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CONTRASTING APPROACHES TO LAND WARFARE: SYSTEMS VERSUS CLASSICAL THEORY

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TABLE OF CONTENTS

FIGURES

ABSTRACT

The classical approach to warfare is founded on a framework of doctrine that is a manifestation of approximately two hundred years of evolving warfare theory. The key theoreticians associated with this doctrine are Carl von Clausewitz and Henri Jomini.

Enigmatically, the allure of the classical approach is also its weakness. It provides a reductionist linear modeling of warfare that is intended to have a cognitive and logical simplicity. However, as is becoming more evident, warfare is inherently nonlinear and increasingly marked by complexity and chaos. Framing complexity with oversimplified linear techniques simply does not work in the 21st century.

Similar challenges of imposing linear analysis on nonlinear phenomena have been encountered by other disciplines ranging from biology, to physics, to economics. Consequently, systems theory is being viewed as an alternative approach because it accepts the existence of nonlinear realities and characteristic of various interacting entities. For military theorists of today it could provide a more comprehensive representation of the complex realities of warfare.

This paper does not compare or examine various decision making processes, although it is a topical subject amongst military writers. Rather, the paper compares the systems and classical approaches for their capacity to provide founding doctrine for today's military in the context of land based operations.

First, the paper examines the genesis of the classical approach and its inherent weakness in using linear reductionist principles. The paper then examines systems theory and the significant opportunity it provides. The conclusion is that although we have trained our imaginations to be fundamentally linear, a paradigm shift to systems theory is now in order.

Once barriers—which in a sense consist only in man's ignorance of what is possible—are torn down, they are not so easily set up again.[1]

Carl von Clausewitz

INTRODUCTION

The Western military culture has been enamored with the theories of Carl von Clausewitz and Henri Jomini for nearly two hundred years. The longevity is attributable to their distillation of the fundamental nature of warfare[2] in a manner that is readily adaptable by successive generations to formulate practical doctrines. They present a reductionist[3] approach of synthesizing the important elements of warfare with cognitive truisms.[4] Their key theories have been utilized substantially by the military to prescribe mechanistic[5] methods to enhance the likelihood of success in a time of war—Jominian ideas of lines of operation plus decisive points, and Clausewitzian center of gravity (CoG). On this foundation of thought the classical approach to warfare has been laid.[6]

The last two decades have, in particular, presented a number of challenges to the classical doctrinal foundation. There was a criticism that the Western approach was too

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[1] Carl von Clausewitz, *On War*, ed. and trans. by Michael Howard and Peter Paret. (Princeton: Princeton University Press, 1984),593.

[2] The word "war" in this paper is inclusive of the entire spectrum of conflict as defined by *Land Operations B-GL-300-001/FP-000*. "Warfare" is merely the engagement in or the state of war. Warfare can take on specific forms such as guerrilla warfare. "Classical Warfare" pertains to the war practiced according to the doctrine arising from the classical works of Clausewitz and Jomini.

[3] Reductionism – "The traditional Western scientific method is predicated on a reductionist philosophy, in which the properties of a system are reduced by decomposing the system into progressively smaller and smaller pieces. However, in so doing, the emergent properties of a system are lost. In the act of exploring properties, reductionism loses sight of the dynamics." Andrew Ilachinski, "Land Warfare and Complexity, Part I: Mathematical Background and Technical Sourcebook," (Alexandria, VA: Center for Naval Analysis, July 1996), 13.

[4] James K.Greer, "Operational Art for the Objective Force," *Military Review* (September-October 2002): 22; http://usacac.Army.mil/CAC/milreview/English/SepOct02/SepOct02/greer.pdf; accessed 28 March 2009.

[5] Mechanistic - explaining behaviour mechanically**:** explaining all natural phenomena, including human behaviour, in terms of physical causes and processes. MSN Encarta *dictionary,* http://encarta.msn.com/dictionary_/mechanistic.html; accessed 22 Apr 09.

[6] Allen English, "The Operational Art," in *The Operational Art: Canadian Perspectives Context and Concepts*, ed. by Allen English, Daniel Gosselin, Howard Coombs and Laurence M. Hickey (Kingston: Canadian Defence Academy Press, 2005), 4-5.

focused on waging wars of attrition and that there was a functional gap between the two accepted levels of war—strategic and tactical. The theorists in the United States (US) military resolved these crises in the early 1980s and introduced the theories of manoeuvre warfare and operational art respectively.[7] However, the classical core elements of doctrine did not change—CoGs were still quintessential and lines of operations laid a preferred path to success. Canada, as an ally, having similar challenges followed suit in this doctrinal reform.

Western armies, including Canada, continue the process of revising their doctrines in light of operational experiences. Recent contemporary operations have had a persuasive impact on how warfare and the continuum of operations are perceived. Strategic imperatives are demanding that armies become increasingly engaged in complex operational milieus, invariably, the demands on operational art increase as well. The conduct of general war is no longer the sole expectation of our armies. New thematic lines of operation are now essential to attain strategic objectives which include lines of governance and development alongside security operations.

The change in doctrine is readily apparent when comparing the table of contents of the current Canadian Army's *Land Operations*[8] with the version it supersedes—*Conduct of Land Operations – Operational Level Doctrine for the Canadian* Army(1996).[9] There is a montage of new concepts, in the new publication, attempting to

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[7] I.C. Hope, "Misunderstanding Mars and Minerva: The Canadian Army's Failure to Define an Operational Doctrine," (Fort Leavenworth, Kansas: United States Army Command and General Staff College, School of Advanced Military Studies Course Paper, 2000), 12-13, 27-28.

[8] Department of National Defence. B-GL-300-001/FP-000. *The Land Operations (Draft)*, (Ottawa: DND Canada, 2008).

[9] Department of National Defence. B-GL-300-001/FP-000. *The Conduct of Land Operations – Operational Level Doctrine for the Canadian Army*, (Ottawa: DND Canada, 1996).

better describe the complex contemporary operating environment.[10] The ten principles of war and various doctrinal concepts remain the same but are now complemented by other hypotheses: a comprehensive approach to campaigns and operations;[11] the need to be concerned about the moral, intellectual, and physical components when generating fighting power; the conduct of manoeuvre is no longer in time and space but now must be contemplated in the psychological plane; and more. All new concepts are an attempt to cope with the many complexities of the operating environment.[12] Nevertheless, these ideas do not replace the classical founding paradigm; they are merely interlaced creating a contemporary hybrid.

Conflict is fundamentally complex and as a human endeavor it will always be unpredictable. Are the classical paradigms still legitimate? According to Colonel James Greer they are not. He believes that "[t]oday's doctrinal concepts for operational design hamstring planners' and commanders' abilities to design and conduct effective, coherent campaigns for operations…"[13] In other areas of study outside the realm of military doctrine such as economics, thermodynamics, and biology, former linear[14] reductionist methods are no longer recognized to adequately explain inherent complexities, and have

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[10] Complex Environment – "A battlespace with a mix of geographical, environmental and human factors that collectively and significantly complicate the conduct of operations." Department of National Defence. *The Land Operations…*, 2-1/24.

[11] Comprehensive Approach - "application of commonly understood principles and collaborative processes that enhance the likelihood of favorable and enduring outcomes within a particular environment. Note: The comprehensive approach brings together all the elements of power and other agencies needed to create enduring solutions to a campaign." Army Terminology Panel approved May 2007. Department of National Defence. *The Land Operations…*,5-16/86.

[12] "The operating environment is a consequence of the overall operational and tactical circumstances in which the Land Force (LF) is expected to conduct operations. It exists on both the physical and psychological planes. It is a complex mix of the geographical, environmental, and human factors that collectively and significantly complicate the conduct of operations." Department of National Defence. *The Land Operations…*, 2-1/24.

[13] Greer, "Operational Art…," 23-24.

[14] Linear implies: proportionality, additivity, replication, and demonstrability of causes and effects. Chapter four provides a detailed discussion on linearity.

converted to a new innovative scientific approach called systems theory. [15] The theory proposes a set of new rules for the complex phenomena. Doctrinal writers have a choice, do they continue to refine—some would argue contort—our linear doctrine to frame the complexities of warfare or do they explore the potential of systems theory to enhance our understanding of warfare?

AIM AND SCOPE

The failure of linear theories to explain a significant number of complex and chaotic phenomena in nature gave rise to systems theory. Systems theory is a nascent science, which is gaining significant notice, as its utility becomes increasingly evident. It provides an alternative approach to explore nonlinear complex interaction between elements and has the potential to enhance our conceptual view of warfare. War is a nonlinear complex endeavour, aptly recognized by Clausewitz who commented on the aspects of the fog and friction of war.[16]

This paper argues that the current classical approach to land warfare founded on reductionist linear principles is no longer adequate. The alternative is a systems approach to warfare which provides considerable opportunity to enhance our ability in framing the complexities of the operational environment.

This paper will not propose any operational decision making processes that employ systems theory although several variants are being trialed such as Systemic

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[15] Systems Theory - "The trans-disciplinary study of the abstract organization of phenomena, independent of their substance, type or spatial or temporal scale of existence. It investigates both the principles common to all complex entities, and the (usually mathematical) models that can be used to describe them." William T. Sorrells, "Systemic Operational Design: An Introduction," (Fort Leavenworth: United States Army Command and General Staff College, School of Advanced Military Studies Course Paper, AY 04-05), 53.

[16] Fog and friction are famous Clauswitzian metaphors. Fog alludes to the disparity between what is thought to be known about a given situation and the actual state of affairs. Friction alludes to the fact that things rarely go in accordance to plans and that even the smallest of events can become amplified into disproportionate effects.

Operational Design (SOD).[17] Rather, what will be explored is the merit of systems theory over the classical linear warfare paradigm. Arguments will be made from a land centric viewpoint and will focus on the operational level.

The first three chapters examine the classical approach, highlighting that it may have been adequate, but it is now past its prime in providing the tools for framing a complex environment. Chapter one will highlight that the inherent linear mechanistic qualities of the classical approach to warfare are a manifestation of the reductionist practices of the 1800s. Chapter two will demonstrate how linear practices limit militaries to certain undesirable doctrinal paths by means of a simplification of the operating environment and the rigid enforcement of order and control. Chapter three will confirm that recent improvements to warfare doctrine have been introduced but these changes have inherent nonlinear systems theory qualities. The chapter also reveals that Clausewitz, long believed to be in favour of linear deterministic ideals, in fact, promoted ideas of complexity and chaos. Finally, technology continues to play an important part in improving military capabilities. However, there is a risk that it could overtly centralize control for want of order.

The remaining three chapters will examine the merits of systems theory. Chapter four is a necessary introduction of system theory basics with objective examples of application. Chapter five will highlight the key arguments of systems theory application to warfare. It will be revealed that warfare readily qualifies as a complex adaptive system. The various complexity domains that a system can migrate to will be discussed, ranging from equilibrium to chaos. To end, the desire for predictability will be explored. Chapter six will consider the implications of adopting systems theory as the conceptual

[17]Systemic Operational Design will be explained with some detail in chapter six.

foundation. Such an undertaking would imply that certain doctrinal concepts might not be compatible. With the adaptation of systems theory would come the introduction of new decision making processes. The chapter provides an insight into the status of the most current systems based decision making processes (Effects Based Operations and Systemic Operational Design). Finally, counter arguments and criticisms to systems theory are reviewed.

CHAPTER ONE – GENESIS OF THE CLASSICAL APPROACH

> *No plan of operations can with any assurance look beyond the first meeting with the main enemy forces. Only layman will think that he can see in the development of a campaign anything like a consistent pursuit of a previously conceived plan, one with all its details worked out beforehand and held to right to the end. The consecutive achievements of a war are not premeditated but spontaneous, and are guided by instinct.*[18]
>
> *Helmuth von Moltke*

Moltke's statement, nearly two centuries old, is as true today as it was then. In spite of a continual pursuit of understanding and overcoming those facets of warfare that generate the "fog of war," the act of war remains a complex human endeavour. Even before Moltke's time, the military's solution was the imposition of structure, drill, hierarchy and methodically prescribed linear tactics to reduce and better manage the complexities. As complexity increased, due to the introduction of larger armies and more lethal weaponry, the instinctive solution was to impose more order. The zenith of systemic control and order came during World War One (WW1) with the need to synchronize artillery barrages and the advance of own troops. Departure from the plan and acts of initiative were not tolerated.[19] The main argument in this chapter will be that Western civilization was on a path of enlightenment, starting in the mid 1700s, by means of heuristic methods with an inclination to master its environment. The classical approach to warfare is a manifestation of this era and therefore is founded on linear, mechanistic and reductionist principles.

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[18] Peter G. Tsouras, *Warriors' Words: A Dictionary of Military Quotations* (London: Arms and Armour Press, 1992), 302.

[19] William S. Lind, "The Theory and Practice of Maneuver Warfare," 1-5, in *Maneuver Warfare: An Anthology*, ed. by Richard D. Hooker, Jr. Forward by General John R. Galvin, U.S.A (Ret.). (Novato, CA: Presidio Press, 1993).

FOUNDATION OF THE CLASSICAL APPROACH

Science and philosophy provided the methods and tools for a better understanding of human endeavours. Sir Isaac Newton[20] and Rene Descarte led the way in defining the world by scientific principles. Through their reasoning, natural phenomena that perplexed mankind for millennia were unravelled. Methodical reductionism was the means by which they explained complex phenomena in simpler terms. Reductionism has been the most successful technique ever used in science.[21]

In the realm of military theory and science, it was Clausewitz and Jomini who, by similar methods, analyzed distinct phenomena pertaining to warfare and proposed theories on war. Jomini and Clausewitz, as "*protégés*" of the Napoleonic period, drew from their observations and respective war experiences. The military has continued to progressively reinvent itself: the introduction of the operational art and the acceptance of manoeuvrist ideas attest to the want for intellectual and psychological innovation. Nevertheless, until some other theories prove to be more effective, military doctrines will continue to be based on the ideas founded on the classical works of Clausewitz and Jomini. [22]

The art of war, by the start of the 19th century, was seated and exercised from two levels—the strategic and the tactical. The strategic level was about formulating plans and

[20] Newtonianism - "… meant much more than a physical theory. It was an amalgam of scientific, political, and religious ideas, which only partially went back to Newton's original works. It was quite common for people who endorsed Newtonian philosophy to have only a vague idea of his mathematical and experimental investigations. Nevertheless, Newton became something of an authority people drew upon in order to resolve matters concerning not only nature's interpretation but also the conduct of man, the function of the state, and the doctrines of religion." http://science.jrank.org/pages/7924/Newtonianism.html

[21] Peter Checkland, *Systems Thinking, Systems Practice* (New York: John Wiley & Sons, 1999), 47.

[22] Shimon Naveh, *In Pursuit of Military Excellence: The Evolution of Operational Theory*, (Portland, Oregon: Frank Cass Publishers, 1997), 2-3,10; I.C. Hope, "Misunderstanding Mars and Minerva…, 18-21.

building forces for the purpose of realizing higher abstract national vision and policies. The tactical level was the mechanistic lower level fixed on realizing and executing battles. The onset of the Industrial Revolution, growing European populations and corresponding growth in agricultural lands, permitted nations to field and sustain increasingly large forces during campaigns. The size and scope of military operations began to stress the coexisting levels (tactical and strategic); singular command was no longer manageable. Operational mass, although advantageous, began to compromise the chance of success due to compromised manoeuvre. These stresses were alleviated by Napoleon Bonaparte's innovative introduction of the Corps structure and by decentralizing command responsibilities. Napoleon, embodying the strategic vision of France, was able to manoeuvre his forces accordingly to accomplish the required decisive tactical battle, his actions manifested concepts of *grand tactics* or *strategic manoeuvre*. Georgii Isserson a Soviet strategist argued that warfare during the Napoleonic era was an "epoch of the strategy of a single point"[23] both in time and space. The success of the Napoleonic form and function permitted a hiatus on the inevitable realization that an intermediate operational level of warfare was required to complement the two existing levels. [24]

The Napoleonic influence and the scholars of the period—Clausewitz, Jomini, Dupuy and others—“armed” western militaries with theories to function adequately up until WW1. During this period, Isserson states that Western armies transitioned through two more periods—“destruction by fire" and "linear strategy.”[25] The advent of

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[23] Georgii Samoilovich Isserson, *The Evolution of Operational Art* (Translated by Bruce W. Menning. The State Military Publishing House ofthe USSR People’s Defense Commissariat: Moscow, 1937), 10, quoted in Craig Dalton, “Systemic Operational Design: Epistemological Bumpf or the Way Ahead for Operational Design?” (Fort Leavenworth, Kansas: United States Army Command and General Staff College, School of Advanced Military Studies Course Paper, AY 05-06) 8.

