CANSOFCOM PROFESSIONAL DEVELOPMENT CENTRE

"WE MURDER TO DISSECT"

A PRIMER ON SYSTEMS THINKING AND WAR

DR. BILL BENTLEY

THE CANSOFCOM PROFESSIONAL DEVELOPMENT CENTRE

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8. assist with the research of SOF best practices and concepts to ensure that CANSOFCOM remains relevant and progressive so that it maintains its position as the domestic force of last resort and the international force of choice for the Government of Canada.

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FOREWORD

I am delighted to introduce the eighth monograph produced by the Canadian Special Operations Forces Command (CANSOFCOM) Professional Development Centre (PDC). I believe it continues to add to and expand on the growing body of literature on Special Operations Forces (SOF) in general and Canadian Special Operations Forces (CANSOF) in particular.

"We Murder to Dissect": A Primer on Systems Thinking and War provides us with an exceptional volume that deals with systems thinking. Lieutenant-Colonel (retired) Bill Bentley, PhD, is a former infantry officer and leading expert on systems thinking. While this monograph is theoretical in nature, its content and message are extremely relevant to the SOF community. Arguably, nowhere are the "wicked problems" that arise in the contemporary operating environment more prevalent than on special operations. As a result, the theory and practice of systems thinking, designed to assist in the resolution of these conundrums, provide an excellent vehicle for SOF operators, as well as others, to help cope with, and excel in, the contemporary and future security environments.

This is an excellent volume that will assist with the cognitive development and agility of SOF operators and help them to master complexity and ambiguity in an unforgiving world. As always, we at the PDC hope this publication is informative, and also sparks discussion and reflection. Please do not hesitate to contact Dr. Emily Spencer, the Monograph Series Editor, if you have comments or topics that you would like to see addressed as part of the CANSOFCOM monograph series.

Colonel Bernd Horn, OMM, MSM, CD, PhD
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SYSTEMS THINKING AND WAR: A PRIMER

The significant problems we have cannot be solved at the same level of thinking with which we created them.

Albert Einstein

The recent conflicts in Iraq and Afghanistan have reaffirmed what a few military practitioners, strategic analysts and some policy makers have always known – war and conflict are very difficult endeavours. They represent the quintessential "wicked" problems. Many more of those involved are gaining a painful appreciation of this reality and they are casting around for the best way to both understand and conduct operations in this very complex environment. As in the past, their search extends – or, at least, should extend – beyond conventional security fields such as history and international relations, to seeking assistance and guidance in other areas as diverse as philosophy (especially epistemology), anthropology, cognitive theory, and traditional science.

One area of study in particular that has proven to be a fruitful source of insight over the past decade or so has been that of complexity theory. The science of complexity has penetrated various sectors of society today and, as in so many other areas of human activity, has convinced many in the security community that war and conflict are best understood as a complex adaptive system. A leading complexity theorist who has applied this science to the subject of conflict posits: "It is reasonable to postulate that warfare can be better executed by those who understand complex adaptive systems than those who focus on simple, linear, transparent, classically logical Newtonian constructs."[1]

This is, indeed, a very important postulate because today most military doctrine, and the mindsets of the majority of military officers and senior non-commissioned officers (NCOs), are still anchored, one could say mired, in linear, analytical, Newtonian approaches to the military problems they face.[2] On the other hand, complexity theorists and their disciples, in and out of uniform, are unanimous in their conviction that complex systems are non-linear and unpredictable and cannot be completely understood using analytical thinking alone. These systems must be viewed holistically and understood through synthesis; that is to say, through systems thinking and the methodologies and techniques derived from such thinking.

This brings us to the title of the Monograph, "...we murder to dissect," which is the last line of a verse by the British Romantic poet William Wordsworth. The full verse reads:

> Sweet is the lore that nature brings;
> Our meddling intellect
> Misshapes the beauteous form of things;
> We murder to dissect.[3]

