change.

Stability is defined as the attempt to reduce redundancy, inefficiency and difference. Because the organization thrives when operating at the edge of chaos, efforts to enforce uniformity and discourage difference will impose an undesirable stability that will result in stagnation. Cultural biases and norms uninformed by a CBM rooted in complexity only serve to reinforce this tendency. Efforts to reduce redundancy and inefficiency run counter to the tendency of complex systems operating at the edge of chaos to achieve both stability and change, adapting through extinction events that follow a power law distribution. Redundancy and difference that may be perceived as sources of inefficiency are in reality a component of the fitness landscape that is optimized at the edge of chaos, where the organization can survive the frequent minor and occasional major extinction event to achieve transformation without becoming totally unstable.

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[98] Knowles, 125-6.

The next chapter will briefly explore the transformation processes of three armies, using these measures of merit to evaluate the degree to which they conformed to the principles of CRP theory, and to describe the resulting impact on their efforts to change.

CHAPTER FIVE

CASE STUDIES

This chapter will provide three historical case studies of the transformation processes resulting in innovation in three armies: Napoleon Bonaparte's *Grand Armee*, the German Army in the decades prior to and during the interwar period, and the U.S. Army during the interwar period. Each of these case studies will be analyzed according to the criteria defined in the previous chapter: Prediction, Control, and Stability. This analysis will demonstrate that Army Transformation fails to take into consideration the nature of innovation in human organizations as described by CRP theory.

NAPOLEONIC ORGANIZATIONAL TRANSFORMATION

The transformation of Napoleon's armies provides a dramatic example of military change based on organizational improvements in an environment of technologic parity. To fully appreciate Napoleonic transformation, one must first realize that neither the transformed nature of warfare in the age of Napoleon, nor the brief ascendancy of Napoleon's *Grand Armee*, can be fully attributed to Napoleon himself. The roots of these changes predated the emperor, emanating from a foundation in theoretical development embodied in the writings of the *philosophes*, and achieving fruition in the wake of dramatic societal and cultural changes caused by the French Revolution.[99]

The century preceding Napoleon's ascendancy, sometimes referred to as the "Old Regime" or *Ancien Regime,* was a period of near-constant struggle and conflict. Failure plagued the balance-of-power system as European nations vying for preeminence entered into narrowly defined alliances, demanded compensation and indemnities from competing nations, and

[99] The *philosophes* were the members of what Azar Gat refers to as the "military school of the Enlightenment," a generally under-recognized group of philosophers and military theorists that advanced military theory dramatically throughout the eighteenth century, laying the foundation for revolutionary transformation. Gat argues that the Napoleonic period, and Clausewitz' interpretation of it, can only be fully

generally pursued policies of self-aggrandizement. This atmosphere of intense cooperation included a military system centered on state commission armies, bands of irregulars or mercenaries raised by various nobles to further their personal aims. While technically volunteer forces, these armies could not be counted on to display motivation or discipline under fire, so mechanistic tactical methods were employed to control them. Battle was costly, because armies were expensive and time consuming to raise, and usually indecisive; leading to a preference for maneuver or positional warfare, or sieges. The resulting form of "war as process" focused on limited aims generally consisting of resource grabbing or securing of concessions.[100]

The French Revolution caused a dramatic paradigm shift in the nature of warfare. Armies made up of a motivated citizenry mobilized more quickly and fought with greater zeal. The resulting popular conscript armies, swelled by the *levee en masse*, were much larger than those of the Old Regime, and patriotic fervor provided them with a marked advantage over other European armies of the day.[101] The resulting transformation, well under way by 1793, gave France's armies unprecedented size, discipline and flexibility: dramatic changes in culture, perception and organization occurred through the self-organizing process of pattern formation caused by the changing nature of complex interactions during the period of Revolution. It only remained for Napoleon to capitalize on and complete the process of transformation:

> Apart from his insistence on the importance of the strategical battle as an integral part and the only possible outcome for a successful plan of campaign, Napoleon contributed little new; generals have always tried, to the limit of their abilities, to achieve speed, surprise, concentration and the rest. Moreover, Napoleon's system of war drew most of its feasibility from three inheritances handed down by the *Ancien Regime* and the Revolution. First, there was the idea of subdividing armies into permanent, self-contained divisions....In the second place, Napoleon

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understood in the context provided by the military school of the Enlightenment. See Azar Gat, *The Origins of Military Thought* (New York: Oxford University Press, 1989), ix and 251-4.

[100] Lynn, "International Rivalry and Warfare," in *Short Oxford History of Europe: The Eighteenth Century*, ed. T.C.W. Blanning (New York: Oxford University Press, 2000), 179-92. As Lynn points out, it is a mistake to view this period of "war as process" as devoid of innovation: for example, the roots of the supposed "artillery revolution" often attributed to Napoleon can be traced to the Seven Years War, where the armies fighting at Leuthen possessed more than three times the artillery fielded at Malplaquet less than 70 years earlier.

[101] Ibid., 205-8.

> inherited from the Revolution the idea of "living off the countryside...." Thirdly, the Revolution provided Napoleon with a promotion system open to talent. The importance of this legacy cannot be overestimated; it was the caliber of the truly "natural" leaders who emerged from the ranks of the Revolutionary Armies to command battalions, *demi-brigades*, divisions, corps and armies, that made Napoleon's achievements possible.[102]

Translating these transformational concepts to the language of CRP theory, the changing nature of culture and interactions in the new popular conscript armies enabled self-organization and emergent change. The other European armies of the period resisted the changes engendered by France's revolutionary fervor, clinging to traditional views of army organization and social distinction between the officer and soldier class. In contrast, soldiers in the French army were no longer viewed as socially inferior:

> ...the new French armies now consisted of citizen soldiers who were equal in social rank to the officers and refused to be brutalized; they had to be led by example. Moreover, the disruption of the officer corps because of the Revolution as well as the exigencies of war itself created a demand for good officers, many of whom rose through the ranks.[103]

The dramatic changes caused by the Revolution resulted in the enabling of change agents throughout all levels of the army. Recognition that personal achievement could gain an individual promotion on merit encouraged excellence and initiative. Emergent patterns of action resulting from the changing nature of the complex interactions in the organization were not suppressed; they were encouraged.