[24] Naveh, *In Pursuit of Military Excellence…*, 1, 9-10.

[25] Georgii, *The Evolution of …*, 13-14, quoted in Dalton, “Systemic Operational Design: …, 8.

unprecedented size and destructive power on the field of battle once again stressed the ability to campaign. To manoeuvre the leviathan formations in an orderly manner so they could exact the required destructive force on the enemy required meticulous control—tactical and strategic doctrine did not address these demands. New doctrinal concepts, attempting to formulate a better liaison between the strategic and the tactical, were required. As well, there was a desire to loosen the strict control of the tactical level from the strategic level. The Allies in World War Two (WW2) learned to campaign but still focused on large scale tactical engagements that were very scripted and tightly controlled (as with innumerable operations in North West Europe). Unfortunately, the introduction of an operational level concept and operational art would be a few more decades away.[26]

Concurrently, methods of projecting command and control were changing. It became increasingly difficult and impracticable to command by personal presence and direction, as was done for millennia. The battlefield became too large; consequently, locating the commander at a key vantage point or with the main effort or simply roving from one critical area to the next had to change. To overcome this predicament the Prussians introduced the concept of "commanding by plan" prior to the Napoleonic period. Desired control and order could be retained without actually having the commander present. The Clausewitzian and Jominian theories were readily employable for the design of large scale plans and therefore reinforced the efficacy of this command approach. The desire to have positive control through "commanding by plan" and the establishment of linear reductionist warfare ideals made for a perfect union. The union

[26] Naveh, *In Pursuit of Military Excellence…*,1-3.

would take on an even greater central role once the operational level bridged the doctrinal gap between the strategic and tactical levels.[27]

NEW (OPERATIONAL) ART-OLD SCIENCE

Operational art was formalized as official doctrine in 1986 in the revised edition of the US Army's *AirLand Battle FM 100-5*. FM 100-5 was "hailed by many observers as the perfect example of operational level doctrine."[28] It was believed, that operational thinking could enable commanders and staffs to transcend the gap between the already established strategic and tactical levels. Operational art is aptly named because it recognizes that the "art" characteristic is an extension of the human cognitive dimension and spirit, perhaps, the most critical essentials of warfare.

The acceptance of the operational art was very rapid; it is now an instituted core teaching objective in the curriculum of practically all war and staff colleges of Western militaries. The operational art and the operational level have proven to be valuable in warfighting. The Canadian Army defines operational art as "the skill of employing military forces to attain strategic objectives in a theatre of war or theatre of operations through the design, organization and conduct of campaigns and major operations."[29] While this is a sound contemporary definition, the essential elements of operational[30] art

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[27] Thomas J.Czerwinski, *Coping with the Bounds…*, 130-137; http://www.dodccrp.org/files/Czerwinski_Coping.pdf; accessed 20 February 2009.

[28] English, "The Operational Art,"…, 16.

[29] NATO Allied Administrative Publication 39 (AAP-39) NATO Glossary of Tactical and Logistical Land Operations Terms and Expressions, defines operational art in similar terms: "the employment of military forces to attain strategic and/or operational objectives through the design, organization, integration, and conduct of strategies, campaigns, major operations, and battles. Operational art translates the joint force commander's strategy into operational design, and, ultimately, tactical action, by integrating the key activities at all levels of war." Department of National Defence. *The Land Operations…*,, 6-3/49.

[30] "The elements of operational design provide a framework for analysis of the mission. They help commanders visualize the operation and shape their intent. The elements of operational design are as follows: endstate, CoG, Objectives, Decisive Points, lines of operation…" *Ibid.,* 6-949; While there are currently over twenty different Elements of Operational Design (EOD) in the combined Canadian and

are based on linear reductionist theories. As will be revealed, a developed campaign plan is all too often focused on a singular effort of determining the enemy's CoG and exacting a decisive blow against it.

Operational doctrine has been extant for over two decades; nevertheless, it has a number of diverse interpretations and a fair number of critics. It resolved a number of control issues but did little to moderate the complexities of warfare. Formulated to support ideas of manoeuvring large forces to meet strategic ends, operational doctrine does not readily support the unconventional campaigns that militaries must prosecute today. Contemporary campaigns will be protracted and less definable with respect to time and geographic location. The orderly Jominian battlespace—the foundation of operational art—is an idea of the past. The "theatre" will be global and not neatly defined. Campaigns will take on greater strategic parameters and not be exclusively military in nature but rather they will be more comprehensive and include such efforts as theatre development and political stability mired in cultural sensibilities. End states will be focused on enduring resolution and not just military victory.[31]

The formalization and introduction of the operational art was to check historical failures. History is replete with many examples wherein the world's "best" militaries were defeated by a lesser foe: Napoleon's army in Russia; the Japanese Imperial Fleet and its culminating defeat at Midway in 1942; the French army's defence against the German blitzkrieg in 1940; and, the US tactical dominance in Vietnam but ultimate

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Allied doctrines, Classical Operational Design is based on four elements; end-state, centre of gravity, lines of operation, and decisive points. William G. Cummings, "Operational Design Doctrine: Hamstrung or Footloose Contemporary Operating Environment," (Toronto: Canadian Forces College Command and Staff Course Final Paper, 2007), 56.

[31] Henry A. Leonard, "Factors of Conflict in the Early 21st Century," Army *Magazine* 53, no. 4 (January 2003): 1-2; http://www3.ausa.org/webpub/DeptArmyMagazine.nsf/byid/CCRN-6CCS72; accessed 2 February 2009; Montgomery C. Meigs, "Operational Art in the New Century," Parameters vol 31, no. 1 (Spring, 2001): 1-4.

strategic defeat. However, as is evident with the current predicament of the US in Iraq and NATO in Afghanistan, winning the peace is the issue, and winning the war should simply be viewed as a means to that end. In spite of unprecedented overwhelming firepower and technological superiority, US historian Robert Kagan questions why the US has "…been so successful in recent wars and [yet] encountered so much difficulty in securing its political aims after the shooting stopped?"[32] Failure to attain strategic ends implies that there is something inherently wrong at the operational level.

This chapter highlighted the origins of the classical approach to warfare and the influence of Jomini and Clausewitz in particular. Much of the doctrine is reductionist and linear with the intent to maintain better control and order thus better managing complexity. The chapter introduced how the operational art and operational level were necessesary in order to harmonize the strategic and tactical levels and thus furthering control. Nevertheless, the complexities of warfare continue to challenge militaries. The following chapter will further demonstrate the linear nature of the classical approach and the related systemic limitations and inadequacies.

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[32] By stating that the shooting stops Kagan implies that the bulk of the warfighting has come to an end. Fredrick W. Kagan, "War and Aftermath," *Policy Review* 120 (July-August 2003): 3-27.

CHAPTER TWO - LINEAR ASPECTS TO CLASSIC APPROACH

Simplicity achieved by idealized isolation of systems and of variables within systems, deterministic laws, clearly delineated boundaries, linear causal trains, and other tools with which to forge analytical prediction have become the hallmarks of good theory.[33]

Professor Beyerchen

Military theories, like many early scientific theories, have been founded on Newtonian scientific ideals. Newtonian methods, also known as mechanistic, were the foundation of classical science up until the start of the 20th century. Newtonian science is founded on ideas of reductionism, determinism, and materialism. It is very popular because it is intuitive, and seemingly complete.[34] What Newton did for science, Jomini and Clausewitz did for warfare. Jomini and Clausewitz described warfare's basic environment and elements to explain its nature. By distinguishing those elements that define warfare and their causality, then perhaps, success could be recreated with regularity. This chapter explores the linear foundations of the classical approach in operational design and its limited functionality in dealing with the complex nature of warfare.

PERVASIVE REDUCTIONISM

Science is founded on ideas of enlightenment—observation, reason, fact, and proof—warfare theories are no differently motivated or adopted. Military theories (observation and reason) when reinforced by historical precedence (fact) and repeated in practice (proof) will merit mention in doctrinal manuals. Ideally, to qualify as

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[33] Alan D. Beyerchen, "Clausewitz, Nonlinearity and the Unpredictability of War," *International Security*, 17, no 3 (Winter, 1992): 98; http://www.clausewitz.com/CWZHOME/Beyerchen/CWZandNonlinearity.htm; accessed 20 February 2009.

[34] F. Heylighen, C. Joslyn and V. Turchin (editors): *Principia Cybernetica Web* (Principia Cybernetica, Brussels), http://pespmc1.vub.ac.be/NEWTONWV.html

comprehensive doctrine, they must have the following components: cognitive, procedural, organizational, material and moral.[35] Ideally, theories that are found to be immutable will become scientific laws.

History and experience have been the test bed for the theories of warfare. There have been enough examples of success to have the theories of Jomini and Clausewitz inculcated as doctrine but there are far too many failures and exceptions to have the theories qualify as scientific law. By Clausewitz's own account, he saw war as more of an art "since no prescriptive formulation universal enough to deserve the name of law can be applied to the constant change and diversity of the phenomena of war."[36] Williamson Murray argues, in *The Making of Strategy*, that theories can offer no formulas for success in war. They merely assist with analysis. Warfare is too complex to codify by theory; however, complexity can be structured for study.[37] As an example, the linear, strictly controlled and ordered battlefield were the doctrine of the day for a considerable time following WW2 at the British staff college. This was influenced by General Montgomery who was credited for turning around British lack of success in the Western Desert against General Rommel. Success came only after returning back to a centralized approach and a "tidy" battlefield. Ideas of manoeuvre, freedom of action and nonlinearity proved unsuccessful. In the first instance, firepower would be used to destroy the enemy rather than foster chaos[38] and uncertainty.[39]

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[35] I.C. Hope, "Misunderstanding Mars and Minerva…,18.

[36] Clausewitz, *On War*…, 152.

[37] Murray and Grimsley, "Introduction: On Strategy"…, 1-6.

[38] Chaos – "complete disorder or confusion." Oxford English Dictionary. Chaos is used extensively in this paper. This definition provides a simple laymen's definition that for all intent and purposes serves the purpose that is required. A more scientific definition is " Deterministic chaos refers to irregular or chaotic motion that is generated by nonlinear systems evolving according to dynamical laws that uniquely determine the state of the system at all times from a knowledge of the system's previous history… The source of irregularity is the exponential divergence of initially close trajectories in a bounded

Jomini and Clausewitz drew from their observations and respective Napoleonic war experiences—a perfectly scientific approach. Jomini postulated a geometric approach[40] and advocated a set of procedural rules attempting to put superior combat power at the decisive point. He was very determined to reduce warfare's complexity to a few straightforward principles—a true reductionist.[41] Clausewitz does not prescribe solutions; rather, he provides a dialectic perspective synthesizing key ideas through methods of argumentative thesis with antithesis. Clausewitz "wrote a treatise to help us better understand the phenomenon of war through debate and synthesis of competing concepts."[42] However, his writings are difficult to follow; consequently, only befitting concepts were selected—those that conveniently had a linear and reductionist nature to them such as CoG and culminating point. Clausewitz was not a true reductionist but select concepts are treated as such.[43]

Simple, cognitive, intuitive are appealing doctrinal objectives particularly when dealing with the complexities of war. The epitome of this reductionist effort was to develop the linear and mechanistic elements of operational design, required for campaign

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region of phase-space. This sensitivity to initial conditions is sometimes popularly referred to as the "butterfly effect," alluding to the idea that chaotic weather patterns can be altered by a butterfly flapping its wings. A practical implication of chaos is that its presence makes it essentially impossible to make any long-term predictions about the behaviour of a dynamical system: while one can in practice only fix the initial conditions of a system to a finite accuracy, their errors increase exponentially fast. Ilachinski, "Land Warfare Pt1…"182.

[39] Brian Holden Reid, *Military Power* (London: Routledge, 1997), 183.

[40] Jomini is known for his detailed vocabulary of geometric terms such as bases, strategic lines, and key points

[41] Colin Gray, "Strategy in the Nuclear Age: The United States, 1945-1991," *The Making of Strategy: Rulers, States, and War,* ed. by Williamson Murray, MacGregor Knox, and Alvin Bernstein (New York: Cambridge University Press, 1994), 593.

[42] English, "The Operational Art,"…, 5

[43] *Ibid.*, 4-5; Christopher Bassford, *On War 2000: A research Proposal* (October 2006): 4; http://www.clausewitz.com/CWZHOME/Complex/Proposax.htm accessed 12 February 2009.

planning. Simplification can be overdone and at a certain point linear models have no relevance attempting to frame complexity.[44]

CLASSICAL APPROACH TO OPERATIONAL DESIGN-LINEAR ENTRAPMENT

> *It may be of interest to future generals to realize that one makes plans to fit circumstances and does not try to create circumstances to fit plans.*[45]
>
> *General George S. Patton, Jr*

Operational art utilizes creativity and cognitive logic to develop a campaign plan defined by the dynamic "circumstances" of the operational environment, as articulated by General Patton. The most unpredictable circumstances are generated by the human element. Commanders must be able to visualize the operational environment and all the dynamic interactions that can hinder or aid in the establishment of the desired end state. A commander's visualization will permit the formulation of a concept of operations which will then be used to formulate an operational design.[46]

The operational design defines the campaign framework. This framework is composed of a series of interdependent elements. The elements have been formulated since before the creation of the operational art and most originated from the theories of Clausewitz and Jomini. The elements of operational design include: end state, decisive points and objectives, lines of operation, culminating point. The CoG is the most important element, and the other elements of operational design are its enablers.[47]

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[44] Pierre Lessard, "Reuniting Strategy with Policy" in *The Operational Art: Canadian Perspectives Context and Concepts*. Edited by Allen English, Daniel Gosselin, Howard Coombs and Laurence M. Hickey, (Kingston: Canadian Defence Academy Press, 2005), 333.

[45] Tsouras, *Warriors' Words…*, 324.

[46] Department of the Army. *FM 5-0…*, 3-9.

[47] Lessard, "Reuniting Strategy…", 226-337.

The elements of operational design are specifically tailored to the environment they will be employed in. The CoG and lines of operation, for example, in peace support operations are different than those in war. Intuitively, the better the environment is modeled and understood the greater the chance of success. For ease of cognition the conceptual view of warfare has been purposely simplified into a linear approach.

FIXATION ON DETERMINISTIC LINEAR DESTRUCTION

The Clausewitzian idea of CoG is a poignant example of the Newtonian ideals of mechanism, reductionism, and determinism. Clausewitz postulated in several key quotes in *On War*:

> The first task, then, in planning for a war is to identify the enemy's centers of gravity, and if possible trace them back to a single one.[48]
>
> The first principle is the ultimate substance of enemy strength must be traced back to the fewest possible sources, and ideally to one alone. The attack on these sources must be compressed into the fewest possible actions—again ideally, into one.[49]
>
> One must keep the dominant characteristic of both belligerents in mind. Out of these characteristics a certain center of gravity develops, the hub of all power and movement, on which everything depends. That is the point against which all our energies should be directed.[50]

It is the last quote that has particularly gripped the military profession and categorically influenced operational design. It intuitively suggests that complexity can be reduced to a quantifiable point to which resources can be focused with a promise of determinism. The linear ideal of cause and effect is articulated in Canadian Army doctrine:

> Destruction or neutralization of the adversary CoG(s) is the most direct path to achieving the end state[]" and "Commanders must plan campaigns in such a manner that allows their forces and actions to attack adversary

[48] Clausewitz, *On War…*, 619.
[49] *Ibid.*, 617.
[50] *Ibid.*, 595-596.