Like all Romantics, scientists, philosophers, historians, as well as poets, Wordsworth was reacting against the desiccated rationalism so prevalent during the Enlightenment period in Europe (circa 1687-1789). Romanticism can be understood as an overwhelming international tendency which swept across Europe and Russia at the end of the 18th Century and beginning of the 19th Century in reaction to earlier neo-classicism, mechanism and rationalism. More than simply a return to nature, the realm of imagination or feeling, it was a synthesizing temper that transformed the entire character of thought, sensibility and art.[4] Romantic scientists and philosophers, especially those in Germany like Georg Hegel, Wolfgang Goethe, Friedrich and Auguste Schlegel and the

historian Leopold von Ranke, were determined to look at nature and society holistically, to see "wholes" and relationships rather than discrete events and phenomena. In other words, they rejected the analytical, reductionist and linear approach of breaking things apart to study them. Rather, they focused on relationships and the systemic nature of phenomena. They were the original systems thinkers and initiated the contest between Positivism, which argued that the only true knowledge was that obtained through the methods of natural science, and those who maintained that ideographic knowledge better reflects the individualizing concepts of the social sciences.[5] Ideographic knowledge relies heavily on a type of understanding best expressed by the German word *Verstehen*, resting as much on holism and interpretation as inductive and deductive reasoning alone. This debate continued throughout the 19th Century and beyond.[6] Although the phrase "systems thinking" does not appear in common usage until the mid-20th Century, its roots, its inspiration even, can be traced to the intellectual movement known as Romanticism.

This monograph examines the implications of Professor Yaneer Bar-Yam's postulate, so reminiscent of Romanticism's rejection of analytical thinking. It offers some specific recommendations regarding how Canadian Forces (CF) doctrine development and the professional development of officers and senior NCOs should be modified to take advantage of advances in systems thinking and complexity theory and their application to the profession of arms.

The argument begins in Section One with a look at the work of the 19th Century Prussian military theorist General Carl von Clausewitz, specifically his monumental text *On War*. Clausewitz was closely affiliated with many of the leading German Romantic intellectuals and his thought was profoundly shaped by their intellectual influence. *On War* is suffused with Romantic ideas and concepts and the result is what the British philosopher (and

Second World War infantry veteran) W.B. Gallie contends is the first, and to date, the only, book of outstanding intellectual eminence published on the subject of war.[7] This testimonial rests on the fact that Clausewitz, perhaps surprisingly, was a quintessential *systems thinker* long before systems theory as such emerged as an established scientific discipline. To this day his observations and insights continue to inform our thinking about war as a complex adaptive system.[8] Section Two puts Clausewitz's theory in the context of modern systems theory and discusses the theoretical underpinnings of complex systems and how they differ from more familiar complicated systems. The section concludes with an outline of systems thinking. Section Three develops the construct of the General System of War and Conflict as a complex adaptive system which must be addressed holistically through systems, and not analytical, thinking. The implications of this approach for strategy formulation, operational art, and command and control in the modern security space are indicated. Finally, Section Four discusses the emerging concept of operational "design" as a particular systems methodology applied to warfare and its relationship to conventional planning based on analytical techniques. Soft Systems Methodology (SSM) is introduced here as a major contributor to the design concept. It is argued that SSM, a mature systems methodology, is a more rigorous method for understanding and coping with ill-structured or "wicked" problems than the current state of thinking on design being developed in the United States Army and Marine Corps. It should be carefully studied in CF educational institutions and utilized for doctrine development, strategy formulation and the practice of operational art.

SECTION ONE
Clausewitz and the Theory of War

American General Colin Powell first read General Carl von Clausewitz's treatise *On War* in 1975 when he attended the US Army War College. Powell reflects, in his autobiography *My American Journey,* that the experience, "...was like a beam of light from the past still illuminating present day military quandaries."[9] Yet another distinguished military officer, General Sir Rupert Smith, reflects a similar admiration for this Prussian military theorist, citing him approvingly no less than ten times in his influential book *The Utility of Force*.[10]

How is it that a soldier and military theorist writing in the early 19th Century could communicate such valuable insights and resonate so well with two accomplished practitioners of the profession of arms in the 21st Century? American historian Alan Beyerchen helps us to understand this phenomenon in a seminal article published in the journal *International Security* entitled "Clausewitz, Non-Linearity and the Unpredictability of War." Clausewitz, Beyerchen explains, had developed his theory of war as a response to the existing paradigm of Newtonian physics and the rationalistic tendencies of the Enlightenment. In response to the positivistic approaches of Jomini and von Bulow, Clausewitz replied that war was not susceptible to linear thinking. On the contrary, Clausewitz's *On War* is suffused with the understanding that every war is an inherently complex, non-linear phenomenon. In a profoundly unconfused way Clausewitz understood that seeking exact, analytical solutions does not fit the reality of the problems posed by war.[11] Unlike a number of Clausewitz's contemporary military theorists influenced by the philosophy of the Age of Reason, Clausewitz was not seeking "laws" governing war. He stood in direct opposition,

for example, to the contention of the Baron de Jomini that all strategy is controlled by invariable scientific principles only awaiting discovery by the rational mind.[12]