Perhaps the best illustration of the adherence of the Napoleonic system to the principles of complexity is the Marshalate. The meteoric rise of soldiers like Davout, Murat, Lannes and Massena, much like Napoleon's own, came as a direct result of the empowerment of change agents within the lower levels of the army; a similar occurrence would have been impossible in any contemporary European army. As facilitators of the Napoleonic system, the Marshals embodied the CRP view: through the *corps d'armee* system, each commanded a redundant

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[102] David G. Chandler, *The Campaigns of Napoleon* (New York: Scribner, 1966), 158-61.
[103] Robert M. Epstein, *Napoleon's Last Victory and the Emergence of Modern War* (Lawrence, KS: University Press of Kansas, 1994), 14.

formation that was fully capable of independent action. This lent an unprecedented degree of strategic flexibility and mobility to Napoleon's armies, because it simplified logistic requirements and allowed operation on an initially broad front. Separate corps could fight independently for extended periods, while the army adjusted its activities to deal with emergent contingencies. Marshals were frequently detached on "corps of observation"[104] missions, encouraging the action of change agents at subordinate levels of command to exercise initiative to attain independent goals. In terms of the complexity CBM, the *corps d'armee* system functioned at the edge of chaos: the number and complexity of interdependent connections created a complex fitness landscape that presented many avenues to advantageous positions. Redundancy between formations, coupled with the power law distribution, ensured that large extinction events (unanticipated significant military misfortunes) would be rare, and easily dealt with.

Analyzing the nature of Napoleonic transformation through the lens of this study's measures of merit demonstrates that the process avoided all of the pitfalls of Prediction, Control and Stability. Rather than focusing on the goal of Prediction of the nature of future warfare, tailoring the army to a specialized force suited to meet a shared vision of some specific future threat, the revolutionary army transformed according to the principles of the *philosophes* to a highly effective generalized force. Napoleon's army embodied the cultural transformation of the French Revolution, maximizing the potential enabled by the changing nature of the complex interactions within the organization. Control was de-emphasized both within the ranks, by adopting the revolutionary suppression of class distinction and adopting concepts of promotion on merit; and at the leadership level, through establishment of the Marshalate and the *corps d'armee* system. Unprecedented flexibility to cope with emergent exigencies while on campaign, as well as a general sense of the empowerment of change agents at all levels of the army, were the result. Command and control was relatively hierarchal in comparison to modern armies, but in

[104] Chandler, 166.

comparison to the undistributed armies of the time[105], no other European army could compare to the level of decentralized control that existed in the *Grand Armee*, whether in garrison or in the field. In keeping with the CRP view of organization design, Napoleonic armies emphasized redundancy and difference over Stability, organizing in similar, redundant subdivision, fully capable of independent, combined arms action. Redundancy provided through overlapping and complementary capabilities ensured durability of combat formations, while difference engendered in the capability of independent action under decentralized control enabled emergent patterns of self-organizing action to occur as the organization operated at the edge of chaos.

The Napoleonic era had a major and lasting impact on the entire world, from the French Revolution's political and social impact, to the conception of a new form of war that inspired Clausewitz' *On War*. While much of Napoleon's success can be attributed to social and military reforms already in place before he came to power, it is clear that his armies rose to predominance in Europe through innovative processes that embodied the principles of complexity theory. The Marshalate positioned key change agents at a lower level than existed in any other European army, and the cultural environment of social equality and promotion on merit encouraged the emergence of beneficial patterns of change from the lowest level of organization.[106]

GERMAN ARMY INTERWAR TRANSFORMATION

Much like innovation in the Napoleonic period, change in the interwar German army was heavily influenced by the social and political environment of the period, and a large body of military theory that expanded upon the foundation built by Clausewitz following the Napoleonic

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[105] Schneider, "A New Form of Warfare." *Military Review* (January-February 2000): 58.

[106] European armies rapidly achieved parity after Napoleon's brief period of predominance from 1798 to 1807. This was accomplished in a variety of ways, such as the adoption of guerilla techniques and Wellington's scorched earth policies in Spain (see Esdaile, *The Peninsular War*, 312), and Russia's effective mimicry of Wellington's scorched earth methods in 1812 (see Roberts, *Napoleon and Wellington*, 93-4). By simply adopting many of Napoleon's methods, European armies achieved parity by 1813. This highlights the dangers of predictive specialization: a determined enemy will quickly match even the most effective means of transformation. Overly specialized armies relying on a technological panacea are susceptible to a particularly rapid balancing effect.

wars. Like the rest of the world, Germany viewed interwar transformation through the lens of its World War I experience. Unanswered questions surrounded the new lethality of the "empty battlefield," the debated role and usefulness of the tank in future wars, the nature of political-military relations, and the difficulty of transforming and mobilizing a new army under the rigid constraints of the Treaty of Versailles. This section will demonstrate that Germany approached interwar innovation as a complex process. As the evolving nature of the contemporary battlefield forced armies to become more distributed, Germany correspondingly distributed change agents down to the lowest levels. This enabled them both to incorporate emergent patterns of change during the interwar transformation processes, and to enter combat in World War II with a highly decentralized tactical method emphasizing independent action of change agents at the junior leaders level.[107]

German theorists recognized as early as 1872 that the increased firepower provided by breechloader rifles spelled the end of massed infantry attacks and cavalry charges. Modern armies would rely on skirmishers to close with the enemy through the deadly final 500 meters covered by the range of the new infantry weapons.[108] While the problems associated with increased battlefield lethality were not solved prior to the end of World War I, they were recognized and studied, resulting in significant changes to infantry doctrine and small unit leadership techniques. The new realities of the battlefield raised two important questions: how should attacking units deal with the increased lethality of defensive weapon systems, and how could leaders exercise command and control of attacking formations? These questions were not answered prior to World War I, despite a lengthy period of debate among both military and civilian theorists between

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[107] This section emphasizes the evolution of German military theory prior to Hitler's rise to power, and specifically addresses German tactical doctrine, because similar achievements at the operational level were reversed by Hitler's suppression of operational cognition within the *Wehrmacht* high command. From 1936 on, German Army doctrine and training emphasized the tactical level--Hitler destroyed any vestiges of their similarly sophisticated operational doctrine, leading to a crisis of operational command. For an excellent analysis, see Shimon Naveh, *In Pursuit of Military Excellence.*

[108] Antulio J. Echevarria, *After Clasuewitz: German Military Thinkers Before the Great War* (Lawrence, KS: The University Press of Kansas, 2000), 23. By 1879, the range of these weapons, including machine

Normaltaktik, a tactical method in which units would maneuver under centralized control in a few easily-memorized standard formations, and *Auftragstaktik*, a tactical method that was much less control oriented, emphasizing flexibility and independent action of tactical-level leaders.[109] While the lack of a solution to the issue of battlefield lethality led to stalemate on the Western Front from 1914 to 1917, major developments in German tactical doctrine in 1918 pointed to a possible answer, in the form of "Infiltration Tactics." Significantly, the primary innovations that led to the success of Germany's new tactical methods in 1918 can be attributed to emergent techniques developed by junior officers, such as Captains Pulowski and Geyer, which were adopted and distributed throughout the army.[110]