> CoGs, both physical and moral. Lines of operation that attack a physical CoG will normally be fairly straightforward.[51]

More often than not, as noted by Dr. J. Strange of the US Marine College, at the operational level, the CoG is the enemy's armed forces because it is the element that is "a dynamic and powerful physical or moral agent of action or influence that possess certain characteristics and capabilities, and benefits from a given location or terrain."[52] Consequently, operational design overtly focuses on finding the enemy force and then bearing the appropriate effects to destroy it. Hence, the reasons why military organizations struggle when faced with COG that are moral agents (the peoples will) as is increasingly the case in contemporary times. For centuries now, Western armies have been structured to engage and fight the opposing force, even before Clausewitz. He only accentuated the CoG's relevance and propagates a need to engage the enemy directly, as seen here:

> …the very concept of war will permit us to make the following unequivocal statements: 1.Destruction of the enemy forces is the overriding principle of war, and, so far as positive action is concerned the principle way to achieve our object. 2. Such destruction of forces can usefully be accomplished only by fighting.[53]

Naveh elucidates as to the "…distorting impact of Clausewitz's principle [of destruction and CoG]." The "addicts of Clausewitzian theory" would perpetuate an enduring belief in the CoG and it would be a "magnetic attraction to theorists." Naveh, further, argues that because of Clausewitz's effective ability to communicate his ideas in a seemingly

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[51] Department of National Defence. *The Land Operations…*, 6 - 15/49.

[52] "What Clausewitz (Really) Meant by Center of Gravity," by Dr. J. Strange, USMC War College and Colonel R. Iron, UK Army, 2006. 22.

[53] Clausewitz, *On War…*, 258.

reductionist, cognitive and deterministic manner[54] we are left with an enduring, unshakable theoretical legacy of striking the operational CoG. It is, more often than not, the opposing enemy force, and it is the battle of annihilation that remains to be the manner in how we conduct the operational art. Lieutenant-Colonel Lessard states in *Reuniting Operational Art with Strategy and Policy: A New Model of Camapign Design for the 21st Century* that in spite of lingering differences of opinion in the interpretation of CoG, Western doctrine dictates that it be defined and acted upon. However, its importance is all too often inflated to such a high level that it becomes more central than the importance of attaining the strategic objectives.[55]

Finally, the CoG has a “magnetism” pulling the operational campaign forward but on eliminating the CoG what happens next? Current theory explains that the adversary should no longer be able to impede achieving the conditions for the end state: the enemy has no source of power to resist. Nevertheless, by historical example, there exists a significant operational gap between destroying the CoG and realizing the end state. Destroying the Wehrmacht, as the German CoG, is significantly removed from establishing a peaceful post war Germany as the end state. In the aftermath of removing Saddam Hussain and his Ba 'ath party there was significant unrest and competing views as to who had legitemacy to exercise law. Chaos resulted from the removal of the very institution that gave the country security and governance. With both the strategic CoG—Saddam—and the operational CoG—Republican Guard—removed, end state was no closer at hand. The situation became significantly altered and complex for the US Forces—arguably the campaign design "expired." This situation now became the

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[54] Naveh, *In Pursuit of Military Excellence…*, 70-71.
[55] Lessard, "Reuniting Strategy…", 337.

antithesis of the original operation—from destroy to rebuild—and a subsequent and a very different operational design was needed. Frederick Kagan proposed that the CoG was not the "destruction of the old system, but the creation of the new one."[56] A linear process of operational design is preferred, inspite of its trappings, because it is more likely to be deterministic in cause and effect. However, what is required is a different non-classical approach that would have recognized the complexity and changing "circumstances."

The contemporary operating environment has introduced a high level of complexity where the CoG is not readily identifiable and harder to deal with. Destruction may no longer be viable or permissible. In asymmetric warfare or stability operations the enemy no longer presents a singular discernable source of military strength. The moral component is more relevant than the physical; consequently, there is no quantifiable physical CoG that generates a capability that can be targetable and destroyed. The Taliban, as an example, which works in numerous cells dispersed in Afghanistan and Pakistan has a relatively flat command structure. Attacking a cell would unlikely affect the structure as a whole. Even eliminating key leaders will result in little damage to the Taliban as a whole. Their strength is derived from ideology and the support of the population even if only through ambivalence. An approach that targets adversarial capability (threat based approach) no longer has much relevance in this situation. Capability approach invariably leads to a choice of destruction or neutralization. An alternative to seeking a capability that is difficult to define and find, the process should be

[56] Kagan, "War and Aftermath"…, 7.

one of defining the desired effect. An approach such as this broadens the selection of ways and means. Destruction is but one effect that is available.[57]

In a counter insurgency operation the will of the indigenous people is more likely the source of strength. The operational struggle is now one of legitimacy in the hearts and minds of the people. In other words, the enemy and friendly forces are now targeting the same CoG.[58] Notwithstanding the morality (unlike the bombing of cities in World War II) of destroying the mutually shared CoG—the will of the people—in fact the effort is to win the legitimacy and wedge a moral distance between the people and the adversary. It is now apparent that military means are no longer the solution. Being singularly focused on an inevitable force-on-force resolution through attrition and destruction of the rival does not bode well for the contemporary operating environment.

This chapter demonstrated that warfare theory is a reflection of its time. Reduction of complexity and application of linear solutions are the preferred methods in framing the operating environment. Adherence to such methods has a cognitive simplicity wherein cause and effect retain a logical correlation. However, the theory begins to default to an attritionalist approach directed at the source of strength of the adversary. The linear elements of operational art are not always successful in dealing with contemporary challenges. Western militaries have not remained reticent but rather have continued to attempt to revise the foundations of warfare doctrine to be more adaptable in the complex operating environment—this will be explored in the next chapter.

[57] U.S. Department of the Army. Clausewitz's Center of Gravity: Changing our Warfighting Doctrine--Again!, Antulio J. Eschevarria II. Carlisle, Pennsylvania: Strategic Studies Institute, U.S. Army War College, September 2002, 11-20.
[58] Arguably this is a strategic CoG but nevertheless it is shared by both.

CHAPTER THREE – COPING WITH COMPLEXITY

Military theorist unendingly laboured to improve the doctrine of the day to adapt for the changing character of warfare. Technological advances or changes to force organization or political status all would necessitate change. The nature of war, deemed to be a constant and universal, was already well founded within the classical approach and saw little change.[59] Nevertheless, theorists realized that war was complex and that linear concepts needed adjustment. This chapter provides arguments and example as to how theorists adjusted doctrine to cope with nonlinear realities. As well, there is mounting support that Clausewitz's writings have new relevance when interpreted through the point of view of complex theory. Finally, the chapter argues that technology has to be carefully managed because in trying to control complexity it could easily over control initiative and freedom of action.

INCREASED LINEAR FIDELITY

> *One has to see the whole before seeing its parts. This is really the first rule, and its correctness can be learned from a study of history.*[60]
>
> *Prussian General Gerhard von Scharnhorst*

How the world is perceived has a significant impact on how it is reduced to gain more knowledge. Macro details about the adversary were all that was required up until the end of the 19th century. Knowing the location of the adversarial force was enough to initiate action in an attempt to destroy it. This approach would change in favour of greater situational awareness. It was hoped that "the whole" would begin to reveal its parts. Instinctively there has always been a desire to better understand the individual

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[59] Milan Vego, "Systems versus Classic Approach to Warfare," *Joint Force Quarterly* 52, (1st Quarter 2009): 46.

[60] Vego, "Systems versus Classic…", 44.

elements of the greater whole because by understanding the makeup perhaps inherent strengths and weaknesses can be identified. Why attack the greater mass if the same effect can be achieved by attacking a few vulnerable elements?

The pursuit for more fidelity of enemy structures and their dependencies did little for linearity and nonlinearity. The approach was strictly analytical and objective. Commanders would process the information to deduce whatever facts they needed. Better situational awareness does not necessarily mean better understanding. This was exemplified during World War II bombing efforts where it was believed that by bombing key components of industry the "whole" could be disrupted; nevertheless, only minor success was achieved.[61] Was it a lack of situational awareness or a misunderstanding of how the whole and its parts worked?

MANOEUVRE WARFARE—LEVERAGING CHAOS

In the 1970s, it was proposed that an alternate means of engaging the enemy be considered. The extant method of attritionalist warfare was no longer desirable. Firstly, it was linear, pedantic and regardless of outcome relied on attrition as a means to the end. Secondly, at the time, the outcome of engaging the Soviet Union in a possible war of attrition, lay in their favour. The alternative method to the doctrine of attrition was the doctrine of manoeuvre, which relied on systematic disruption of the enemy by way of creating undesirable operational situation.[62] As Sun Tzu's *The Art of War* advocates, "Subjugating the enemy's army without fighting is the true pinnacle of excellence."[63] Decisive engagement was not the objective; consequently, smaller forces could be used.

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[61] *Ibid.*, 41.

[62] English, "The Operational Art,"…, 34-36; Lind, "The Theory and Practice...",3-4

[63] Sun Tzu, *The Art Of War*, Ralph Sawyer and Mei-chun Lee Swayer, trans. (New York: Barnes and Noble, 1994), 177.

In the beginning, the manoeuvrist doctrine did not gain much support because it was judged to be too simplistic, decentralized and incoherent because it lacked the subjective elements militaries were accustomed to having.[64] It was also presented as the antithesis to attritional war.

In time, as the concepts of manoeuvre warfare matured it received a greater following. Manoeuvre warfare is now widely defined as "A war fighting philosophy and approach to operations that seeks to defeat the enemy by shattering his moral and physical cohesion—his ability to fight as an effective coordinated whole—rather than by destroying him physically through incremental attrition."[65] The dichotomy of attrition and manoeuvre was no longer an issue: they were now complimentary. As an example, attrition is required as a supporting activity, to the initial break-in through enemy defences to permit forces to then commence manoeuvre warfare and inflict chaos upon the enemy. Clausewitz's concept of friction and fog of war were the very theoretical elements that manoeuvre warfare relied on. Manoeuvre warfare is not only a concept of physical actions but advocates that the "primary" weapon is the use of tempo that outpaces the adversary.

Ideally one’s own forces maintain a rapid tempo, which attempts to destabilize the enemy and inflict chaos. Operational art is the medium through which a concept of manoeuvre is conceived and then implemented. The stage must be set to permit the campaign to strike at the enemy in a manner that threatens his CoG. Avoiding the unnecessary battles is as important as engagement. The nuance of manoeuvre warfare is that as long as freedom of action is not restrained and the exploitation of opportunity is

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[64] I.C. Hope, “Misunderstanding Mars and Minerva…, 12-14.

[65] NATO Allied Administrative Publication 39 [AAP-39], Glossary of Land Military Terms and Definitions.

pursued then a cascade of further opportunities begins to materialize. As the enemy is disrupted or dislocated the opportunities begin to materialize. Nevertheless, at times attritional engagement is needed to open up the opportunities.

This notion of exploiting opportunity and weakness is a fundamental departure from the traditional approach of maintaining order, which was predicated on choosing an objective and then not departing from the purpose, means and method. When and where opportunity materializes cannot be predicted and it certainly becomes harder to predict each successive cycle of finding then exploiting weakness. To avoid a pell-mell approach some control is always needed. By articulating a higher intent, all actions and effort is bounded to a common direction. As well, specific tasks are assigned to subordinate organizations to provide an element of focus and responsibility within the greater whole. In essence, the change from the traditional methods of rigid control and order may seem superficial but in actuality are profound. The philosophy to which operations are conceived and executed changes: do “this” to achieve “that” now becomes do “this” and exploit “with a view to…” An element of risk must be tolerated and judgment skills enhanced.

Perhaps the greatest departure associated with manoeuvre warfare from traditional linear reductionist methods is that—to work—practitioners must be permitted a high degree of freedom of action and initiative. It is not enough to merely understand manoeuvre warfare but rather a change in culture is advocated, which then demands an institutional commitment. The manner in which the military is educated requires reconfiguring. The current culture of order will have to change and become one of "how to think" and not necessarily "what to think." Leadership must be permitted to take calculated risk. The alternative is to follow a detailed plan that is likely to loose its relevance as time passes.[66] Command method would switch from "plan" into a concept of "influence." [67]

Is manoeuvre warfare anything more than a fanciful wish? Proponents are quick to refer to historical examples while contrarians will argue that without intent the examples are coincidental and taken out of context and therefore not relevant to the argument.[68] Neither point of view should be dismissed. The historical example of the 1940 German invasion of France through the Ardennes is frequently cited as an example. However, Germany was executing its doctrinal *kesselschlacten*—cauldron battles—wherein the idea was to surround then annihilate that which was enveloped. It was tactically initiated rather than operationally designed. [69] By happenstance or not, it had the same desired effect advocated by a manoeuvre warfare practitioner—the paralyzing and shocking of the French and the Allies, into submission. Moreover, it underlines the disproportionate success that non-linear process can have against an ordered force. A counter insurgency against a conventional force is also a good example. Within a few weeks the German's dislocated the Allies and their preconceived intricate defensive plan was made irrelevant. Moreover, any attempt to devise a counter to the German success by traditional deliberate methods was compromised before orders could be issued for execution: the Germans had already moved past the point wherein the French planned to intervene with a counter move. Desert Storm and Iraqi Freedom are contemporary

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[66] Lind, "The Theory and Practice...", 14-15.
[67] Czerwinski, *Coping with the Bounds …*,130-137.
[68] Daniel P. Bolger,"Maneuver Warfare Reconsidered,"19-41 in *Maneuver Warfare: An Anthology*. Edited by Richard D. Hooker, Jr. Forward by General John R. Galvin, U.S.A (Ret.), (Novato, CA: Presidio Press, 1993), 26-29.
[69] I.C. Hope, "Misunderstanding Mars and Minerva…, 32.

examples of the ease to which a nation can be made to capitulate if its operational CoG—the Iraqi military—is overwhelmed and paralyzed. But victory is falsely attributable to deliberate operational manoeuvre warfare.[70] Victory is more attributable to the tactical abilities to "fix, strike and exploit" with technological and firepower superiority. Through the use of superior technology and firepower it is possible to create weakness and exploit the weakness it may have induced. The only difference compared to WW2 is the precision of the weapons thus requiring fewer bombs—old habits die-hard.

Order, the antithesis to manoeuvre requires the implementation of centralized control through detailed orders and careful centralized planning. The premise being that centralized control is needed to have efficient control of mass and have it act at a designated time and place to annihilate the enemy force. Timetables begin to dictate the synchronization of events and desired effects. The metric for success is communicated by means of battlefield damage assessment. Either the enemy is annihilated or he is not. The simplicity of measuring success by an objective count of destroyed tanks is much more comforting than a subjective account of trying to assess if the enemy's will is on the verge of collapse and how much more is required to push it over the edge and by what additional ways and means. Therefore it is readily seen why manoeuvrist ideas are hard to sell. The manoeuverist counter argument is that strong central control breeds more reliance on central authority. Without modified orders to adjust for a changing situation forces can become paralyzed. As well, the carefully calculated plans take time to generate because of the want of minimizing chance.

The theory of manoeuvre warfare attempts to instil: how to think over what to do; finding weakness and exploiting it to one's own advantage, and attempting to break the

[70] Bolger,"Maneuver Warfare Reconsidered..." 26-29.

enemy's will. It is decisive and was promoted as an alternative to attrition warfare but in fact is now been viewed as complimentary. In its "pure" form manoeuvre philosophy holds all the traits for a successful breakaway from the traditional modes of mechanistic and linear thought. It views the opponent as something that has intrinsic weaknesses and strengths. The strengths are avoided but weakness is exploited with intent to destabilize the adversary as a whole. It is viewed as a preferred manner of conducting operations. It holds a lot of promise but was never fully exploited as a principle "doctrine" but rather only accepted as a philosophy. It merely complements its antithetical form—linear, deterministic attrition.

CLAUSEWITZ REDUX

Clausewitz made no attempt, on his part, to be prescriptive but rather be descriptive of the battlefield environment and nature of war. Many of his ideas were interpreted as reductionist, providing linear solutions to the warfare debate. However, some of his key nonlinear and complexity arguments, such as fog and friction, were peripheral to the linear thinking norm of the period and not embraced as a basis for doctrine. [71] Nonlinear concepts did not lend themselves to the process of exacting order and control on the battlefield. Paradoxically, Clausewitz opposed any suggestion that warfare had any mathematical or geometric structure. He was specific that in its modeling, war could not be simplified into a few elements.[72] Clausewitz's reference to the unpredictable chaotic human dynamic are not totally ignored but instead are taken as cautionary truisms and often qualify as the "doctrine" of apologists when things do not go as expected.