Today, complexity theory is being applied to better understand the true nature of war in opposition to the proponents of the so-called revolution in military affairs (RMA) who argue that ultimately, technology can "lift the fog of war." In response to these RMA enthusiasts, Barry Watts suggests that human limitations, informational uncertainties and non-linearity are not pesky difficulties that better technology and engineering can eliminate, but built-in or structural features of the violent interaction between opposing polities pursuing incommensurate ends we call war.[13] Remarkably, Clausewitz would likely feel comfortable engaging in this modern discussion. While this is certainly historically interesting, the more important point is that his penetrating and trenchant observations concerning war and conflict still often equal, or even exceed those of many of today's military theorists and doctrine writers.

Complexity science addresses the structural issues of war that Watts referred to in an effort to better understand their dynamics. In fact, complexity science is a broad field of inter-disciplinary inquiry that has left practically no area untouched and can be located within a broader cultural movement. Mark Taylor has notably shown how the ideas of complexity are echoed in a number of modern developments in architecture, art and social theory.[14] In an intriguing parallel, Clausewitz's thought can also be located in a broader cultural movement during which Romantic philosophy and Romantic science were overturning the classicist orientation of the Enlightenment in art, emerging social thought and science.[15] Clausewitz was writing at the very time when the mechanistic, linear science of Newton was being amended through developments in electro-magnetism, thermodynamics and especially biology. The Romantics were interested in all these subjects but it was

their particular interest in biology that led them to begin uncovering the fundamental concepts underpinning complexity, open systems and positive feedback at the turn of the 19th Century. All of these subjects influenced Clausewitz's thinking.

Clausewitz joined the Prussian army in 1792 and fought against the French Revolutionary and Napoleonic forces until the Battle of Waterloo in 1815, serving for a period between 1812 and 1813 with the Russian army. During this time he participated in several major campaigns including Jena, Borodina, the Battle of Nations and Waterloo. Clausewitz was certainly not a trained philosopher but he was, nonetheless, a man of a particularly strong philosophical bent. He read voraciously and broadly, far beyond the field of military history.[16] He was also scientifically literate, reading mathematical treatises and attending lectures just as science was turning to the study of energy, and advances in the theories of probabilities were being made. His major work *On War* still sought to provide a reasoned understanding of war as were the efforts of many of his contemporary theorists. However, he insisted on recognizing the inherent limits of analytical reason when grappling with such a dynamic and complex phenomenon, in the same way that thermodynamicists came to trade the mechanistic claims of complete predictability for a more stochastic understanding of the natural world.[17] Above all, however, Clausewitz was strongly influenced by the early Romantic philosophers and scientists such as Schelling, Goethe and Hegel, *Naturphilosophen*, whose interests were thoroughly grounded in the natural organic world of biology.[18]

During the hiatus between Clausewitz's return to Berlin in 1808 and his entry into Russian service in 1812, he partook of the rich intellectual life of that city. Through her contacts, Clausewitz's wife Marie seems to have introduced her husband to Achim Arnim, an important Romantic folklorist, dramatist and poet, and William

von Humboldt, philosopher and educational reformer. These two urged Clausewitz to join the Christian-German Symposium, a group that met for discussions every two weeks. A list of its active participants reads like a who's who of leading Berlin Romantics including Fichte, Schleirmacher, von Kliest, Adam Muller, Clemans Brentano and Philip Bury. Later when Clausewitz returned to Berlin to head the War College he met still other cultural figures including Georg Hegel. Achim von Arnim also came back into Clausewitz's life with his wife Bettina, a considerable Romantic author and editor in her own right.[19]

Significantly, Clausewitz chose the emerging field of electromagnetism from which to draw his primary metaphor for his theory of war.

> War is more than a true chameleon that slightly adapts its characteristics to a given case. As a total phenomenon its dominant tendencies always make war a paradoxical trinity – composed of primordial violence, hatred and enmity, which are to be regarded as a blind, natural force; of the play of chance and probability within which the creative spirit is free to roam; and of its element of subordination, as an instrument of policy, which makes it subject to reason alone.
>
> The first of these aspects mainly concerns the people, the second, the commander and his army, the third, the government. The passions that are to be kindled in war must already be inherent in the people; the scope which the play of courage and talent will enjoy in the realm of chance and probability depends upon the particular character of the commander and army; but the political aims are the business of government alone.