The manner in which Germany evaluated doctrinal concepts following World War I demonstrates its emphasis on the activity of change agents throughout the army. Perhaps the most universal and enduring concept influencing the German Army's interwar transformation was a thorough and honest process of critical self-evaluation. This conceptual framework was firmly established in German army culture by General Hans von Seeckt, commander-in-chief of the army in 1919. Von Seeckt began the process of preparing for the next war by filling most of the army's major command and staff positions with officers of the German general staff, creating a very different officer corps from the one it replaced, "one whose cultural ethos emphasized intellectual as well as tactical and operational excellence."[111] The full impact of this sweeping integration of general staff officers throughout the army can be understood by reviewing the highly demanding educational process utilized in the German General Staff College or *Kriegsakademie*. The curriculum and performance standards were highly demanding and failure rates were high. Exercises and written problems put students in highly complex situations

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guns, was 900 meters. Infantry generally dispersed to skirmish formation at 2,500 meters from enemy positions--the effective range of supporting artillery (see Echevarria, 71-2).

[109] Ibid., 32-42.

[110] Timothy T. Lupfer, The Dynamics of Doctrine: The Changes in German Tactical Doctrine During the First World War (Fort Leavenworth, KS: Combat Studies Institute, 1981), 46-57.

[111] Murray and Millett, 36.

characterized by a chaotic, maneuver-oriented situation, stressing rapid decision-making on the spot. In stark contrast to the American system (then and now), no "school solutions" were provided.[112] Rather than inculcating a rigid, prescriptive view of doctrine, the staff school aimed to develop officers who possessed creativity and initiative. The curriculum was clearly designed to develop highly capable officers, equipped and empowered to serve as change agents taking decisive action in self-organizing, emergent patterns of action in complex situations. The impact of an officer corps seeded with individuals trained in this manner cannot be underestimated.

Von Seeckt then formed fifty-seven committees of officers with tactical and operational experience to conduct critical surveys of nearly every major area of combat operations, emphasizing "solid, realistic estimates of what had actually occurred, not on what generals might have believed to have happened."[113] The resulting reports formed the basis of Germany's innovative process throughout the interwar period--a foundation of honest, critical self-analysis, rather than one of cultural bias and parochialism. To further ensure its discourse on war did not diverge from reality, the German army thoroughly tested its new doctrinal concepts in experimental units and during many comprehensive maneuvers: "...a typical German Army captain or major in 1940 would have participated in more multidivisional maneuvers than the average British or French general."[114] When attempting to incorporate new technologies, the Germans relied on foreign analysis where it was available, but they emphasized exploiting their own lessons learned through testing of these technologies in experimental units.[115] Remarkably, they avoided parochialism in even the most contentious areas of debate; for example, the most vocal armor advocates emphasized the tank's role as an integral member of the combined arms

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[112] Harlan H. Harness, "Report on the German General Staff School--1936," in *Supplementary Readings on the Evolution of Modern Warfare* (Fort Leavenworth, KS: Combat Studies Institute, 2001), 63-87.
[113] Murray and Millett, 37. According to Williamson Murray "...the most important single factor in German innovation was the fact that they possessed a coherent doctrine based on a thorough and honest reading of the evidence." Murray and Millet, 41.
[114] James S. Corum, *The Roots of Blitzkrieg* (Lawrence, KS: University of Kansas Press, 1992), 205.
[115] Mary R. Habek, *Storm of Steel* (Ithaca, NY: Cornell University Press, 2003), 193.

team, avoiding the pitfalls of the armor-centric view emphasized by contemporary British theorists.[116]

After decades of debate and experimentation, *Auftragstaktik* emerged as the conceptual foundation of German tactics. This is reflected in the emphasis on "considerable independent tactical authority for junior leaders," both officers and non-commissioned officers, in the 1921 Army Regulation 487, *Leadership and Battle with Combined Arms*.[117] As described by Williamson Murray:

> Post-World-War-I German doctrine consequently emphasized conceptions that were starkly different from those of the British and French. The first was a belief in maneuver. The second emphasized an offensive mind set; the third demanded that commanders decentralized operations to the lowest level possible. The fourth required officers and NCOs to use their judgment on the battlefield; the fifth stressed that leadership at all levels must always display initiative.[118]

The basic philosophy embodied in *Auftragstaktik* traces its roots to Clausewitz' emphasis on fog and friction in combat, emphasizing decisive action with limited information in an environment characterized by meeting engagements. War was not viewed as a predictable event subject to centralized control and specialized units. Rather, tactical and operational methods were developed to conform to war's inherently chaotic nature, emphasizing the ability to operate in a state of self-organized criticality, where flexibility and initiative were maximized to enable emergent patterns of action.

German military theory evolved during the interwar period in accordance with its late 19th and early 20th century traditions. Throughout this transformation process, the Germans avoided the failures of Prediction, Control and Stability. In keeping with Clausewitz' emphasis on fog and friction as the central characteristics of war, they avoided a discourse on future warfare centered on Prediction. Rather, they focused on contemporary technologies that proved their worth both in experimental units, and during exercises replicating realistic battlefield conditions

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[116] Murray and Millett, 40.
[117] Corum, 39-40.
[118] Murray and Millett, 37-8.

and complex, dynamic situations. They conducted self-assessments based on critical analysis, and improved doctrine by incorporating the emergent innovations of change agents operating throughout all levels of the army. The German Army was comfortable operating in a state of self-organized criticality, at the edge of chaos. Its leaders facilitated this distributed process through decentralized Control. Continuing in the Napoleonic tradition, they approached the problem of an increasingly distributed battlefield by correspondingly distributing and empowering change agents throughout all levels of the army. This emphasis on decentralized Control, embodied in *Auftragstaktik*, made the German army particularly suited to take advantage of the fleeting emergent opportunities typifying the complex environment of modern warfare. Similarly, innovative processes in the German army de-emphasized Stability. Rather, the highly self-critical culture of the German army encouraged difference, facilitating the adoption of good ideas from within, instead of enforcing compliance with the conception of key individuals relying on a top-down approach to innovation.