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[71] Bassford, *On War* 2000…, 1-2,
[72] Vego, "Systems versus Classic…", 46.

There is a rising "neo-Clausewitzian" following by a number of contemporary theorists who argue that *On War* has new found relevance when interpreted through the point of view of complex theory: "in a profoundly unconfused way, [Clausewitz] understands that seeking exact analytical solutions does not fit the nonlinear reality of the problems posed by war, and hence that our ability to predict the course and outcome of any given conflict is severely limited."[73] Clausewitz argues that friction is derived from the interaction of two animate forces and opposing wills. In equal vigour the enemy is trying to exact the same decisive actions and effects upon our own forces. Clausewitz in true antithetical form describes that military forces are easy to manage but being organized of individuals each capable of generating friction

> The military machine—the army and everything related to it—is basically very simple and therefore seems easy to manage. But we should bear in mind that none of its components is of one piece: each part is composed of individuals, every one of whom retains his potential of friction.[74]

It is human nature to have certain expectations from cause and effect however if the expectations do not materialize then cognitive disorientation (friction) is unlikely alleviated through the application of linear remedies. Nevertheless, commanders are required to make decisions with the information available and accept the risk. Invariably the action initiated will likely generate further friction. The link between fog, friction, chaos and nonlinearity of warfare becomes readily evident.

Clausewitz's ideas of chaos are becoming increasingly relevant in the contemporary theory of warfare. Proponents of manoeuvre warfare use it as the primary point of argument. Manoeuvre warfare would, first, induce chaos through direct or indirect action and then capitalize on it to the point that the enemy's cohesion and will is broken. Like

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[73] Beyerchen, "Clausewitz, Nonlinearity…," 62.
[74] Clausewitz, *On War*…,119-120

Clausewitz's ideas on chaos, manoeuvre warfare never succeeded in being a doctrinal cornerstone but rather remains a war fighting philosophy. Systems theory, on the other hand, includes chaos as a state that a complex system can enter. There is an ideal complement between Clausewitz and the emerging systems theory.

TECHNOLOGY

No argument about an approach to warfare would be complete without raising the issue of technological impact. The will for transformation has never been stronger due in part because of the opportunities offered by technology but also as a matter of necessity to deal with the growing challenges and complexities of the operational environment. Revolution in military affairs (RMA) is an associated catch phrase for the fundamental shift in the conduct of military operations resulting from advancements in technology, combined with changes in militaries organization and doctrine. Operational concepts, under the auspices of the RMA, promise dominant manoeuvre, precision engagements, improved force protection and focused logistics.[75] There is no question as to the tangible enhancement it generates with precision effects in the operational environment as is evident in comparing recent military campaigns to those of even ten years ago (operations Desert Storm and Iraqi Freedom). RMA advancements easily impress because they are largely quantitative and objective. Nevertheless, technology does have its limitations and is not always the panacea that its proponents advocate.

Command systems, a critical requirement for operations, are a good argumentative example of the increased capability stemming from technological advancements. Technology has become a stroke of luck for those who support centralist

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[75] Lothar Ibrugger, *The Revolution in Military Affairs*, Report Prepared for the NATO Science and Technology Committee (NATO: Nov 1998) http://www.iwar.org.uk/rma/resources/nato/ar299stc-e.html#1

control doctrine because it removes issues of time and space and deflates manoeuvrist argument for the advantages of decentralized decision making. Technology permits “real time” positional awareness and visual observation through unmanned aerial vehicles and the ability to bear strategic assets to tactical events faster than a tactical commander can formulate plans from his “narrow” vantage point. However, technology for command systems will always require a human interface in order to process the information and make decisions but the sheer volume could now incapacitate that process. To better manage the potential volume of information flowing from the operational area of responsibility there is a script to which the battle is tracked. The tactical level is instructed as to the information that is to be collected and relayed. Indicators and events trigger action but first the indicators must be detected. As chaos mounts, the information is unlikely to be any clearer than it has been in the past because more may be known but what is relevant may be lost in the exigency of the moment. There is an intrinsic tension that becomes acute between having situational awareness and the want for control to remove uncertainty and maintain order. Higher echelons inherently see more and have more resources to shape the run of events. Command practices have evolved from being directive, to issuing detailed plans, and recently to one of instilling influence. Technology provides an opportunity to revisit directive command which is the least desired method in a non linear complex environment.

Technology due to its appeal can—as in the past—define the character of war and lead militaries down doctrinal paths: some good (air power) but also some of false hope (air power alone could win wars). Technology can also be a force multiplier to assist in further developing and pursuing a chosen doctrinal path. The classical approach to warfare suggests that technology will be leveraged to facilitate a desire of controlling the complexities of the operational environment. Historically it is in the very nature of the military to be methodical and to over control and technology makes it increasingly easier to do so. The systems approach suggests that technology should be leveraged to work within complexities and encourage decentralized low level initiative. The paradox is that the two efforts are dichotomies and so long as militaries are overly concerned with controlling complexity exploring the possibilities of existing within complexity will be limited.

Chapter three argued that the US military, not satisfied with its attritional way of war, introduced manoeuvre warfare. In doing so they inadvertently also began to address the shortcomings of its overtly mechanistic linear operational doctrine. Under examination, manoeuvre warfare has many innate nonlinear characteristics. Manoeuvre, warfare begins to exploit the complexities of the operational environment and induce chaos into the adversary. As well, the chapter casts light on a new interpretation of some of the Clausewitzian observations on the nature of warfare. Wherein his most interesting theories of fog, friction and chaos never made it as founding linear doctrine but find relevance in explaining nonlinear behaviour. Finally, the chapter made a point that technology can be leveraged to improve the approach to warfare but what is good for the classic approach is not necessarily conducive to increased effectiveness in a complex environment.

In the following chapters there will be a shift from analyzing the background and shortcomings of classical approach to now exploring the merits of a systems theory approach.

CHAPTER FOUR - ADVENT OF SYSTEMS THEORY

The paradigm that dominates contemporary Western thought is best described as the Newtonian worldview—a view that resolves around absolute mechanics enabling precise measurement of specifics.[76]

Anton Kuroc

A new view of the world is taking shape in the minds of advanced scientific thickeners the world over, and it offers the best hope of understanding and controlling the processes that affect the lives of us all. Let us not delay, then, in doing our best to come to a clear understanding of it.[77]

Ervin Laszlo

INTRODUCTION

Mankind is heavily influenced by the discoveries and promises of science. Newtonian science, for one, established a following that advocated a "mechanistic" view of the world. Everything—it was believed—could be reduced to their very rudimentary elements to determine the causality of behaviour. Newtonian thinking merited a strong following due to its cognitive simplicity. Through reductionism a complex phenomenon could be understood by analysing its individual components. Taking this process to its limits it was believed that all phenomena—physical, biological, or social—could be explained through materialistic reasoning.[78] Newtonian science implies that all systems be linear. The implication being that what is put in to the system is directly related to the output. The whole is equal to the sum of its parts. Due to this input and output relation the system is inherently predictable.

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[76] Anton Kuroc, The Relevance of Chaos Theory to Operations in the *Australian Defence Force Journal* No. 162 September/October 2003, 4

[77] Ervin Laszlo, *The Systems View of the World: A Holistic Vision for Our Time*, (Cresskill: Hampton Press, Inc., 1996), viii.

[78] F. Heylighen (2006): "Newtonian World View", in: F. Heylighen, C. Joslyn and V. Turchin (editors): *Principia Cybernetica Web* (Principia Cybernetica, Brussels) http://pespmc1.vub.ac.be/NEWTONWV.html 25 February

Science advocates that theories be supported through application and replication. By that virtue, Newtonian reductionist applications are not able to explain all that is found in nature. In particular, Newtonian theory ignores, and thus fails, to explain human characteristics particularly those of non-deterministic free will. Consequently, science has introduced systems theory (systems complexity and chaos theories as subsets) to explain those phenomena in nature and social sciences that are beyond the bound of classical reductionist linear explanation. As such, systems are nonlinear wherein inputs and outputs are not proportional. Further, the most puzzling nonlinear phenomenon is that identical actions can lead to significantly different results. Society, being a system, has a long history of disproportionate cause and effect (images of the prophet Mohammed in a Danish new paper and resulting protests, circa 2006).[79]

This paper is not a *how to* apply systems theory, as there are many fine papers written that provide information on the *how to* enhance decision making through the use of systems theory. There are also many papers that provide a comparative argument on the strengths and weaknesses of current operational decision making methods and proposed systems theory methods (these methods are introduced in Chapter six). The overarching message being relayed herein is that system theory provides a superior paradigmatic foundation for the causal nature of warfare. It compliments rather than contradicts many of the Clauswitzian theories because when those theories are interpreted from a nonlinear (non classic) perspective they communicate a greater degree of insight.

The essential elements of systems theory and its theoretical framework will be introduced in this chapter and concurrently the links to warfare and the operational art

[79] The Danish newspaper *Jyllands-Posten* published several cartoons of Mohammed. The publication led to outrage among the Muslim immigrants living in Denmark which quickly swelled into world wide protest.

will be introduced. The body of science can be quite technical and highly mathematical but only the descriptive, practicable aspects will be presented. In particular, it is the characteristics of complex adaptive systems[80] that are key. Many of the postulates will seem rather obvious and true to describing warfare's character and nature but that is in essence the quintessential allure of systems theory and hence the mounting interest from military theorists. Arguably, although its origins have no relation to military requirements, its adaptability and relevance is readily evident.

SYSTEMS THEORY

> The trans-disciplinary study of the abstract organization of phenomena, independent of their substance, type or spatial or temporal scale of existence. It investigates both the principles common to all complex entities, and the (usually mathematical) models that can be used to describe them.[81]

A system[82] is described as a set of independent but interrelated elements designed to work as a coherent entity. The system as a whole has properties and behaviours different to the individual elements. Changes to an element or its interaction with others will result in effects elsewhere. The elements in themselves can be sub-systems (system of systems). The system elements can be practically anything as long as they are constituent parts of the collective whole. In other words, for military purposes, an element could be an individual soldier or a sub-system such as military unit or formation (this is an important point to retain whilst continuing through this paper). Systems theory has greater holistic relevance because it is inclusive of linear and nonlinear systems.

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[80] Complex Adaptive Systems – "…interacting units that are endowed with the ability to evolve and adapt to a changing environment." *Ibid…*, 184.

[81] Sorrells, "Systemic Operational Design…" 53.

[82] Living systems is said to be an autopoietic system which "is a networked pattern in which the function of each component is to participate in the production or transformation of other components in the network." Fritjof Capra, *The Web of Life: A New Scientific Understanding of Living Systems* (New York: Anchor Books Doubleday, 1996) 162.

The study of systems is generally concerned with “cause and effect” or “input and output.” In very broad terms there are two methods of analyzing input and output dynamics. First, if all that is needed is a measure of system output due to respective input then the inner workings of the elements can be ignored. This would be a simplified method of analysis. A good example of this approach would be the study of the effects of medication on the body. Medication goes in and tangible effects are observed. How the medicine is processed by the internal organs is not required—more medicine produces more effect.[83] In contrast, a second means of study would be an analysis of the inner workings of the system. However, to avert Newtonian reductionist failings, noted earlier (an analytical approach), the interactions between elements cannot be discounted. The challenge is that these interactions are rarely linear cause-and-effect interactions. Using a military example, knowing the state of each member of a platoon does not guarantee that the state of the platoon as a whole can be predicted. The interaction and network of interdependencies between members will dictate output as much as the individuals themselves. The most intriguing aspect of this method is that to function successfully and to survive as a whole the interactions between elements must have an underlying common purpose.[84] That is to say, common purpose serves the whole but is not necessarily vital to the individual elements. This premise is further illustrated in what is labelled as “downward causation;” wherein the laws governing the whole also dictate the behaviour of the elements. Conversely, from a reductionist argument there is “upward causation” wherein the laws governing the parts can influence the behaviour of the whole.

[83] Heylighen "Newtonian World View…", 3.

[84] This point of common purpose will be more evident in a military context, in chapter four, when presenting Shimon Naveh's arguments of the need for an operational aim to maintain the integrity of the system due to the inherent tension between the tactical and strategic levels.

This is what is meant by the expression that the whole is greater than the sum of its part wherein the "greater" is the higher law that trumps laws originating by the lower level. This downward causation is an important aspect of emergence.[85]

The dual method of analyzing a system—the whole or the internal workings—illustrates that there exists a higher and lower structural hierarchy. The higher level is the conceptual which gives the view of the whole without the details of it parts. The lower level is the view of all the working parts but not necessary knowing how they are ordered to form the whole. Each level has its own laws but often these laws tend to be very similar; consequently, each level is likely to have similar structures and functions for systems belonging to different levels.[86] For a military organization this hierarchical logic is well known and understood: higher level rules having precedents over the lower.

OPEN AND CLOSED SYSTEMS

Troubled by the manner in which physicists modeled systems, the biologist Ludwig von Bertalanffy[87] developed and proposed General Systems Theory. Bertalanffy noted that physicists in studying system phenomena would “simplify” the model by considering it in isolation from all surrounding external influences. This is known as a reductionist process. It is assumed that any influence that external forces have are either negligible or already accounted for within the isolated system. While an acceptable method for the study of mechanical systems, it is not very effective for a multitude of other systems. Why do this? Because if the system permits itself to be modeled in this

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[85] Emergence – Emergence refers to the appearance of higher-level properties and behaviours of system that-while obviously originating from the collective dynamics of that system's components-are neither to be found in nor are directly deductible from the lower level properties of that system. Emergent properties are the properties of the whole. Ilachinski, “Land Warfare Pt1…" 187.

[86] Heylighen "Newtonian World View…" pg 3.

[87] Ludwig von Bertalanffy was a biologist and founder of General Systems. His seminal piece on the subject was - *Theory General System Theory: Foundations Development Applications*.

manner, it is easier to calculate and predict, within acceptable accuracy, a system's behaviour and future states because all variables are known. Under general systems theory a system that functions in isolation is known as a closed systems because it receives no external input nor does it produce an output.[88]

Most systems do not lend themselves to being modeled as a closed system. If, as is usually the case, external influences play an important part in the functioning of a system then reductionist modeling to predict a system's behaviour cannot be readily done. There is no utility in studying or modeling phenomena in this manner if, in actuality, they are sensitive to their external environment. For a biologist, like Bertalanffy, this was particularly relevant because organisms cannot survive without interaction with the external environment. No organism could survive; to be closed would require deprivation from water, air, and food. Systems that demanded external input because they cannot function otherwise are known as open systems. The interaction is a reciprocating exchange of input and output and more or less an input will lead to an output although they may be disproportionate to each other. The operating environment and the systems (units) within would be considered as open.[89]

Moreover, the environment that a system exists within is likely to have other systems present. Consequently, there is likely to be interaction between these systems. The interacting systems can now be considered to be their own larger system. The output of this new larger system is likely to be different than the sum of the individual smaller sub-systems. An interesting premise considering that in contemporary operations it is

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[88] Sorrells, "Systemic Operational Design…," 55-56.
[89] Sorrells, "Systemic Operational Design…," 55-56.

important to include the non-combatants, non-government organizations, etc as factors in all cause and effect analysis.

Closed systems will expend unrecoverable energy[90] and settle into equilibrium.[91] Once in equilibrium, a system will become still and for living systems that is tantamount to death. A living system, in contrast, (military organizations included) is an open system and requires replacement of energy expended. It will exist far from equilibrium as a result of its inherent dissipative structure.[92] As an organization, a living system exists in a self-created "closed" boundary. "This organizational closure implies that a living system is self-organizing in the sense that its order and behaviour are not imposed by the environment but are established by the system itself."[93] But fundamentally, it interacts with its environment openly to meet its need for energy, information and other material. A military organization is frequently viewed as co-existing as a distinct entity within its society at large (distinct dress, code of conduct, etc) but relies on the "external" society for fundamental support.