> These three tendencies are like three different codes of law, deeply rooted in their subject and yet variable in their relationship with each other. A theory that ignores any one of them or seeks to fix an arbitrary relationship between them would conflict with reality to such an extent that for this reason alone would be totally useless.
>
> Our task, therefore, is to develop a theory that maintains a balance between these three tendencies, like an object suspended between three magnets.[20]

This metaphor is apt because, despite the theoretical foundation of the law of magnetism, in the real world[21] an object suspended between three magnets will oscillate in unpredictable, non-linear ways, exhibiting some of the characteristics of a complex system. Unaware of the term "complexity" as employed today, Clausewitz reflected on the characteristics of such a phenomenon long before it was christened as such.

As an instrument of policy Clausewitz goes on to place war squarely in the political system, domestically and internationally.

> If we keep in mind that war springs from some political purpose, it is natural that the prime cause of its existence will remain the supreme consideration in conducting it. That, however, does not imply that the political aim is a tyrant. It must adapt itself to its chosen means, a process which can radically change it; yet the political aim remains the first consideration. Policy, then, will permeate all military operations and, in so far as their violent nature will permit, it will have a continuous influence on them.
>
> We see, therefore, that war is not merely an act of policy, but a true political instrument, a continuation of political intercourse carried on with other means.

Clausewitz was keenly aware that the political system, of which war was an inextricable part, was not a mechanical system, subject to the linear laws of Newtonian motion. Rather it was a complex system of the kind described by complexity theorists over 150 years later.

> Whenever you look at very complicated systems you generally find that the basic components and the basic laws are quite simple; the complexity arises because you have a great many of these simple components interacting simultaneously. The complexity is actually in the organization – the myriad possible ways that the components can interact.[22]

This is precisely how Clausewitz saw war.

> In war everything is uncertain and calculations have to be made with variable quantities. Other theorists direct their inquiry exclusively towards physical quantities, whereas all military action is intertwined with psychological forces and effects. They consider only unilateral action, whereas war consists of a continuous interaction of opposites.[23]

He goes on to emphasize this point, insisting upon the importance of interactivity's role in properly defining war.

> War belongs to the province of social life. War is not an activity of the will exerted upon inanimate matter as in mechanics, or upon a living but passive, yielding subject like the human mind like the fine arts; but against a living and reacting force. Strictly speaking war is neither art nor science, rather it is part of man's social existence.[24]

This insight was extended by Clausewitz to address the concept of non-proportionality, another characteristic of complex systems.

Here cause and effect are not necessarily predictable – small causes can produce disproportionately large outcomes and vice versa. Thus, Clausewitz points out that in war, "Success is not due simply to general causes. Particular factors can often be decisive – details known only to those who are on the spot. Issues can be decided by chances and incidents so minute as to figure in histories simply as footnotes."[25]

Furthermore, Clausewitz argues that trying to understand and conduct war in accordance with some form of calculable mathematics is sheer delusion. From the outset there is a play of possibilities, probabilities, good and bad luck, "...which spreads about with all the course and fine threads of its web." To help explain this aspect of war he uses the concept of friction. However, Clausewitzian friction is not the mechanical phenomenon of Newtonian physics. The non-linear phenomenon of friction had been excluded from Newton's laws of motion on the grounds that its effects were so marginal for most cases that it could be safely ignored in most calculations. Conversely for Clausewitz, friction is everywhere in war and can accumulate with disastrous consequences.

> Friction is not concentrated, as in mechanics, at a few points, but rather is everywhere brought into contact with chance; and thus, incidents take place upon which it is impossible to calculate – their chief origin being chance.[26]

Therefore, friction cannot be dismissed as a minor and mostly insignificant deviation from the ideal mechanism, rather it is a fundamental and irreducible property of war. Clausewitz's use of the term "friction" is hence much closer to the understanding of thermodynamics than that of mechanism since unpredictability and chance are understood to be endogenous to the system.

Modern complexity theory also insists that complex systems, especially complex adaptive systems, cannot be understood solely

in terms of their parts. Such systems must be explored holistically and in terms of their interaction with the wider environment of which they are also a part. This conclusion was already apparent during Clausewitz's time in the emerging field of biology since biological entities were seen to be those where the whole is greater than its parts. Clausewitz was clearly aware of this scientific fact and applied it to his conception of war and conflict. At the beginning of *On War* and then, perhaps for emphasis, in its conclusion he made his point as follows:

> In war more so than any other subject, we must begin by looking at the whole, for more than elsewhere the whole and the part must be thought of together.[27]

> War should be conceived as an organic whole, whose parts cannot be separated, so that each individual act contributes to the whole and itself organizes in the central concept.[28]

The power of Clausewitz's theory of war continues to astonish those who choose to study him carefully. He remains as relevant today in helping to understand "war amongst the people," and all other forms of war, regular and irregular, as he has been for the past 180 years. Of course, military thought, particularly as it has been shaped by modern science, and complexity theory in particular, has progressed significantly. Insights that Clausewitz was able to glean through strenuous study of then young sciences have been expanded and refined in recent years. As such Section Two examines the current state of play of complexity theory and systems thinking in order to understand why they must form the basis for a better appreciation of the problems posed by war and conflict.