US ARMY INTERWAR MECHANIZATION

The U.S. Army's approach to innovation in the interwar period is strikingly different than that of the Germans. This is best reflected in the Army's most contentious change process: the mechanization of Army ground forces. This process was approached in a top-down manner, heavily influenced by branch parochialism and cultural bias. These problems were exacerbated by resource constraints: congressional insistence on an active force and military budget much smaller than that requested by military leaders ensured that any resources committed to innovation in one branch or arm of service would result in corresponding decreases elsewhere. [119] The resulting intensely competitive and dysfunctional environment resulted in an army that entered combat in the European Theater of Operations in 1942 with internally inconsistent

[119] Mark T. Calhoun, "Defeat at Kasserine: American Armor Doctrine, Training and Battle Command in Northwest Africa, World War II" (Master's Thesis, Command and General Staff College, Fort Leavenworth, KS, 2003), 28-9.

doctrine, inadequate equipment, and a cultural mindset poorly prepared for the chaotic reality of mechanized maneuver warfare on the contemporary battlefield.

The primary lesson the U.S. Army drew from its World War I experience was the belief that it was the man, not the machine, that won wars. Tanks had only a minor impact on the conduct of the war, and the Americans did not enter the war until the worst years of trench warfare were over. In keeping with this basic theme, a provision of the National Defense Act of 1920 dissolved the Tank Corps and placed all tanks under the control of the Chief of Infantry.[120] Throughout the 1920s, armor doctrine and tank design were driven by the basic philosophy that tanks existed solely to support the infantry. The process was further constrained by the top-down, conformist environment in which innovation was only allowed to occur within the limits of branch bias and the confining vision of senior military leaders. This facet of the process directly impacted the career of Captain Dwight D. Eisenhower in 1920, when an article he submitted to the *Infantry Journal* highlighting the under-appreciated capabilities of the tank and advocating a future independent role for armored units drew the attention of the infantry branch chief, Major General Charles S. Farnsworth. Farnsworth personally informed Eisenhower that his ideas were incompatible with infantry doctrine, and if he continued to voice his unorthodox opinions, he would be court-martialed. As a result, Eisenhower asked for a transfer out of tanks. The participation of junior officers in the innovative process was sharply constrained as the "rules for sanctioned discourse tightened" throughout the 1920s.[121] Clearly, this was an environment in which innovation was to occur strictly according to the vision of senior leaders, who suppressed difference in the organization by exercising top-down control.

In an effort to reduce the impact of branch bias on the mechanization process, the War Department briefly experimented with mechanized units in 1927 and 1930, but both experiments were quickly scrapped; the first, because of the inadequacy of existing tanks, and the second due

[120]Christopher R. Gabel, *Seek, Strike and Destroy: U.S. Army Tank Destroyer Doctrine in World War II* (Fort Leavenworth, Kansas: Combat Studies Institute, 1985), 4.

to widespread fears of armor branch gaining independent status.[122] In 1930, cavalry branch became involved in the mechanization process, exploring the usefulness of "combat cars" in traditional cavalry roles.[123] From this point forward, mechanization proceeded along two divergent paths controlled by the infantry and cavalry branches--adding to the lack of cohesion was the fact that technical design and production were under the sole purview of ordnance branch.[124] Eventually, the War Department intervened, holding a secret meeting at the 1940 maneuvers in Louisiana (the infantry and cavalry branch chiefs were not invited) where the responsibility for armor development was taken away from the infantry and cavalry. General George C. Marshall approved the formation of an autonomous mechanized force on 6 June 1940, but placed it under the command of a conventional cavalry officer, Brigadier General Adna R. Chaffee.[125] The result was an autonomous mechanized force with very little modern equipment, many doctrinal hurdles to overcome, war rapidly approaching, and a conventional approach to innovation that was essentially traditional cavalry doctrine. Unfortunately, even limiting the debate to cavalry-centric views did not unify the mechanization effort, because the cavalry had been entrenched in a long-standing, contentious battle between those wedded to the centrality of the role of the horse, and those seeking to embrace the potential of mechanization.[126]

The mechanized force emerged in 1940 from two decades of contentious debate regarding the role and design of the tank, only to find itself in an environment in which doctrinal development was the sole purview of Brigadier General Leslie J. McNair and his staff of twenty-

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[121] David E. Johnson, *Fast Tanks and Heavy Bombers* (Ithaca, NY: Cornell University Press, 1998), 74-5.
[122] Ibid., 99.
[123] Christopher R. Gabel, *The U.S. Army GHQ Maneuvers of 1941* (Washington, DC: Office of The Chief of Military History, Department of the Army, 1991), 22-23.
[124] Johnson, 117. Due to the lack of coordination between concept development within infantry or cavalry branch, and equipment development within ordnance branch, the Armored Force had only about 400 tanks, all obsolete, as late as summer, 1940 (Johnson, 147).
[125] Gabel, *GHQ Maneuvers*, 24.
[126] Rick Atkinson, *An Army at Dawn* (?), 9.

four officers at General Headquarters (GHQ).[127] The War Department recognized the need to standardize doctrine that had previously been the responsibility of the various field armies, but the combination of limited time and resources to conduct realistic experimentation and critical self-assessment, combined with General McNair's strong personal biases, resulted in a highly centralized, top-down method of doctrinal development. For example, one of the key doctrinal questions surrounded the role of the tank versus the anti-tank (AT) gun as a tank killer. Despite the objections of both the infantry and the armor branch chief, General McNair imposed his preference for AT guns on the 1940 Louisiana and Carolina maneuvers. Believing U.S. tanks would not fight enemy tanks, this responsibility falling instead to the AT gun and tank destroyer, McNair did not include tank versus tank engagements in the maneuvers. He placed all of the armor in only one of the opposing armies, and biased the maneuver referees in favor of the AT guns and tank destroyers. As a result, the AT guns and tank destroyers appeared unrealistically effective against armored forces during the maneuvers, reinforcing McNair's vision in which the tanks' role would not include defeating enemy tanks.[128]

The negative impact of this confining vision was ultimately realized in the defeat of the 1st Armored Division at Kasserine Pass. The tankers fighting in Tunisia found themselves in direct engagements against German tanks despite predictions that these engagements would not occur. German combined arms techniques overcame American defenses based on the AT gun, and American offensive AT gun doctrine was simply unrealistic in the contemporary environment of maneuver warfare. German Mark III tanks severely outclassed American Stuarts, while Mark IV and Tiger tanks similarly dominated American Shermans. The lack of training in tank versus

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[127] Kent Roberts Greenfield and Robert R. Palmer, *Origins of the Army Ground Forces: General Headquarters United States Army, 1940-42* (Washington, DC: Department of the Army Historical Division, 1947), 10.