LINEARITY

Linear systems, as supported by the Newtonian influence, have had a pervasive and enduring impact on how the world has been scrutinized and modeled. Its philosophy has had an impact on warfare theory—as was made evident in the first three chapters. Linearity has a rightful place in describing specific systems exhibiting specific traits. It is when theorists try to impose linear ideals on nonlinear phenomena that difficulties occur,

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[90] Energy is a metaphor in this context and includes other resources that a system may need to survive.

[91] Law of entropy - The measure of the degree of randomness or disorder in a system. Determines a system's capacity to evolve irreversibly in time. Ilachinski, "Land Warfare Pt1…"187.

[92] Dissipative structure - An organized state of a physical system whose integrity is maintained while the system is far from equilibrium. Ilachinski, "Land Warfare Pt1…," 186.

[93] Capra, *The Web of Life…*, 208.

as is the case of classical approach to warfare. Systems theory classifies systems as being linear if they exhibit proportionality, replication, additivity, and demonstrability of cause and effects.[94]

When input is matched by output a system has proportionality and any change to input is matched by an equal change in output. In military terms this would be the proportional matching between cause and effect. Replication means that under the same circumstances and influences the system will produce the same results at every attempt. Additivity implies that the whole will equal the sum of its parts. Consequently, through reductionism every part can be analyzed for its contribution to the system and by studying the constituent parts the aggregate functionality can be understood. Parts can be duplicated and reassembled to replicate the greater system. Finally, demonstrability of cause and effect implies that with minimal insight in how the system behaves by means of "linear deduction" the remainder can be inferred. These inherent traits, listed above, are what facilitate predictability of the linear system. Mechanical systems exhibit conventional characteristics of linearity; hence, it is too easy to become preoccupied with the physical characteristics of warfare. These basic and comprehendible traits are far different than those exhibited by nonlinear systems.

NONLINEARITY

Nonlinearity includes the concepts of chaos theory and complexity theory. Nonlinear systems display vastly different features than linear systems. Everything is interconnected and therefore an attempt at reducing the system to its simpler components will fail to account for higher orders of effect generated within the system. The system is sensitive to initial conditions and changes to those conditions can cause disparate and

[94] Czerwinski, *Coping with the Bounds …*, 8-9

disproportionate effects; consequently, attempting to replicate results is not a feasible event. Input to the system is not met with proportional change to the output. Additivity does not apply. Knowing a little bit about the system does not promise to unlock any greater understanding; consequently, predictability is not achievable. Most importantly, nonlinear systems exist in a state of complexity, a state that is representative of warfare.

By brief comparison of linearity and nonlinearity, it is evident why the former is more attractive to scientific and military theorists, particularly the premise of an aspect of true predictability. It would be very disconcerting to campaign on the basis of nonlinear philosophy: a theory that manifestly cannot predict if a prescribed path to a desired endstate can be achieved. By comparison, linearity would suggests success is repeatable at every attempt so long as the analytical logic is adhered to: to be victorious requires having a force larger than your adversary; attriting the enemy will reduce the whole to ineffectiveness; and replicating organization and doctrine which works will not guarantee success but will invariably, increase the odds. Warfare is recognized as a complex endeavour but like other phenomena it can be "tamed" through imposition of order in those elements that could be controlled. Order and control would give an approximation of linearity. Tactically it would equate to drill, tactics and procedures: operationally, it is the adherence to elements of operational design.

In the arguments of this chapter there emerge the primary universal concepts of systems theory. There are universal principles of organization and interaction that matter more than the material components that comprise a system. Although by many accounts the utility of systems theory is still emerging, this universality does show promise for many applications including warfare.[95] The information introduced in this chapter is a baseline of concepts that will be used in the proceeding arguments. The next chapter explores the expanded aspects of systems theory: those that are applicable to warfare.

95 Robert Jervis, "Complex Systems: The Role of Interactions," in *Complex, Global Politics, and National Security*, ed. David S. Alberts and Thomas J. Czerwenski (Washington, DC: National Defense University Press, 1997), 22.

CHAPTER FIVE - QUEST FOR REDUCTIONISM

Zoroaster, the ancient Persian prophet, proclaimed some 3,000 years ago "[t]here are elements of chance, choice, and certainty in every aspect of our lives."[96] Linearity (certainty) and nonlinearity (the randomness of chance and choice) are two phenomena that have coexisted since the beginning of time. The degree to which either dictated mankind's awareness of reality was related to his ability to understand and define his surroundings. In ancient times, by means of philosophy, mankind reduced the complexity of the physical earth into five classical elements—fire, air, water, earth and aether[97]— although today mankind understands a lot more paradoxically nature continues to be perceived as very complex and chaotic. As new horizons of knowledge are attained more intangibles are solved and others are then discovered. At each barrier to further enlightenment mankind invariably must adjust the approach to investigation because the method to that point is no longer adequate.

To be of practicable application the manner by which we choose to approach warfare must be reducible. Reduction is required if there is to be any success in formulating doctrine and establishing an associated decision making process. For example, classical approach reduced the nature and character of warfare into discrete linear elements of operational design. This chapter explores the idea or reductionism for nonlinearity.

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[96] Jamshid Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*, (Butterworth Heinemann, 1999), 25.

[97] Ancient Greek philosophy proposed these five coincidently Hindu, and Japanese philosophers proposed similar classical elements.

LINEAR REDUCTIONISM

In contemporary times it has been linear analytical science (Newtonian) that has been the means by which we have reduced complexities.[98] Due to the relative success of linearity most other methods of investigation have been ignored. When linearity is required to explain nonlinearity, it is done through reduction of the bigger problem into smaller components to facilitate linear approximation. As was argued in the first three chapters, the study of warfare has been beset with challenges. Its complexities have been reduced to permit linear approximation as prescribed by theorists inspired by Clausewitz and Jomini. Linear approximation has had significant success with technology but less so with systems involving the will and tenacity of clashing forces. Wherein linear elements of operational design have been adopted and optimized for conventional war, they have a greater challenge dealing with the complexity of non-conventional conflict.

Linearity's greatest drawback is the inability to deal with the interactions between system elements. Linear reductionism of the system focuses on the elements and not the interactions. This is a significant omission because the general mathematical tenet suggests that the number of possible interactions between elements is roughly equal to half the square of the total number of elements in the system, as an example: ten elements could generate up to 45 interactions and 100 would generate 4950.[99] Reductionism becomes extremely harder to achieve regardless of how good the linear model is when there are so many permutations at play. This partially explains why the contemporary operating environment is seemingly more complex and why linear decision making models (e.g. the Canadian Forces Operational Planning Process) do not work particularly

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[98] Czerwinski, *Coping with the Bounds …*, 25-26; Gharajedaghi, *Systems Thinking: Managing Chaos…*, 25-27

[99] Czerwinski, *Coping with the Bounds …*, 28-39.

well. Conventional warfare focuses on an adversary's military strength and all that is associated with it, as a system of systems. The elements are rather homogenous and recurring; consequently, the concern is the destruction of the system as a whole. The reductionist view is not overly concerned with the extensive interactions between elements unless an element can be identified as being a system's vulnerability. The only interaction of concern is generated by the command and control network which is readily identifiable. With enough elements destroyed the system will fail: the interactions are irrelevant. At least that is the conventional wisdom; however, as history has proven other problems could percolate as unresolved issues or grievances then generate the next round of future conflict.

Insurgents are difficult to distinguish from the population. Their success is directly related to their ability to intermingle with the surrounding population to conceal their activities. "[An insurgency] may fight without constraints or rules of engagement and will exploit its amorphous character for purposes of intelligence gathering and attacking."[100] The insurgency is a much more complex system that is intricately connected to the local population. The interactions amongst the elements of this system are its strength. To destroy elements could inadvertently cascade into doing more harm than good in the overall aim and mission. As an example, the town's spiritual leader could be the chief recruiter of a local insurgency but also a galvanizing element for the ambivalent but stable majority. This is recognized in our doctrine where it states, "The objective sought is not primarily the destruction or capture of insurgents. Objectives should focus on controlling the level of violence, reducing popular support for the

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[100] Department of National Defence. *The Land Operations* …, 2-12/24.

insurgency, cutting its external links and correcting the root causes and grievances of the insurgency."[101]

The challenge of dealing with the various contemporary threats and conflicts is that previous linear approximations (elements of operational design) are not applicable. They must be readjusted or a new approach be introduced. The emergent quality of insurgencies and their nonlinear nature finds its strength in the interaction between elements and not the elements within the system. Conversely, conventional forces are less able to cope with nonlinear threats. Their emergent quality is less evident because it is structured to be conforming and linear for ease of control and order.

NONLINEAR REDUCTIONISM

As is suggested in the previous section, linear reductionism has many limitations when applied against the nonlinear realm. Conceptualization and systemic order is increasingly difficult to attain: a new method is required. As suggested by Jamshid Gharajedaghi "[a] language of interaction and design will help us learn a new mode of living by considering various ways of seeing, doing, and being in the world. We can then design new methods of inquiry, new modes of organization…"[102] To understand nonlinearity requires that we comprehend the elements and language of complexity and chaos. Complexity can be imagined as a domain that the system can reside within, between the "edge of equilibrium" at the more stable end and the "edge of chaos" at the other extreme.

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[101] Department of National Defence. *The Land Operations* …, 2-17/30.
[102] Gharajedaghi, *Systems Thinking: Managing Chaos…*, 26.

Chaos Theory

Linear systems are based on Newtonian ideas of proportionality (cause and effect are equal) and additivity (the whole is equal to the sum of its parts). A linear system's position can be predicted through mathematical means based on start state variables. A change in start variables results in proportional changes. However, linear system's modeling had no utility as was argued. Like closed systems, linear system modeling has limited and specific utility. Nonlinear system modeling is truer to form. As such, the study of nonlinear systems introduces the field of chaos theory. First introduced by Henri Poincare[103] its usefulness was not realized until the 1960s by Meteorologist Edward Lorenz. Unlike a linear system, very small changes in the start state would result in significantly disparate end states. Chaotic systems are not random nor are they periodic. The future state is dependant on the initial conditions and although somewhat unpredictable, they can be modeled mathematically and constrained within a set of rules for short periods of time. Modeling is possible because it can be estimated as to what variables drive the system. Once modeled then control is potentially possible. Such systems also have attractors[104] that can cause a chaotic system to converge upon and by analyzing these attractors an estimate can be made as to how long the system can remain stable. Finally, predictions can be made as to how long it might take to have chaos

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[103] "French mathematician, one of the greatest mathematicians and mathematical physicists at the end of 19th century. He made a series of profound innovations in geometry and the theory of differential equations." Encyclopædia Britannica**,** *Poincaré, Henri*, (Encyclopædia Britannica Online. 2009): <http://www.search.eb.com/eb/article-9060534>; accessed 2 May 2009.

[104] Sorrells provides the "simplest" idea of an attractor as "An attractor is something that the system gravitates towards when in complexity. An example is the natural leader to whom all turn when something catastrophic happens. These attractors could be considered as depressions within an area as they attract the system when it is in chaos." Sorrells, "Systemic Operational Design…" 61; No matter where the system starts from or is perturbed to, it will eventual settle down or drift towards a small number of these attractors. Linda P. Beckerman, *The Non-Linear Dynamics of War*, (Science Applications International Corporation, April1999): http://www.calresco.org/beckermn/nonlindy.htm; accessed 24 April 2009. 4.

dissipate from the system and have the system return back to its environment. The relevance of chaos will become far more evident once these arguments are applied to the larger discussion on complexity theory.

Complexity Theory

Arising from chaos and general systems theory is complexity theory. General systems theory was merely the foundation and chaos theory, in spite of its promise to unlock a significant branch of study, is limited in its application to specific phenomena. Complexity theory provides answers to those phenomena that are nonlinear in cause and effect and exist beyond equilibrium but short of entering chaos. Complexity theory—the study of complex systems—recognizes that size and number of elements is not what is key but rather the dynamic interaction of those elements. In other words, behavioural complexity is more important than system complexity.[105] This is a significant and an enlightening statement when comparing a modern military and its (system) complexity—in all facets—to (behavioural) complexity of an insurgency.

[105] Andrew Ilachinski, "Warfare and Complexity, Part II: An Assessment of the Applicability of Nonlinear Dynamics and Complex Systems Theory to the Study of Land Warfare," Mathematical Background and Technical Sourcebook (Alexandria, VA: Center for Naval Analysis, July 1996), 50-60.

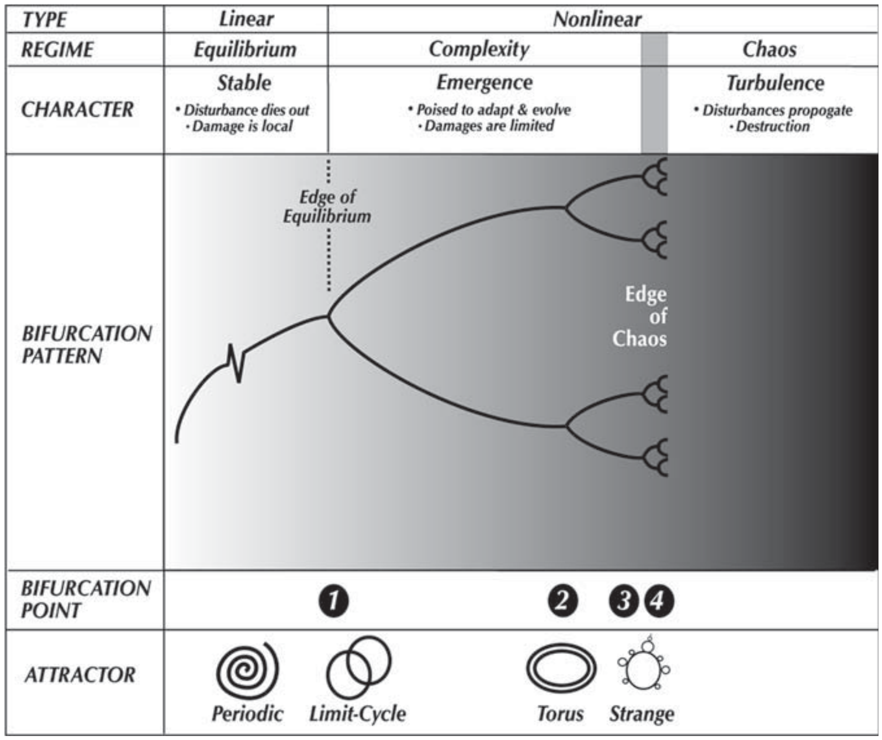

Figure 5.1 - Period Doubling Cascade[106]

Nonlinearity can be visualized as a series of domains in which a system can exist. The diagram above provides a representation of this model. The two ends are the “edge of equilibrium” at the more stable end and the “edge of chaos” at the other. At equilibrium a system is so stable that there is no longer innovation and growth. There is complacency to the point that the system can no longer survive: the Roman Empire and France 1942 would be good examples wherein the former’s equilibrium was manifest from complacency but the later was manifest due to compromised situation wherein no political or military choices were available. Vichy France could qualify as an emerging system. Although, France was defeated, Vichy France emerged from equilibrium as a "new" system back into the complexity domain. Conversely, in the chaos domain the system is in such turmoil that control is no longer possible—intervention is virtually

[106] Czerwinski, *Coping with the Bounds* …, 36.

hopeless. In between the two ends—the complexity domain—is the state at which a system has the best chance of surviving. It is the domain wherein Complex Adaptive Systems (CAS) thrive. [107]

Within the complexity domain, complex nonlinear systems will bifurcate[108] as energy is input into the system and it moves towards the edge of chaos. At each bifurcation a perturbation will cause a system to choose between two options or paths. The model (diagram) shows that within the complexity domain there are four bifurcation points that occur—the first on transition from linear to nonlinear and from that point the bifurcations begin to occur at an accelerated rate. Past the fourth bifurcation point the time to the next one is so compressed and the bifurcation options so vast that the human mind is no longer able to comprehend and draw logic from the state of chaos. The actual boundary for the edge of chaos is dependant on the relative perspective it is assessed from. For computers, for example, the edge would be the third bifurcation because they are less capable than the brightest of human brains.[109] This provides confirmation of the need to have an intellectual and visionary commander able to assimilate the complexity arising within the operating environment (at the fourth bifurcation) and reacting to it accordingly. It is Napoleon, Alexander, and other great Generals that see out to a greater event horizon. The following is an excellent example of bifurcation phenomena:

> An example of this repeated bifurcation would be the behaviour of the residents of Mogadishu during the operation to seize Aidid clan leaders. The state of Somali citizens going about their normal daily living bifurcated upon the perturbation by our forces into those still going about

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[107] CAS – Any dynamic system composed of many simple, and typically nonlinear, interacting parts whose parts can evolve and adapt to a changing environment. Sorrells, "Systemic Operational Design…" 50.