[128] Gabel, *GHQ Maneuvers,* 191-192. Umpires were told the .50-cal machine gun would defeat light tanks at 1,000 yards, despite the fact that the .50-cal was not capable of penetrating the armor of contemporary tanks. The 37-millimeter antitank gun was ruled capable of defeating a light tank at 1,000 yards, and medium tanks at 500 yards, even though Ordnance insisted the gun was obsolete, and tests showed it was unable to penetrate one inch of armor at 100 yards. See Gabel, 49. It seems clear that umpire procedures

tank engagements only exaggerated the American disadvantage.[129] Unfortunately, U.S. armor development was so far behind, and biases were so firmly entrenched, that in 1945, American tankers were still fighting in only moderately improved Shermans, against much more capable German Panthers and Tigers. It was only sheer volume of tanks and personnel that enabled the American tankers to defeat German panzer units in battle.[130] These realities could easily have been prepared for in an innovative process of unconstrained discourse, realistic exercises and honest experimentation. Unfortunately, the U.S. Army chose a predictive, top-down, control-oriented innovative approach during the interwar years, resulting in a costly period of Recognition and Adjustment. In two days of fighting at Sidi Bou Zid and Sbeitla, the 1st Armored Division lost 1,600 men, nearly 100 tanks, fifty-seven halftracks and twenty-nine artillery pieces; only Combat Command B, which had been detached for most of the fighting, remained combat effective. It was only the fact that Erwin Rommel's attacking forces had reached offensive culmination prior to the final battle for Kasserine Pass that averted total disaster.[131]

An analysis of the American interwar mechanization process according to this study's measures of merit demonstrates that the process was plagued by all of the errors of Prediction, Control and Stability. Efforts at Prediction defined the process, particularly in the prevailing view after the formation of GHQ in 1940 that American tanks would not fight enemy tanks directly, but would fulfill traditional cavalry roles. Senior military leaders tried to develop an armored vehicle based on their particular vision of the future battlefield, but cultural biases and resource-driven branch parochialism resulted in a disjointed process that failed to accurately predict the nature of future warfare and resulted in a force that was not adequately prepared, physically or

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were intentionally biased in favor of the doctrinal concept that antitank guns and tank destroyers, rather than American tanks, would be used to defeat enemy armor.

[129] To make matters worse, American doctrine described independent operations by tanks well beyond the range of supporting field artillery--this would be overcome, according to Army doctrine, through reliance on close air support (CAS). Unfortunately, the Army Air Corps had essentially written CAS out of their doctrine during their interwar bid for independence, centered on the predictive vision of future wars that would be won by the independent action of air force strategic bombing. See Calhoun, 34 and 39-40.

[130] Johnson, 192-9.

intellectually, to deal with it. The influence of Control can be clearly seen in the narrow delineation of rules during the Louisiana and Carolina maneuvers, where a valuable chance to experiment became merely an exercise in validating prevailing views of senior military leadership. Change agents did not exist at the lower echelons of the organization - these agents were expected merely to conform to the defining vision prescribed by senior leadership; junior-level innovation and emergent patterns of self-organization were neither encouraged, nor embraced if they occurred. The emphasis on Stability is seen in the rules of constrained discourse governing the interwar mechanization debate that resulted in the suppression of the innovative ideas of Captain Dwight D. Eisenhower and his peers.

Unlike the innovative processes of the Napoleonic and German interwar periods, the U.S. Army did not approach interwar mechanization as a complex responsive process. Change agents were not distributed to the organization's lowest levels--rather, innovation was directed by a few senior leaders whose individual biases and branch parochialism prevented an honest, professional dialogue. Rather than focusing on development of innovative concepts leading to viable operational design and doctrine, the process merely focused on incorporation of technology into existing ideas. Doctrine served as a script, regimenting conceptions and dictating forms and methods based on a predictive view of future war. The entire process was heavily influenced by culture, guided by leaders functioning under a split teleological process rather than transformative teleology. The similarities to Army Transformation are striking.

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[131] Calhoun, 20-5.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

> Without a "scientific" theory of change and transformation, social and organizational change could only be driven by trial and error and by people's accumulating experience and confusion. However, this cannot be enough to prove anything about "progress," since it would have no theoretical framework within which to make such a claim. It would be purely subjective and a matter of opinion and taste. Today the situation has changed, because we do now have a scientifically based theory of change and transformation, namely complexity theory or complex systems science.[132]
>
> Peter M. Allen and Mark Strathern

Army Transformation is a relatively new name for what is traditionally an ongoing process of innovation in military organizations. The new name is symbolic of an effort to harness revolutionary change. Caught up in the fervor over the notion of an I-RMA, the overall focus of the process has become the search for technological panaceas, built on an intellectual foundation of eliminating uncertainty in war. History shows a more balanced approach would combine the search for improved technologic capabilities with equal vigor in improved operational and organizational design, honest experimentation and critical self-assessment. Instead, Army Transformation has resulted in the migration of future concepts to current doctrine; force structure changes are currently driven by the need to create more units to satisfy overseas commitments; the few experiments that occur are manipulated to make future vision a current "reality;" and critical thinking is rejected in favor of the inculcation of transformation dogma.

Discourse diverges from reality when Army Transformation claims to be full-spectrum focused, when in actuality it is guided by traditional cultural biases--resulting in efforts to improve warfighting capabilities that are already the best in the world, while neglecting skills and capabilities proven most critical in recent stability and support operations. Because a return to the Army's tradition of "small wars" appears to be the primary characteristic of current and future

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[132] Peter M. Allen and Mark Strathern, "Evolution, Emergence, and Learning in Complex Systems," *Emergence* V, no. 4 (2003): 8.

operations, a transformation process that relies on long-range destruction of targets seems anything but "full-spectrum." On the contrary, Army Transformation appears to be trapped in the Cold War "spectrum-of-conflict" model, in which the Army focused most of its effort on the types of conflict least likely to occur, on the upper end of the scale of violence (global conventional war, theater nuclear war). While preparedness for major conventional war remains necessary, its decreased likelihood in today's global environment, and the reality of repeated engagements on the other end of the spectrum, highlights the need to question whether Army Transformation is truly full-spectrum.

While many critics in the defense establishment have identified these issues, Army Transformation continues to be driven in a top-down manner according to concerns of future relevance, and without a foundation in sound scientific theory. Significantly the U.S. Army has had success in the past with a less control-oriented approach. While the case study on U.S. Army transformation in the interwar period presented a change process disturbingly similar to today's, one can find a positive example in the transformation of the late 1970s and early 1980s. During this period, due to the post-Vietnam Army's decline, a major effort to overhaul Army doctrine resulted in the publication of FM 100-5, *Operations*. This was the U.S. Army's first true cognizance of operational art. Although key individuals such as General William E. DePuy and Major General John H. Cushman can be identified as major influences during the period of doctrinal development and organizational change between the first version of FM 100-5 in 1976, and the version of 1983 in which "Airland Battle" was introduced, the process was not top-driven as it is today. On the contrary, is was characterized by intense debate, critical thinking, honest analysis of contemporary warfare and experimentation, and the contributions of change agents at all levels within the Army and the civilian community.[133] In Hans Binnendijk's words: "its chief characteristic was pluralism in its ideas and organizations, reflecting the dynamics of economic

[133] See Naveh, *In Pursuit of Military Excellence*, and Herbert, *Deciding What Has to be Done*, for detailed discussion of the development of U.S. Army operational doctrine.

markets and democratic politics, rather than control from atop by any single plan. While this process was turbulent and confusing, it worked."[134] In this key phrase, Binnendijk is describing an innovative process that is in keeping with all of this study's measures of merit, but bears little similarity to Army Transformation.

CRP theory provides an intellectual foundation upon which Army Transformation could be based. This theoretical shift would provide a positive influence on culture through a guiding CBM that recognizes the manner in which human organizations best achieve positive change. CRP theory recognizes the inherently unpredictable nature of complex dynamic human interaction, and therefore encourages innovative processes that avoid Prediction, decentralize Control, and encourage difference rather than Stability. If the U.S. Army adopts CRP theory as the theoretical basis for organizational innovation, it will engender an operational and tactical mindset in which change agents at all levels are comfortable operating in a state of self-organized criticality at the edge of chaos--in peace and in war--where they are optimized to achieve beneficial adaptation in the form of self-organized patterns of emergent behavior. In contrast to transformation efforts that focus on technological innovations, inculcation of a complexity CBM will enable the U.S. Army to see the innovations already resident within the organization, waiting to emerge, rather than pinning hopes on the unproven technologies of the future.

RECOMMENDATIONS

This study demonstrates that Army Transformation is in conflict with all of the major principles of dynamic systems, complex networks, chaos, and complexity theory. Several recommendations are in order. These recommendations focus on culture, by attempting to influence discourse so that it is at less risk of severe divergence with the reality of the complex world. In order to bring Army Transformation in line with CRP theory, the Army should: (1)

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[134] Hans Binnendijk, *Transforming America's Military* (Washington, D.C.: National Defense University Press, 2002), 69.

facilitate emergence by encouraging the innovative efforts of change agents distributed throughout all levels of the Army; (2) modify education and training systems to promote adoption of a complexity CBM; and (3) abandon the speculative pursuit of the "I-RMA" and its associated technological panaceas.

The Army understands how to encourage emergence during combat operations. Leaders at all levels are taught to display initiative and find innovative solutions to problems, retaining freedom of action within the guidance of the commander's intent. It is the commander's intent that maintains cognitive tension, allowing the various elements of the complex system of a military organization to pursue their distinct aims in combat, while maintaining a unity of effort through pursuit of the commander's aims. This same spirit must be inculcated within the peacetime Army as well. Instead of perpetuating the tendency to establish constricting layers of bureaucracy and control in peacetime (and even in combat, once the crisis has passed), the Army must engender an environment that keeps the spirit of initiative and innovation alive in peace and in war. This can best be accomplished by embracing a complexity CBM in the form of CRP theory.

Emergence will be best enabled when the container, transforming exchanges and significant differences in Army organizations are modeled according to CAS theory. Organizations (the container) must be designed to maximize freedom of action and encourage innovation by focusing on human relationships and self-organizing patterns of action. The Army's current force stabilization and brigade reorganization programs appear to be promising efforts to optimize the container for emergence. Transforming exchanges must be similarly maximized to enable change agents at all levels to build relationships, share ideas and collectively develop emergent innovations. There is much to do in this area, particularly in the reevaluation of power relations. As CRP theory demonstrates, innovative processes are characterized by the cultural norms regarding who is part of the change process, and who is not. Top-down methods of innovation may seem attractive to those brought up in the Army's culture of control, but they shut out a large portion of the Army's talent, who are forced to "get things done anyway" while

operating under the confining vision of leaders attempting to maintain the illusion of control. Finally, significant differences should not be suppressed--the necessary experimentation in search of beneficial future technologies cannot be allowed to migrate to a confining vision of current methods; doctrine must not become dogma. Engendering difference will reduce the conflict caused by cultural bias and parochialism by emphasizing those innovations that are demonstrated to be effective rather than those that "win" the contest for limited funds and perceptions of relevance. Significant differences can perhaps best be encouraged by changing how the Army conducts exercises and experiments. Organizations must be placed in unpredictable situations where they are not expected to follow a script or prescriptive doctrine, but use innovative methods to succeed. If the Army optimizes its containers, transforming exchanges and significant differences by adopting a complexity CBM, innovations already resident within the organization will emerge, enabling a shift away from the predictive reliance on future technologies and the associated risk of severe divergence of discourse from reality.

Improvements in officer education are necessary to engender an environment that encourages emergent innovation. The trend toward "distance learning" is particularly disconcerting because it focuses on individual learning methods that are antithetical to the interpersonal relationships and transforming exchanges necessary for emergent innovation to occur. Similarly, methods of instruction must be shifted away from a process of indoctrination to one that emphasizes both knowledge and critical self-assessment of current doctrine.

The German General Staff College serves as an excellent contrast to our current officer education model. Instructors never provided "school solutions" for the tactical problems they presented to their students, who were routinely put in situations in which rote application of current doctrine would likely cause them to fail in their mission.[135] The Army would benefit from a Department of Defense initiative to develop a similar general staff model. This could be easily

accomplished by shifting a small percentage of officers early in their careers into a new career path. This path would begin with an intensive education process emphasizing the operational art and complex, dynamic systems. General staff officers would no longer serve in their basic branch or service; rather they would serve in operational level positions throughout the joint community. Concerns that this would become an elitist organization should be alleviated by the fact that this did not occur in the German army, because general staff officers were required to successfully rotate through field commands.[136] The U.S. General Staff system would consist of a group of dedicated leaders who, early in their careers, would become aware of operational art and the concepts of complex responsive processes. Their periodic rotation through operational assignments would engender transforming exchanges and inculcation of the complexity CBM, facilitating the emergent innovations of change agents at all levels of the Army.

Finally, and perhaps most importantly, the Army must tone down the rhetoric of the I-RMA. Rather than emphasizing a technology centric approach to innovation based on precision weapons and efforts to eliminate the fog of war, the Army must focus on innovations in organization, doctrine and operational design. This should be approached as an evolutionary process--one that emphasizes resident innovations already present in the system only waiting to emerge. Changes in expensive procurement programs should be made only as they are required by operational design requirements, and only when the technologies upon which they are based prove to be capable in honest, demanding experiments. This may require the difficult decision to eliminate expensive procurement programs, and give up the race for "relevance" in today's environment of service competition and parochialism. Nevertheless, both history and science clearly point to the advantages to be incurred by adopting a CBM based on the concepts of complexity embodied in CRP theory.