[108] Bifurcation occurs when a small change made to a system causes a sudden 'qualitative' or topological change in its behavior. Order emerges spontaneously and complexity unfolds. Capra, *The Web of Life…*, 190; Ilachinski, "Land Warfare Pt1…," 191.

[109] Czerwinski, *Coping with the Bounds …*, 38-39.

> daily living and those erecting barricades and lighting summoning fires. As the mission progressed, Somali citizens increasingly abandoned daily living and thronged to the scenes of action. Those with arms fired at our forces from rooftops, windows and from locations within crowds. As our forces fired back at massed crowds comprised of both armed and unarmed citizens, the mobs responded to that perturbation with yet another bifurcation. Now they stormed towards the Americans and more switched from "bearing witness" to actively helping Somali gunman take the Americans out in the increasingly intensive fire fight (e.g. using children to point out the American positions to hidden gunmen). During the various firefights, Somalis massed and dispersed, massed and dispersed (they oscillated back and forth between these two states, with scenes of action being one attractor and places of cover being another). Militia adapted to our fire by deliberately surrounding themselves with civilians and hiding their weapons under their robes. When a Somali militiaman shot down the Blackhawk with an RPG, the wreck site became another scene of action and the Somalis converged towards it. At this point they again switched state to pure revenge, hacking at and parading around with parts of the dead airmen bodies. They were in yet another state when they set up a camera crew and entered the process of ransoming the pilot off.[110]

Success will be achieved by keeping one's own force out of either of the two extreme domains while attempting to force the adversary into one of them. As an example, prior to WW2, the Allies attempted to keep Germany in equilibrium but failed to do so. Germany proved to be a CAS. In spite of the stringent Versailles Treaty, Germany adapted within the imposed Treaty constraints and evolved into a system that would eventually dominate all those around it. Paradoxically, the other European nations became complacent and nearly fell into a state of equilibrium.[111] It is not uncommon for systems to drift back and forth between the two extremes: the danger lies in crossing an “edge.” With further development of systems theory and its application to warfare, it may be possible to control and predict entry into the two extreme domains.

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[110] Beckerman, *The Non-Linear Dynamics of War…*,5-6.

[111] More explanation will be provided on this competition between systems in chapter five – Fitness Landscape.

Each bifurcation will lead to an increase or modification of the system's internal model for future reference. [112] This bifurcation and choice between options will continue with further perturbations and a greater number of internal models will be formed. The bifurcations may begin to overwhelm the system's ability to make the right choice of states or paths to enter due to shortened time frames to make a good choice. Eventually the system, on entering chaos, will have an infinite number of states to choose from. This, however, does not necessarily mean an end to the complete system. The system unable to exist in chaos will attempt to establish order by being pulled toward an attractor. Failing to find an attractor, the system will brake apart. Resilience is a function of the systems ability to self-organize[113] (more on this later). Systems that do recover from chaos will reconstitute back into equilibrium and eventually back into complexity.[114] Entering chaos is not an entirely bad event. The universe and biology depend on it because of its evolutionary consequence.

> In human and social systems, both linear order and chaos intertwine in varying degrees and alternate throughout the life history of the system. A period of relative order is followed by a period of chaos, which in turn brings forth a new order. The period of deep chaos is a natural and necessary part of the development of every living and social system. It comes at the bifurcation point of discontinuous change. The conditions that are the fertile ground for the creation of the new order are born out of the turbulence of chaos.[115]

As suggested in the quote, the altered system then loops around to the equilibrium domain; however, the new system is unlikely to resemble its former self. In the real world where tangible results are more comforting than the unknown result of entering

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[112] Internal Model – used by agents to "anticipate" and "predict" events in their environment. Ilachinski, "Land Warfare Pt1…", 100.

[113] Self-organize – The spontaneous emergence of macro organized structure due to the collective interactions among a large assemblage of simple micro objects. Ilachinski, "Land Warfare Pt1…",199.

[114] Sorrells, "Systemic Operational Design…", 65.

[115] Uri Merry, *Coping With Uncertainty* (Westport: Praeger Publishers, 1995): 41, quoted in Czerwinski, *Coping with the Bounds …*, 46-47.

chaos, strategic or operational decisions will be made to avoid crossing the edge into chaos.

Systems thrive in the complexity domain and will interact with other systems and the environment to maintain this end. Failing to sustain complexity will lead to a return to equilibrium. However, such a struggle requires the expenditure of energy. All along, the system is steered by its internal model as to what actions to take and which state to enter when faced with a bifurcation choice. Systems entering the complexity domain will interact and compete with other systems within the shared environment. At times this can lead to conflict; however, not interacting with the environment or other systems can lead to entering a state of relative equilibrium and possible destruction. As well, if a system loses visibility of the other systems there is a chance that its relative development is likely to slow down. In this competition between systems attempts are made to gain optimal positioning. The system is guided by its internal model which in turn continues to learn and update. Actions are taken based on predicted outcomes and the lessons from prior actions. The action of each system impacts the other systems and thus changes their relative positioning. Less than optimal systems will likely not survive hence the willingness to expend energy to adapt to its environment. They bifurcate and enter a heightened state of complexity.

Fitness Landscape

This competition amongst systems is akin to Darwinian concept of survival of the fittest. This competition can be modeled in what is known as the fitness landscape model (figure 2).[116] From a military perspective this explains why when encountering an enemy

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[116] The landscape is modeled as a three dimensional map similar to a topography map of peaks and low points. Sorrells, "Systemic Operational Design…," 66-67.

a failure to destroy it on initial encounter will result in that system learning from the incident and seeking to develop itself to comeback more fit. The US after Pearl Harbour and the Soviet Union after the German invasion are examples of the competition. The fitness landscape also accommodates the notion that the competition between systems is not only evolutionary for the systems it also has an effect on the environment which in turn may then favour one system over the other. In a counter insurgency the environment does change and knowing this both sides of the conflict will try and accommodate environmental change to their respective advantage. A secure environment equals progressiveness in governance and development which promotes human freedom but also threatens traditional status quo. Either argument will promote choice amongst the ambivalent populace.

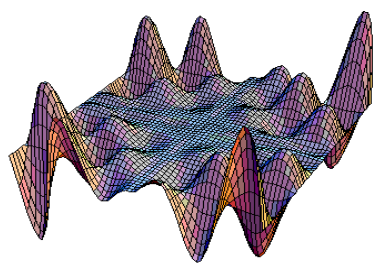

Figure 5.2-Fitness Landscape[117]

COMPLEX ADAPTIVE SYSTEMS[118]

The central argument of complexity theory is that of the CAS. There are four distinguishing characteristics for CAS. First, a CAS has interrelated elements that are able to act autonomously if need be. Second, the relationship between elements is non-

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[117] The fitness space can be thought of as a two-dimensional region, the fitness landscape may look like a mountain range above this region. The height of the peaks is a relative measure of a system's fitness. http://classes.yale.edu/fractals/CA/GA/Fitness/Fitness.html

[118] Ilachinski, "Land Warfare Pt1…," 99-100; Czerwinski, *Coping with the Bounds …*, 13-23; Greer, "Operational Art…", 29.

linear. Third, they will break from routine to take advantage of a situation. Finally, they have a capacity to act collectively (this is the adaptive aspect) and they can do so with anticipation and no central direction. Living systems (including the military) are a CAS also known as an autopoietic system and unlike non-living systems they have the ability to self-bound, self-organize, self-generate, and self perpetuate.[119] Interactions between CAS will impact the environment making it eventually less welcoming to one of the competing systems.

CAS have seven attributes (four properties and three mechanisms). The properties are: aggregation, nonlinearity, flows and diversity. The mechanisms are: tagging, internal models, and building blocks.

Aggregation concerns the emergence of significant complex behaviour from the grouping of smaller less complex elements. The emergent behaviour is a result of the aggregate interactions of the smaller elements. A good example of this would be the formation of a Battle Group from various smaller capability components. Within a hierarchical framework, the aggregate can in turn act as a higher hierarchical element (the Battle Group within a Brigade). Emergent behaviour stresses the idea that the sum of the parts is much greater than the whole.

Non-linearity emphasizes that attempting to make linear approximations about the aggregate system is futile due to the multiple nonlinear interactions between elements. The system has the ability to avoid predictability therefore it can remain readily adaptable. Innovation and asymmetrical warfare would be the military example.

[119] Capra, *The Web of Life…*, 208.

Flows are the movement of various entities, including information, resources through the system between nodes via the connectors. The nodes process the flow and the connectors facilitate the interaction. A military example would be the movement of supplies or information networking.

Diversity is the ability of a system to use a variety of models, and capability components to optimize its ability for survival. Diversity, as a property, does not support the development of generic elements that are optimized for a set range of scenarios. This is avoided to prevent stagnation and entry into equilibrium. If a hole is created when an element is removed then diversity ensures adaptation to find a replacement. A military example would be that units are at their best as an amalgam of diverse sub-units. A battalion will always perform better as a Battle Group because of the increased diversity and capability due to the attached supporting elements. A Battle Group can be more self-sufficient in a wider range of task.

Tagging is the manner in which various elements and components identify themselves. This identification facilitates the formation of aggregates. Tagging permits better cooperation amongst elements and facilitates the emergence of larger more capable systems. It is the mechanism that makes possible hierarchical organizations. Military example would be the use of distinct uniforms, call signs or a unit's "colours."

Internal Models is the mechanism of analytical ability to permit a system to deal with problems based on prior learning. Internal models provide the power of anticipation. Systems adapt to change and control themselves in accordance to both negative and positive feedback from its interaction with the surrounding environment. Based on decisions it may have made, the resulting effects on a system can be stabilizing or destabilizing. The military utilizes cognitive and intuitive leadership based on combat and training. There is no alternative to combat experience.

Building Blocks are associated with internal models and are the selected component parts of past events that can be reused to provide bearing in future events (think of them as discrete memories of action). These parts are not random but rather reflect an inherent ability to select what is important. In other words, how we deal with a new situation is based on the ability to recall discrete building blocks of past experiences to solve the current problem. This is a preferred method over a scripted list of detailed rules for every possible event. Every time a building block is reused it is improved. For the military it is preferred to follow higher command's intent rather than detailed scripted orders. As well, it is preferred to have leadership know how to think and not what to think.

CAS are able to instinctively self-organize and, as mentioned earlier, systems that are self-organizing have a greater resilience and ability to transform into highly ordered states (more on this trait in the next section). This can be done without central coordination but is attributable to the internal model. Although self-organized, the system's internal workings will have changed in spite of not altering its external form. The system now exists in a form of tension that could be exploited to break it apart. The tension is created by two opposing inclinations. The first is the aggregation tendency which encourages the elements of a system to work as a whole. The second is the self-assertive tendency, which encourages elements to act individually. Naveh utilizes this CAS characteristic of tension to validate the need for an operational level, wherein the two opposing inclinations are the strategic and tactical levels respectively (more on this later). Another state wherein the system may be vulnerable after self-organization would be the period of calm initiated by the interactions between elements as the internal model is updated. Obviously, weaknesses make for opportunity for the adversary.

For a CAS to be able to pursue its characteristics and attributes, it must maintain its ability to process information and feed its internal model. The internal model provides the perspective that is needed to recognize threats, opportunities, and relative strength to other systems and judge the likely outcome of its actions.

ADAPTIVE SELF-ORGANIZING AND SELF-ORGANIZING CRITICALITY

Systems that are self-organizing have a greater resilience and ability to transform into highly ordered states. They manage to survive in a state that assures a higher probability of survivability. Achieving equilibrium is to be avoided because it suggests that the system has no inclination to develop or improve and therefore prone to demise. Equilibrium is a self-imposed condition wherein a system has removed its ability to generate variety (see Ashby's Law below). Nevertheless, when threatened, all systems will strive to survive and avoid defeat by adapting; even systems in equilibrium, although their ability to do so is limited.[120] On the other hand, the system avoids being pushed in the other direction which would drive the system into chaos which is an equally undesirable condition. The notable aspect of the self-organizing argument is that this can be done without central control. This self-organization can only be possible if the interactions between elements permit this to happen as a benefit from their internal model. As with the fitness landscape model, this premise of self-organization is Darwinian in

[120] Madelfia A. Abb, "A Living System On The Verge of Annihilation," (Fort Leavenworth: United States Army Command and General Staff College, School of Advanced Military Studies Course Paper, AY 99-00):8; http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA381925&Location=U2&doc=GetTRDoc.pdf; Accessed 15 February 2009.

principle. A final aspect of self-organization is that it promotes resilience of the system which will dictate how easily the system can recover from attacks.

Self-organizing criticality is the self-organization at the extreme limit at the edge of chaos. There a system can exist for an indefinite period of time at critical state. However, a mistake from the internal model can plunge the system over the edge. Paradoxically, self-organization is less likely as a system moves away from the edge of chaos. Falling into chaos can spell the demise of the system with it breaking up. The remaining elements that are not destroyed may join other systems. Self-organization events often lead to periods of calm initiated by the interactions between elements. Thus the conditions are right for emergence.[121]

PREDICTABILITY

Perhaps the most erroneous aspect of linear reductionist ideals, as exemplified in the classical approach, is the notion of predictability. Predictability is a desired condition because without the idea of predictability the concept that an endstate and other parts of a plan can be achieved becomes suspicious. It is believed that reducing uncertainty (removing the fog of war) and controlling the situation (controlling the friction of war) can influence predictability. Uncertainty, as commonly understood, can be reduced through increased level of information gathering and situational awareness. It is also believed that uncertainty can be decreased through the practice of generating precise campaign plans based on detailed analysis of the situation. However, as will be agued in the next section nonlinearity does not support such basic notions of predictability.

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[121] Definition – "Emergence refers to the appearance of higher-level properties and behaviours of a system that…are neither to be found in nor are directly deductible from the lower-level properties of the system." Ilachinski, “Land Warfare Pt1…," 187.

Ashby's Law

Predictability of a system is governed by variety which in turn depends on the level of constraint imposed upon a system—the greater the constraint the less variety available and thus the more predictable a system is. Accordingly, if a rival system's options can be reduced then its actions become more predictable and thus it can become controllable. This proposition is founded on the argument of Ashby's law of Requisite Variety which states that "only variety can destroy variety."[122] In other words, to have dynamic equilibrium then the rival system must be matched. The obvious implication, in military terms, is that flexibility is paramount and the quicker innovation can be introduced the greater the chance for success. None of this should come as an astounding revelation. The military has discovered and established this tenant by introducing concepts of *Auftragstaktic*[123] or by having a compressed decision-action cycle.

The Prediction Horizon

Linearity dictates that the state of the system at a later time can be determined if the initial condition is known and the cumulative cause and effect are factored in. However, with nonlinear systems inputs into initial conditions do not equate to predictable and proportional output. In fact, the outcome is likely to be very disproportionate to the initial input thus making predictions very difficult. Such sensitivity in the initial conditions implies that regardless of the number of times a particular scenario is run, each occurrence would end differently.

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[122] Ashby, W.R. *Introduction to Cybernetics,* (New York: John Wiley & Sons, 19556), 207, quoted in Sorrells, "Systemic Operational Design…," 57.

[123] *Auftragstaktic* also known as Mission Command - "The philosophy of command that promotes: unity of effort, the duty and authority to act, and initiative to subordinate commanders." Department of National Defence. *The Land Operations* …, 5-83/86.

An interesting predictability premise is the idea of analyzing past battles and in retrospect judging how the outcome may have been more favourable had certain decisions and actions been made differently. The determinism argument suggests, the outcome is very much predicated on the system's sensitivity to initial conditions. So while a change will result in a different outcome it is difficult to predict what that outcome may be (good or bad).

A nonlinear system will habitually deviate from a predicted run of events (as per a plan); however, initially in time and space, the deviation will be very little. The degree to which a system's behaviour is reasonably predictable is known as the prediction horizon. For example, weather could be considered to have a medium term prediction horizon. In spite of historical data and sophisticated computer modeling weather predictions are hard to make, and a long term prediction in the weather even more so.[124] Therefore, knowing a system's sensitivity in initial conditions would assist in estimating the stability and predictability of an outcome.

“Planning is the means by which the commander envisions a desired outcome, lays out effective ways of achieving it, and communicates to his subordinates his vision, intent, and decisions, focusing on the results he expects to achieve.”[125] Planning as defined in doctrine intonates a manifest outcome of an operation. A plan, in effect, is an effort to predict how the fitness landscape[126] will behave; however, a landscape is affected by multiple systems which are, in turn, affected by multiple factors. The logic of an attainable long term operational design is in contradiction to this reality. The generation of effects and the induction of perturbations into the fitness landscape to

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[124] Beckerman, *The Non-Linear Dynamics of War…*, 9
[125] Department of the Army. *FM 5-0…*, 1-2.
[126] Chapter 5 has more detail and a figure with respect to the fitness landscape.

achieve decisive points change the landscape. There is a resulting change in the existing condition and the potential to split off into new unpredictable states. Having a contingency plan may seem a prudent measure but that assumes that the plan can successfully predetermine what the new landscape will look like.[127]

Armies compensate for changes in the landscape by advocating situational awareness and rapid decision making cycles (technology is working to that end). Failure to keep pace with the changing situation exposes the operation to increased risk. Because the operating environment (synonymous to fitness landscape) is shared with an adversarial system it becomes a race for planning action cycles—acting within the adversary decision-action cycle. In other words, although the current battle is important, compromising the adversary's ability to plan and limiting his future options is more important. It is a race for dominance in the fitness landscape by marginalizing his plan into irrelevance.

Although predicting the adversary's actions and reactions may be difficult, as important is the deliberate effort in preventing one's own predictability and thus making it easier for the adversary to plan accordingly. This is highly evident wherein conventional Western forces abiding to their doctrine are more predictable (longer prediction horizon) than less scripted unconventional forces using terror tactics. It also questions the logic of being overtly open to the media on the sequence of events during a major campaign. Therefore deceiving the enemy is very important to make it more difficult to predict actions of friendly forces. Sun Tzu prescribed such an effort. "Therefore, when capable,

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[127] Beckerman, *The Non-Linear Dynamics of War…*, 10.

feign incapacity; when active inactivity. When near, make it appear that you are far away; when far away, that you are near…"[128]

Finally, implications of the above arguments are significant because the confidence level in any operation unfolding as planned is directly related to a system's sensitivity in initial conditions. Planners should be aware of the prediction horizon and so long as the operational timeline is within the limit of the horizon, the plan should have a low risk of deviating. Such an argument has significant bearing on the efficacy of long term campaign plans in highly complex environments.[129] It also suggests that decision making and planning in systems theory will be less concerned about maintaining a set course but rather be flexible enough to take alternate paths to the same desired end state. This reality is captured in US FM 5-0 which states…

> Although planning attempts to project the commander's thoughts and designs forward in time, it involves an appreciation for planning horizons. Because the future is always uncertain, plans should not specify future actions with precision. Rather, they remain flexible and adaptable, allowing the opportunity to pursue a variety of options.[130]

Chapter five has introduced the most pertinant aspects of systems theory for the conceptual application to warfare. Linear reductionism, which is the foundation of classical warfare, is a favoured and steadfast method of investigation and modeling that has served theorists for over two hundred years but it has inherent shortcomings in coping with the the behaviour of complex systems. Linearity is only a small part of a greater range of system behaviour. Nonlinear reductionism opens up a wide ranging realm of comprehension in the analysis of warfare because it provides a truer mode of inquiry to

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[128] Tsouras, *Warriors' Words*…,121.

[129] Beckerman, *The Non-Linear Dynamics of War*…, 9-10

[130] This statement is an endorsement of systems theory and confirms the efficacy that systems theory is better suited to model complex behaviour. Department of the Army. *FM 5-0*…, paragraph 1-123.

explain and understand nonlinear systems. The chapter revealed that military systems are best described by CAS and the associated attributes (aggregation, nonlinearity, flows, diversity, tagging, internal models, and building blocks). All complex systems strive to exist in the complexity domain, away from equilibrium and chaos. Finally, efforts to remove uncertainty and have a more predicatable outcome are futile. Decision making and planning in systems theory will be less concerned about maintaining a set course but be flexible enough to take alternate paths to the same desired end state. The next chapter will validate the need for a switch to systems theory and address some of the implications.

CHAPTER SIX – IMPLICATIONS OF A NEW FOUNDATION

Complex systems theory has been successfully applied to many dissimilar systems found in nature. The implicit message that should be realized is the obvious suitability of the various models of systems theory to warfare. Even more striking is that none of this theoretical work was developed specifically for military purpose. In fact, it is more associated with other forms of complexity such as termite colonies, other biological events and economic phenomena. There are obvious immutable similarities for all complex systems regardless of their nature. Systems theory continues to be enhanced and successfully applied to various fields and has boundless potential for application in the theory of warfare. It can formulate a truer foundation and better illustrate causality than the current classical linear model. In spite of the logic and apparent correlation would there be a discernable benefit? This chapter explores that very question.

DO WE REALLY NEED A SYSTEMS THEORY APPROACH?

Certainly our classical doctrine and theory cannot be completely wrong requiring complete purging and overhaul? Undeniably, in spite of some difficulties, there have been a fair number of successes. So is it necessary to change the foundations of our operational doctrine from the classical linear theory into systems theory?

To answer why linear mechanistic concepts are perceived to work—successfully at times—then the answer can be provided by a system theory analysis referring back to the diagram with the Period Doubling Cascade (figure 1). It is evident that quantifiably a system does not become overtly nonlinear until the second bifurcation point. Employing linear reductionist techniques to model a system at the lower end could work within tolerable accuracy. In other words, the classical elements of operational design could work with reasonable success, as long as the operation remained in the lower part of the complexity domain. Avoiding higher levels of complexity can be achieved through rapid iterative planning cycles. Doing so, corrects the conduct of operations to be relevant to the immediate situation and thus keep the system at the lower end of the complexity domain. As an example, short sharp raids by specialist units that have high levels of training and a well laid out plan are examples of where a system will remain in the lower portion of the complexity domain while driving the attacked system into chaos. However, no plan or preparations can predict all contingencies. If "Murphy's Law"[131] materializes an operation can be spoiled resulting in chaos as exemplified by the US Iranian Embassy hostages rescue attempt (Operation Eagle Claw) or the "Black Hawk Down" incident of a failed special operation in Somalia. The assumptions above work well so long as a system is relatively stable enough to be treated by linear analysis but once pushed into chaos, linear principles no longer apply. [132]

There are specific doctrine concepts and theories that provide a good degree of success further into the complexity domain—manoeuvre warfare and the operational art are examples. Inquiry as to why reveals that success is due to the fact that inadvertently nonlinear principles are manifest in those doctrines. Much of the terminology may be missing but nonlinear systemic theory is visible. This should not come as a surprise

[131] Murphy's Law is a supposed law of nature, to the effect that anything that can go wrong will go wrong. F.G. and H.W. Fowler, *Pocket Oxford English Dictionary*, ed.Catherine Soanes, 9th ed. (New York: Oxford University Press, 2001).

[132] Czerwinski, *Coping with the Bounds* …,52-53.

because—in case it is overlooked—today's Land Forces are a system and one of the key theories is that a system is adaptive and will evolve to better cope with its environment.

Manoeuvre warfare (as discussed in chapter three), as an example, is a philosophy that has inherent nonlinear qualities. Manoeuvrist concepts were introduced as a means of moving from mechanistic attritionalist ideology to a philosophy of opportunity seeking. Manouevre warfare works by promoting decentralized command and control—also known as *auftragstaktic* (mission command). This form of approach promotes the idea that a system has an increased chance of success by devolving the burden of encountered uncertainty to subordinates thus not burdening a singular entity (the commander for example). As well, the inherent strengths of a CAS are leveraged, particularly the ability to instinctively self-organize and thus be very resilient. Manoueuvrist philosophy that has been adopted into doctrine based on the observed successes of the Germans in WW2 has intrinsic system theory qualities that should be further exploited.

The need for the operational level—a relatively new doctrine—is acknowledged as a system necessity to conduct campaigns. Shimon Naveh makes compelling arguments about how the operational level and a military system conform to the ideals of systems theory. As the West strives to fully understand and adapt operational level doctrine, systems theory provides the necessary introspective foundation. He argues that a system is dominated by its aim[133] which has a holistic effect on the system. Aim provides overarching focus towards an end state and defines the interaction of its elements and the external environment. The aim is a powerful cognitive force that directs the system against rival systems. The aim is the “unifying determinant”[134] that ensures

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[133] Naveh uses aim but the implication here is higher intent.
[134] Naveh, *In Pursuit of Military Excellence…, 6.*

the system is complex and adaptive which, because of their inherent self organizing abilities, provides the system with resilience. Ultimately the system's aim must be translated into discernable objectives and missions for its elements to act upon. But as can be imagined, moving the system and all its elements forward in a unified manner does create systemic cognitive tension and a dichotomy between the whole and the elements: this is true of a CAS. To control the system's dichotomy and maintain the cognitive tension (thus preventing system segregation), Naveh proposes that an operational level is required. Finally, Naveh recognizes the other advantages of a CAS are at play, in particular, aggregation wherein the whole becomes greater than the sum of its parts. Using arguments by Stephen R. Covey, Professor Tom Czerwenski proposes that strategic purpose or vision (aim) acts as a strange attractor.[135] Therefore on entry into chaos, aim will enable a greater degree of stability.[136]

As indicated throughout this paper, systems theory provides an alternative means of viewing warfare. It elucidates some of the doctrinal irregularities that linear reductionism is unable to resolve. It readily explains why certain linear things work and why others do not. It accommodates the complex nature of warfare rather than enforcing order. Those parts of doctrine that do not work particularly well are those that depend on system stability and minimal complexity—something that cannot be guaranteed. Consequently, with the classical approach an appreciable degree of effort is placed in designing capability that maintains systemic stability and avoiding extremes. Conversely, not enough is being done to explore the precipitous regions at the extremes. As long as we remain tied to linear doctrine it will provide limited solutions fixated on complexity

[135] "For chaotic systems, which don't settle down, the sum of all the states visited is called a "strange attractor." Beckerman, *The Non-Linear Dynamics of War…*, 4.

[136] Czerwinski, *Coping with the Bounds …*,123-126.

avoidance through simplicity and directive control and order. Ironically, as demonstrated by manoeuvre warfare and operational level doctrine, there is evidence of accommodating complexity but these doctrinal epiphanies are coincidental rather than the deliberate application of system theory resolutions.

NON-COMPATIBLE CLASSICAL ELEMENTS

> *Efforts were therefore made to equip the conduct of war with principles, rules, or even systems. This did present a positive goal, but people failed to take an adequate account of the endless complexities involved. As we have seen, the conduct of war branches out in almost all directions and has no definite limits…*[137]
>
> *Carl von Clausewitz*

The merits of retaining doctrinal concepts that exclusively guide our system in retaining stability and avoiding the thresholds of chaos and equilibrium will have to be evaluated. Providing sage cautionary guidance with respect to the nature of land combat, on the one hand, and paradoxically prescribing the implementation of a linear decision making process to generate a linear operational design—as our current *Land Operations* doctrine does—has limited utility in a complex environment.[138] The domains of linearity and nonlinearity are analogous to the continuum of operations wherein our forces, with slight modification, can function through the whole continuum. With similar ease, we need to be able to move up and down the complexity domain and not remain anchored to a stable portion of it. Consequently, adaptation of systems theory would obligate the military to amend or relegate certain elements of our doctrine to the archives. An example, for the purpose of argument—to make the point—would be the CoG.

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[137] Clausewitz, *On War*…,134.

[138] Several pages of cautionary points exist in Department of National Defence. *The Land Operations* …, 2-21/22 to 2-23/24.

The CoG is the critical component in operational design: all other elements are linked to it and build the methodical path to attaining it. In chapter two its allure to Western theorists, because of its deterministic nature, was highlighted. It is promoted as that essential element which is the source of power for both hostile and friendly forces: if the CoG is defeated, end state will be attainable.[139] The efficacy of the CoG being the principle way of achieving end state is increasingly doubted in the contemporary operating environment.[140] Under closer scrutiny even Clausewitz, who is acknowledged as the CoG theorist, is not clear as to CoG's relevance. Professor Alan Beyerchen states "Even this most Newtonian-sounding analogy of a "center of gravity" becomes swamped in qualifications and caveats intended to convey the complexity of war."[141] Systems theory confirms the detrimental characteristic in having a preordained CoG because it then constrains all action to a linear and deterministic path. A system may have a source of power but it could be singular (military organization) or it could be distributed widely (will of the people). While a CoG can be determined and a plan for its removal conveyed, the nature of the final outcome cannot be predicted. The CoG could be too discrete, ignoring the greater underlying source of cognitive energy of the system. Removal of Saddam Hussein (strategic CoG) was a discrete action, which led to the chaotic destruction of the former whole, which led to the emergence of a fractured and far more complex system driven by historical cognitive hatred. Nonetheless, systems theory warns that systems will not likely react in the manner it is hoped. Particularly if predicted by a

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[139] Department of National Defence. *The Land Operations* …, 6-15/49

[140] Darfus L. Johnson, "Center of Gravity: The Source of Operational Ambiguity and Linear Thinking in the Age of Complexity," (Fort Leavenworth, Kansas: United States Army Command and General Staff College, School of Advanced Military Studies Course Paper, AY98-99): 2-3; http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA366222&Location=U2&doc=GetTRDoc.pdf; accessed 20 February 2009.

[141] Beyerchen, "Clausewitz, Nonlinearity…," 96.

linear decision making process. A systems self-organizing nature will resist destruction and will adapt accordingly. Holistic weaknesses in a system do exist but the system must be studied to understand how the system survives and sustains its effectiveness. Exploitation will come by affecting both the system's elements and the associated interactions. Naveh suggest that a system's primary weakness is its source of operational strength: its aim. Its removal will induce operational shock and system disintegration.[142] Other suggested approaches would be isolating or disrupting networks, structures and cognitive elements that enable the system to live; neutralize a system's ability to self-organize; and force the adversarial system into equilibrium (towards a more linear form of actions) thus restricting its actions to being predictive and reactionary.[143] Finally, attacking the identified CAS mechanisms and properties (aggregation, nonlinearity, flows, diversity, tagging, internal models, and building blocks). With systems theory the CoG is not the optimum target.

The example above is indicative of the type of purging of current classical operational doctrine that might happen by measuring their relevance and merit with respect to systems theory. CoG not being particularly relevant to systems theory doctrine implicates the other classical element of operational design—decisive points, objectives, lines of operation, etc.—as also being incompatible because of their inexorable link to the CoG.

HOW TO LEARN FROM THE SYSTEM

This paper focuses on the fundamental question as to the value of the current classical approach to warfare vice that advocated by system theory. How should warfare

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[142] Naveh, *In Pursuit of Military Excellence…*, 16.
[143] Abb, "A Living System On The Verge…," 47-53.

be framed (modeled)? How should it be perceived? Answers to these questions will dictate the process in which we should conduct decision making. A decision making process is just that: a means of generating a plan of action out of how the operating environment is viewed and how it can be manipulated to conform to a desired endstate set within the context of the mission statement and higher intent.[144] Consequently, if it is decided that the operational environment is to be framed in the context of nonlinearity (complex and chaotic) then a linear mechanistic process such as the current classical based decision making processes will not survive.