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[135] Harlan N. Harness, "Report on the German General Staff School--1936," in *Supplementary Readings on the Evolution of Land Warfare* (Combat Studies Institute, US Army Command and General Staff College, Fort Leavenworth, KS, 2001), 63-87.
[136] Murray and Millet, 48.

As difficult as it may be for an Army culture based on bureaucracy and control, the key lesson of CRP theory may be that an organization will innovate better by doing less. Society's prevailing worldview is still dominated by the linear approach of Newtonian physics and the reductionist, time-reversible assumptions of the scientific method. But all of the major discoveries of the past twenty years demonstrate that a new conception of the way the world works is in order. Complexity demonstrates that an innovative process based on prediction and certainty is fundamentally flawed--Clausewitzian friction is a permanent feature of war. It is only the facilitation of emergence through the adoption of a CBM based on CRP theory that will enable the U.S. Army to achieve the evolutionary advantages provided by operating, in peace and in war, at the edge of chaos.

APPENDIX A

Comparison of Frameworks for Thinking about Causality:

	Secular Natural Law Teleology	Rationalist Teleology	Adaptionist Teleology	Formative Teleology	Transformative Teleology
Movement to a future that is:	A repetition of the past	A goal chosen by reasoning autonomous humans	A stable state adapted to an environment that may change in unknowable ways	A mature form implied at the start of movement or in the movement. Implies a final state that can be known in advance	Under perpetual construction by the movement itself. No mature or final state, only perpetual iteration of identity and difference, continuity and transformation, the known and the unknown, at the same time. The future is unknowable yet recognizable: the known-unknown
Movement for the sake of/in order to:	Reveal or discover hidden order, realize or sustain an optimal state	Realize chosen goals	Survive as an individual entity	Reveal, realize or sustain a mature or final form of identity, of self. This is actualization of form or self that is already there in some sense	Expressing continuity and transformation of individual and collective identity and difference at the same time. This is the creation of the novel, variations that have never been there before
The process of movement or construction, that is, the cause is:	Universal, timeless laws or rules of an "if-then" kind, that is, efficient cause	Rational process of human reason, within ethical universals, that is, human values. Cause is human motivation	A process of random variation in individual entities, sifted out for survival by natural selection. This is formative cause	Process of unfolding a whole already enfolded in the nature, principles or rules of interaction. A macro process of iteration, that is, formative cause	Processes of micro interactions in the living present forming and being formed by themselves. The iterative process sustains continuity with potential transformation at the same time. Variation arises in micro diversity of interaction, transformative cause
Meaning:	Has no time dimension	Lies in the future goal	Lies in future selected adapted state	Lies in the past enfolded form and/or unfolded future	Arises in the present, as does choice and intention
Kind of self-organization implied is:	None	None	Competitive struggle	Repetitive unfolding of macro pattern already enfolded in micro interaction	Diverse micro interaction of a paradoxical kind that sustains identity and potentially transforms it
Nature and origin of variation/change:	Corrective, getting it right, fitting, aligning	Designed change through rational exercise of human freedom to get it right in terms of universals	Gradual change due to small chance variations at the individual level	Shift from one given form to another due to sensitivity to context. Stages of development	Gradual or abrupt changes in identity or no change, depending on the spontaneity and diversity of micro interactions
Origin of freedom and nature of constraints:	Freedom understood as conforming to natural laws	Human freedom finds concrete expression on the basis of ethical universals	Freedom arising by chance, constrained by competition	No intrinsic freedom, constrained by given forms	Both freedom and constraint arise in spontaneity and diversity of micro interactions; conflicting constraints

APPENDIX B

MAINSTREAM THINKING ON LEARNING AND KNOWLEDGE CREATION

Figure 6, from Ralph D. Stacey's *Complex Responsive Processes in Organizations*, summarizes mainstream thinking about the system of learning and knowledge creation:

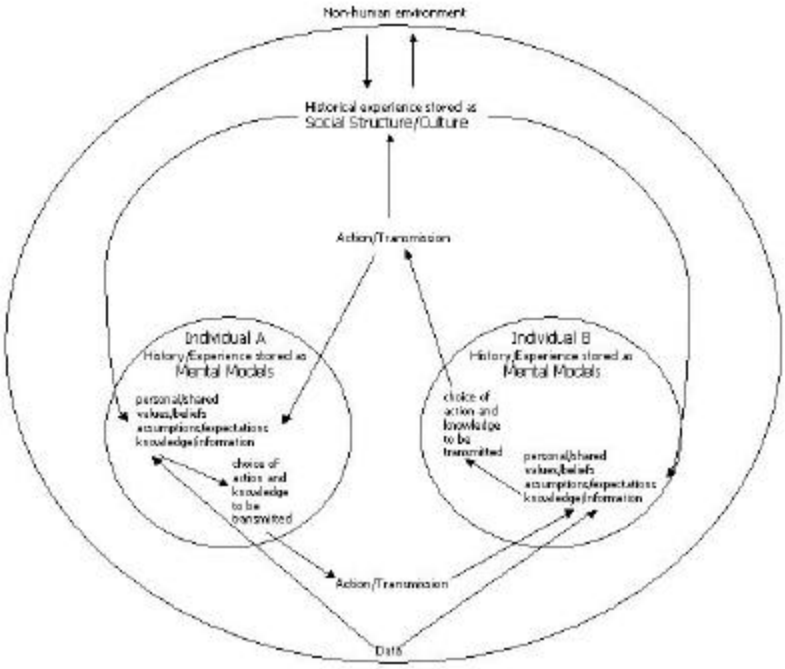

Figure 6 - Mainstream System of Learning and Knowledge Creation[137]

In the mainstream view, data are viewed as a set of discrete objective facts about events. Information is "data that makes a difference"--a message passed from a sender to a receiver that shapes the perception of the receiver. Data becomes information when the creator of the information adds meaning to the data. Knowledge is the framework for evaluating and incorporating new experiences and information. This framework originates in the mind of the

[137] Ralph D. Stacey, *Complex Responsive Processes in Organizations* (NY: Routledge, 2001), 16.

knower, and it is formed by past experience and current values/beliefs. It is stored as memory in fluid and structured forms. It may be explicit or tacit and is transmitted from one knower to another. Knowledge is synonymous with the concept of Mental Models.