Systems approach uses reductionist modeling which will differ from commonly known linear techniques. A linear system uses pre-existing tools of analysis: "[t]hey are basically linear; they are proportional, additive, replicable, and they will result in an expected, measurable effect on the cause."[145] The tools are built from knowledge of past linear performance with a view to using them repeatedly to measure the same conditions. The idea of analyzing a linear system is to establish a database of information (the more the better). Attempting to devise tools for nonlinear phenomena is not practicable. Instead, it is proposed that "aids to learning"[146] be used because unlike tools there is less permanence to them. The premise is to "allow evolving global patterns to emerge from the local rules!"[147] Weather forecasting makes for a good example wherein spite of various quantitative tools (barometers, weather vanes) historical modeling (aid of learning) and pattern recognition is required including intuitive experience to aid in

[144] The military decision making process is a planning model that establishes procedures for analyzing a mission, developing, analyzing, and comparing courses of action against criteria of success and each other, selecting the optimum course of action, and producing a plan or order. As defined in Department of the Army. *FM 5-0*, 3-1.

[145] Czerwinski, *Coping with the Bounds …*, 48.

[146] The term "aids to learning" is introduced by Tom Czerwinski in his *Coping with the Bounds.*

[147] Ilachinski, "Land Warfare Pt1…," 8.

pattern recognition to produce an "accurate" forecast.[148] In surmising the nature of nonlinear aids Professor Czerwenski writes…

> Nonlinear reductionist techniques do not optimize; they satisfice. Their object, like CAS, is not the perfect answer, but one good enough or fast enough to ensure survival. They seek the fittest, not the fanciest, avenue. They are inelegant and messy compared to the fastidious but often ineffective constructs of the linearist.[149]

Pattern recognition is an example of an aid to learning that would be used to define a system and thus permit us to take appropriate action. All systems have observable inherent patterns—a recognized quality of complex systems. The better these patterns are understood the better they can be exploited. Intuition—a command quality—plays an important part within the process of pattern recognition.[150] Patterns are a formulated intuitive response mechanism by a system to be used and reused in time to respond to other situations when and where required. If these patterns can be identified they can be targeted. As an example, tactics, techniques and procedures would qualify as patterns inherent to a system; hence the efficacy of "templating" the enemy's behaviour. A decision making process that is based on a pattern recognition philosophy, and is gaining interest, is the Recognition Primed Decision model (RPDM).

The RPDM was developed as an alternative to the traditional decision making process which was viewed as not capable of producing plans and orders fast enough. RPDM harnesses the strength of a Commander's intuition and experience. Based on those strengths, a Commander can assess a situation rapidly through pattern recognition,

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[148] John H. Holland, *Hidden Order: How Adaptation Builds Complexity* (Reading, MA: Addison-Wesley Publishing Company, Inc, 1995),168. quoted in Czerwinski, *Coping with the Bounds …*, 48-49

[149] Czerwinski, *Coping with the Bounds …*, 50.

[150] There is a correlation between pattern and building blocks. As mentioned in chapter five, as part of their mechanism, a CAS utilizes building blocks. Building blocks is an attribute that permits the system to decompose a scene into parts that are used and reused in combinations. They impose regularity in a complex environment. When a new situation is encountered previous blocks are used to formulate a proper response algorithm. Czerwinski, *Coping with the Bounds …*, 22-23.

mental wargaming courses of action, and make a decision. The staff assists by ensuring that the course of action is feasible, acceptable and suitable. In addition to leveraging the aspect of pattern recognition, the RPDM is found to achieve higher tempo and greater participation between Commander and Staff.[151]

SYSTEMS THEORY AND DECISION MAKING

As systems theory becomes more widely accepted for it merits, there are effort to develop a complimentary decision making process. Two current processes most commonly associated with systems theory are Effects-Based Operations (EBO) and Systemic Operational Design (SOD).

Effects-Based Operations

> Effects-Based Operations (EBO) utilizes a holistic understanding of the operational environment in order to influence the behaviour of the threat system. It translates strategic objectives into desired effects on the threat's Political, Military, Economic, Social, Information, and Infrastructure (PMESII) systems, and implements various elements of national power in order to achieve them.[152]

The notable aspect of EBO is that it supplements and enhances existing decision making processes.[153] It focuses the process on the achievement of effects rather than achieving tasks. EBO utilizes a System of System Analysis (SoSA). The systems are categorized into the six discrete PMESII systems, each of which consists of nodes and

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[151]"The current process involves four iterative steps Step 1. Identify the Mission and Conceptualize the COA, Step 2. Test and Operationalize the COA, Step 3. Wargame the COAs, Step 4. Develop the Orders;" David A. Bushey, and Michael J. Forsyth, "The Recognition Primed Decision Model," *Field Artillery*. (January-February, 2006):11-12. Karol G.Ross, , *et al*. "The Recognition Primed Decision Model." *Military Review*. (July-August 2004): 7.

[152] Ketti C. Davison, "Systemic Operational Design (SOD): Gaining and Maintaining the Cognitive Initiative" (Fort Leavenworth: United States Army Command and General Staff College, School of Advanced Military Studies Course Paper, AY 05-06), 17; http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA458361&Location=U2&doc=GetTRDoc.pdf; accessed 4 April 2009.

[153] EBO has four major components: knowledge base development, effects-based planning, execution, and assessment. They are consistent with current planning processes but add embedded enhancements that reflect changes in the way commanders and staffs think about and conduct operations.

links (between nodes and systems). SoSA produces a nodes analysis and couples the nodes to effects.[154]

Systemic Operational Design

SOD is perhaps the most recent decision making process associated with systems theory and perhaps the most contentious due to its departure from known methods. SOD focuses on the relationship between elements of a system. It learns about a system and develops a rational for it by injecting energy and observing the resulting action. Recognizing that uncertainty is manifest in CAS, SOD does not rely on preconceived notion that the operational problem is understood.[155]

SOD starts through a process of problem setting or framing (how should I think of the problem as opposed to what is the problem?). This permits for the development of a rational for the system's behaviour and logic that can then be used by the designer to facilitate the system's movement in accordance to the designer's aim. SOD is operationally motivated and develops concepts aimed at systemic shock. SOD is achieved through a design team that conducts seven discourses that leads to a holistic design that will facilitate planning.[156]

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[154] Canadian Land doctrine subscribes to EBO (but calls it Effects Based Approach) however it makes no reference to SoSA but does recognize the PMESII. "The environment is often referred to as a collection of systems, identified by the acronym PMESII. While all the elements represented by PMESII certainly exist within a society or environment, and they do interrelate and affect one another, it is believed that there are too many variables, including individual personalities, to allow a scientific “systems approach” to constantly and accurately predict exactly how they will react." B-GL-300-001/FP-000 *Land Operations*…, 5-26/86

[155] Ketti, Davison, “From Tactical Planning to Operational Design.” Military Review (September-October 2008): 37-39; http://usacac.army.mil/CAC2/MilitaryReview/Archives/English/MilitaryReview_20081031_art009.pdf; 4 April 2009; Sorrells, "Systemic Operational Design…" 15-22.

[156] Davison, “From Tactical Planning to…," 37-39; The seven discourses are systems framing, rival as rational, command as rational, logistics as rational, operational framing, operational effects, and forms of function. Sorrells, "Systemic Operational Design…" 23-28.

What distinguishes EBO from SOD, besides process, is that SOD focuses on transforming the relationships between system elements whereas EBO focuses on disrupting the nodes and relationships.[157] As well, EBO attempts to identify familiar patterns based on experience wherein SOD attempts to spot changes in patterns and develops deductions about action to take.

Two decision making processes founded on systems theory have made their way into mainstream doctrine. Debate continues as to the best manner in which to leverage the apparent advantages of systems theory. For now, at least, interest remains relevant.

CRITICISM OF SYSTEMS THEORY

There are criticisms directed at systems theory on its theoretical merits and not as a result of a resistance to change. The critics can be placed into three categories. First, those that do not believe in systems theory as a valid science—of which there are few. The science, although new, has found many applications in science, industry and other fields. Second, there are critics who believe that systems theory has no advantage over the current classical theory and therefore no change is warranted. A third category of critics are those that criticize the systems theory's decision making process.

EBO's potential for improving the operational art was short lived. Various interpretations of EBO generated a lot of confusion in the US Joint Force Command and its multinational partners. Consequently, both the US Army[158] and US Joint Forces Command (USJFC) have stopped its use. The Commander of USJFC, General J.N. Mattis, has stated, "…we must return to time honored principles and terminology that our forces have tested in the crucible of battle and are well grounded in the theory and nature

[157] Davison, "Systemic Operational Design (SOD): Gaining…," 31.

[158] United States. Army Training and Doctrine Command (TRADOC) Doctrine Update #1, *Army Doctrine Update* (Fort Manroe, VA: US Army TRADOC, 24 February 2007), 4-5.

of war." [159] Mattis is referring to the principles arising from Clauswitzian and Jominian paradigms. This criticism falls into the third category. Although Mattis may have not supported a systems theory related decision making process, he did not show any aversion to systems theory itself, in fact, in denouncing EBO he writes that “chaos makes war a complex adaptive system, rather than a closed or equilibrium-base system.”[160]

Perhaps the most ardent critic is Dr. Milan Vego who has published two papers denouncing every aspect of systems theory. His first article, *Systems versus Classic Approach to Warfare,* has been widely read. He argues that no systems theory based approach could replace the classical approach. However, Vego makes some fundamental errors in his arguments. He mistakenly states "[a]ll proponents of the systems approach…essentially share the mechanistic or Newtonian view of warfare." Further, he states "[systems enthusiast] are neo-Newtonian because they view warfare as a machine. For them, the outcome of war is quite predictable."[161] Unfortunately for Vego, these statements are not in line with the true arguments of systems theory. Consequently, the facts of the article are debased.

Vego's second article, *A Case Against Systemic Operational Design* raises some valid concerns with respect to EBO and SOD. He makes no erroneous claims with respect to systems theory; in fact, his only reference to systems theory is that SOD is founded on Bertalanffy's general systems theory (GST). Although he refers to GST as a

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[159] United States. Joint Forces Command, Memorandum: *Assessment of Effects Based Operations,* 14 August 2008.

[160] *Ibid.* As a note of interest Canada's response to this was "Canadian Joint doctrine has not operationalized the concepts of EBO to the same degree achieved by the US Joint Operations community. The CF Joint doctrine approach is to use effective thinking, vice EBO…It is therefore assessed that a decision to remove EBO from US Joint Operations Doctrine will not impact CF Joint doctrine." Department of National Defence, "CF Joint Doctrine: Use of Effects Thinking in Operational Planning," *CANFORGEN 005/09 CFD*, 002, R091621Z JAN 09.

[161] Milan Vego, "A Case Against Systemic Operational Design," Joint Force Quarterly, Issue 53 (2nd Quarter 2009): 69-75.

pseudoscience, this is a valid criticism because GST was the early foundation of systems theory that has since evolved to involve a deeper theoretical baseline. Vego remains a classical theory supporter and provides no alternative for an approach that holds little hope in managing the complexities of the 21st century.[162]

In summary, systems theory has its critics but their comments are mainly directed at the representative decision making models and not at the theory itself. This is not a reason for dismissing a valid theoretical foundation: one that is more promising than the classical theory. It should in fact motivate more exploration and effort to find a process that will work.

This chapter addressed the implications of introducing systems theory. While the discussion regarding aids to learning may sound rather obtuse it is because it is relatively foreign and not as quantifiable and tangible as current tools and methods being used in classical thinking. Advocating pattern recognition is a hard sell because it implies protracted scrutiny of a system vice formulated decisive points on a designed line of operation to achieve objectives. The greatest challenge facing systems theory is developing a decision making process: EBO was rejected and SOD is not widely accepted. In fact this is the underlining point of directed criticism to systems theory.

The last two chapters introduced the practicable and founding arguments for systems theory with appropriate examples. The innate similarities of a CAS and a military organization are remarkable. Systems theory not only opens up new levels of understanding of the complexities of warfare but also affirms which current doctrinal trends are on the right track—operational art and manoeuvre warfare—and which are not—CoG.

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[162] *Ibid*., 69-75.

CONCLUSION

This paper lays out two contrasting conceptual approaches to warfare. First, the classical approach developed from the theories of Clausewitz and Jomini are predicated on the immutable nature of warfare. The "nature" of warfare consists of those qualities that remain constant through the ages. Second, the systems theory approach is predicated on the premise that warfare has all the key features of a CAS and therefore can be characterized as a system.

Where the two approaches differ is in the method used in synthesizing the respective theories. The classical theory is founded on the Western-Newtonian method that is based on a linear reductionist philosophy. Systems theory is founded on the premise that all systems share a general set of fundamental principles that underline system behaviour. Warfare, as a CAS, can be studied by the same methods as any other CAS. The contrasting view of warfare by the two approaches is substantive.

If war was Newtonian in the strictest sense: warfare is readily controllable because linearity dictates a proportional relationship between cause and effect; warfare is deterministic as long as the initial conditions are known and the doctrinal principles and tenants for success are applied; reductionism permits an understanding of the greater whole by studying the smallest element; warfare is mechanistic and therefore susceptible to external perturbations; through analysis, all problems are solvable; finally, command and control takes a very methodical approach to exact positive control to enforce order and achieve certainty. War, as most theorists agree, does not manifest itself in strict Newtonian terms as described above. Yet, Western militaries continue to endorse the classical approach which is founded on Newtonian ideals.

In contrast, using systems theory: warfare involves a large number of nonlinear interacting elements difficult to control, therefore cause and effect are disproportionate; self-organization promotes resilience and a survival instinct amongst systems; warfare encourages systems to enter a higher order of complexity where a system is at its best and readily adaptable to its environment; there is a hierarchical command and control but there is no master influence over the actions of each and every combatant thus leaving a degree of uncertainty. It becomes evident that warfare is nonlinear and dynamic as is advocated by systems theory. Thus, warfare should be considered to be a CAS rather than an entity aspiring to follow a linear paradigm.

The classical approach has never been adequate and even less so in the contemporary operating environment. It professes a linear ideal of finding an adversary's center of gravity and applying methodical military force against it. That pursuit has led militaries to exert a lot of effort in establishing control and order to avoid states of complexity and chaos. Technology in particular has been leveraged in that respect. System theory, on the other hand, advocates the accommodation of the complexity of warfare.

In real terms, there should not be a struggle between the classical and systems approaches but rather there should be recognition that linear methods are a sub-domain of the bigger spectrum of complexity—ranging from equilibrium to chaos. In other words, the classical approach provides doctrine that is best suited to a specific portion of the complexity domain: the portion that is most stable. It is for that reason that the classical approach cannot be dismissible altogether, rather, it needs to be properly framed.

There has been some notable doctrinal gain made under the auspices of the classical approach such as manoeuvre warfare. However, under closer scrutiny manoeuvre warfare has more connection with nonlinear than with linear theory. Manoeuvre warfare is based on a philosophy of inducing chaos on the adversary and avoiding the attritional battle. As with manoeuvre warfare, the systems theory approach provides a new metric to which we can validate current hypothesis to ascertain their efficacy for the operational environment. Even Clausewitz has had a reprieve from being judged as a "linearist" as some of his more profound concepts of fog and friction are supported by complexity and chaos theory.

The introduction of systems theory as the new approach to warfare would not be easy. The implications would be far reaching, and would entail changes to lexicon, doctrine, training, and decision making processes, etc. Some progress has already been made with an increasing utilization of systems theory terminology and broad concepts (effects based operations is founded on the idea of systems). As well, an increasing number of criticisms have been aired at systems theory as the possibility of its implementation becomes real. However, these criticisms are mainly directed at the associated decision making process (EBO and SOD for example) and not the underlining systems theory. The criticisms are valid, for now, because they point out what is probably the biggest inherent challenge. Classical theory approach, in spite of its outmoded modeling, still provides an easy and familiar decision making process. Nevertheless, all means and effort by research analysts and doctrine developers must be allocated to apply the necessary resources in developing systems theory to its full potential. It has replaced linear theories in the study of other complex human and worldly phenomena and has the potential to do so in the approach to warfare. It confirms and supports the hierarchical levels of operations and could be applied to work within a joint and interagency framework. It is the approach for 21st century.

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