Action is a choice made on the basis of knowledge, and that knowledge is evaluated in light of the consequences of the decisions and actions (this is systemic, error-activated learning). Explicit knowledge is formal, systematic knowledge, easily transmitted as language (verbal, mathematical, numerical). What is transmitted is a translation of existing tacit information into language. Therefore, language is a formal, objective system of symbols located outside of people and used as a tool to translate already existing ideas and concepts into a form that can be readily transmitted to others.

Tacit knowledge is personal, located in minds of individuals. It is a subjective phenomenon of insight, intuition and hunches, below the level of awareness, making it hard to formalize and communicate. It is rooted in action and shows itself as skill or know-how. Tacit knowledge is synonymous with Mental Models held below the level of awareness. It is unexplained how new knowledge arises in an individual's mind. Once this tacit knowledge is there, it is transmitted to others (as explicit knowledge) who then incorporate it into their tacit knowledge store through a form of mimicry.

> "In the mainstream thinking briefly summarized above, organizations are taken to be learning, knowledge-generating systems of individuals interacting with each other in group/social contexts. Individuals and contexts are taken to be two distinct phenomenological levels interacting with each other to form the whole system. It is then taken for granted that these whole knowledge-generating systems must be managed in some way in order to optimize, or at least improve, their functioning."[138]

As a result, emphasis is placed on conversion of implicit to explicit knowledge through prescriptions of how to codify and proceduralize it. Knowledge generated in informal ways is not trusted or considered part of the organizational knowledge. This leads to interest in information technology and information systems, since the only information of value is that which is

organizational (explicit, codified, measured and stored in databases). Since this cannot fully supplant knowledge possessed by individuals, emphasis is also placed on management of those individuals. Elitism through recruitment of a small number of the best people is a result. Non-performers are weeded out, requiring systems for appraisal and feedback. Incentive systems and performance standards push individuals beyond their comfort zones to "promote creativity." This perspective demonstrates the split view in which formative teleology governs creation of implicit knowledge, while rationalist teleology guides managers to the manipulation of employees and their "intellectual capital." This view is deeply flawed, in that it cannot explain where the knowledge comes from in the first place, but only views it as another component of the system subject to mechanical manipulation by the manager. [139]

THE CRP THEORY OF LEARNING AND KNOWLEDGE CREATION

Figure 7, also from Ralph D. Stacey's *Complex Responsive Processes in Organizations,* summarizes the Complex Responsive Process view of learning and knowledge creation. Stacey describes CRP view of knowledge creation in human interaction, based in large part on Mead's recognition that "self" is created in the human experience of social interaction, as follows:

> "Humans communicate with each other in the medium of symbols, where these symbols are the responsive bodily interactions of relating. These active symbols are meaning and knowledge. Knowledge, therefore is not an 'it' but a process of action. Action is undertaken in the living present and is, therefore, ephemeral. Knowledge, it follows, cannot be stored nor shared simply because it is bodily action."[140]

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[138] Ibid., 24.
[139] Ibid., 16-31.
[140] Ibid., 116.

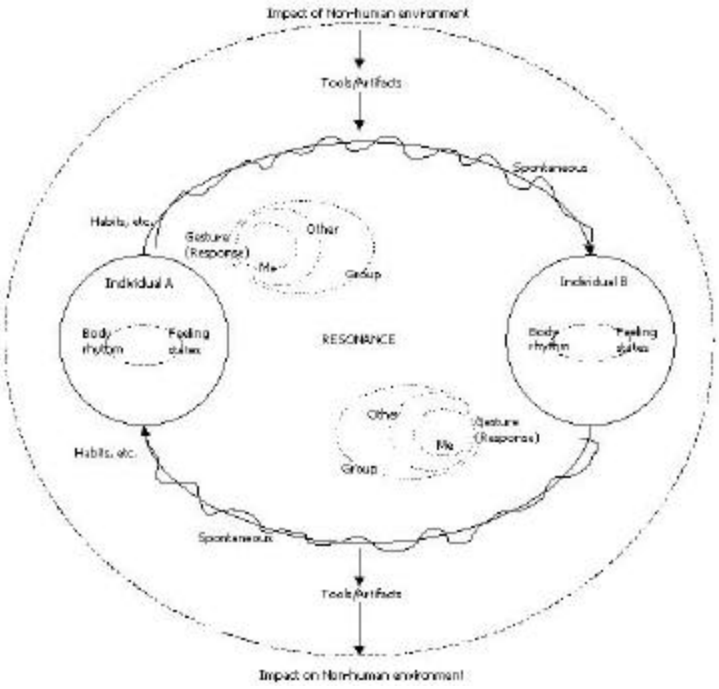

Figure 7 - CRP System of Learning and Knowledge Creation[141]

The significance of this advanced understanding of the process of learning and knowledge creation, and its significance to Army Transformation as a cultural phenomena, is apparent in Stacey's description:

> "The essence of complex adaptive system is the interaction between agents, which consist of arrangements of digital symbols....[t]he essence of human action is the communicative interaction between people in the medium of reified, significant and proto symbols. They are clearly very different kinds of interaction in very different kinds of symbols. However, I argue that there is an analogy in that both forms of interaction can be thought of as self-organizing processes with the property of emergent coherence. When the interaction takes place between different arrangements in these symbols it has the potential for transformation and repetition at the same time....[t]he simulations of complex adaptive systems clarify and point to the possibility of self-organizing interaction in the medium of symbols organizing itself into coherent patterns. The power of this insight is the suggestion that there is no need to look for some kind of hidden reality or

[141] Ibid., 98.

> mechanism other than interaction itself to explain coherence in human action with its characteristics of continuity and potential transformation."[142]

According to CRP theory, knowledge is not a resource to be managed and stored; it emerges in a process in which it creates itself in the local interactions of agents in the living present. Thus, the efforts of managers to manage the agents and their tacit and explicit knowledge are often futile. Managers' efforts would be better spent facilitating the relationships in which knowledge is created, rather than engaging in a hopeless effort to manipulate mental models and store desirable explicit knowledge for general consumption. This highlights the need to empower agents of change--it is their interactions that generate new knowledge, from which emergent innovations arise, not the rationalist actions of the elite manager.

Implications for Army Transformation are particularly evident in Stacey's words:

> "A major implication of the shift in thinking I am suggesting, then, has to do with the policies and initiatives governments and organizations might simply abandon, with enormous savings in money and time and reductions in stress and anxiety levels. The kind of thinking I am pointing to, suggests that we might be able to achieve a great deal more if we did less rather than more. If this is true it has enormous practical implications."[143]

[142] Ibid., 141.
[143] Ibid., 229.

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