SECTION TWO
Complexity Theory, Complex Adaptive Systems and Systems Thinking

Complex systems are both interactive and non-linear. For a system to be linear it must meet two simple conditions. The first is proportionality indicating that changes in system outputs are proportional to system inputs. Such systems display what in economics is called "constant returns to scale" implying that small causes produce small effects and large causes generate large effects. The second condition of linearity, called additivity, underlies the process of analysis of such systems. The central concept is that the whole is equal to the sum of the parts. This allows the problem to be broken into smaller pieces that, once solved, can be added back together to obtain the solution to the original problem.

Non-linear systems, that is to say complex systems, are those that disobey proportionality and additivity. Interactive complexity is based on the behaviour of the parts and the resulting interactions between them. The greater freedom of action of each individual part and the more linkages among the components the greater is the system's interactive complexity. Interactively complex systems are also highly sensitive to inputs; immeasurably small inputs can generate disproportionately large effects. Equally important with interactive complexity, it is often impossible to isolate individual causes and their effects since the parts are all connected in a complex web. Interactive complexity produces fundamentally unpredictable and even counter-intuitive behaviour. Such systems must be viewed holistically – the whole is greater than the sum of the parts. They cannot be properly investigated using analytical techniques; rather they require systems thinking to achieve a full understanding of their dynamics and behaviour.

Complex adaptive systems constitute a special case of complex systems. They are capable of changing and learning from experience. Complexity theorist John Holland defines a complex adaptive system in a social, political or organizational context as a dynamic network of many agents acting in parallel, constantly acting and reacting to what the other agents are doing. Such systems exhibit coherence under change, via conditional action and anticipation, and they do so without central direction.[29] Since the control of a complex adaptive system tends to be highly dispersed and decentralized, any coherent behaviour in the system arises from competition and cooperation among the agents themselves. It is the accumulation of all of the individual decisions taken by the multitude of agents that produces the overall behaviour of the system. This, it will be demonstrated below, is of great significance for command and control in modern war and conflict.

The concept of a complex adaptive system is actually a very broad meta-subject, but at its core is a single image – the concept of an adaptive whole – a system that will contain sub-systems, while itself being capable of acting as a sub-system of yet a wider system. Such a whole may be able to survive in a changing environment, which is delivering shocks to it, if it has available both processes of communication and a repertoire of responses which can enable it to adapt to its changing circumstances. The general model of this kind of organized complexity is that there exists a hierarchy of levels of organization each more complex than the one below. The higher level is characterized by emergent properties that do not exist at the lower level. Indeed, more than the fact that they do not exist at the lower level, emergent properties are meaningless in the language appropriate at the lower level.

In response to this complex phenomenon of hierarchy and emergence, a specialized theory – hierarchy theory – has been developed. It is the discipline concerned with the fundamental

differences between one level of complexity and another in a given system. Its ultimate aim is to provide both an account of the relationship between different levels and an account of how observed hierarchies come to be formed, what generates the levels and how emergence occurs.[30] These hierarchies are characterized by processes of control operating at the interface between levels. In a hierarchy of systems, maintenance of the hierarchy will entail a set of processes in which there is a flow of information for purposes of regulation and/or control. All control processes depend on communication, upon a flow of information in the form of instructions or constraints, a flow which may be automatic or manual.

A complex adaptive system acquires information about its environment and its own interaction with that environment, identifying regularities in that information, condensing these regularities into a kind of "schema" or model, and acting in the real world on the basis of that "schema."[31] Jamshid Gharajedaghi refers to such systems, specifically with regard to human activity systems, as purposeful, multi-minded socio-cultural systems; a depiction very reminiscent of Clausewitz's conception of war as a socio-political system.[32]

Gharajedaghi identifies five principles that, acting together as an interactive whole, define such a system. These are – openness, purposefulness, multi-dimensionality, emergent property and counter-intuitveness.

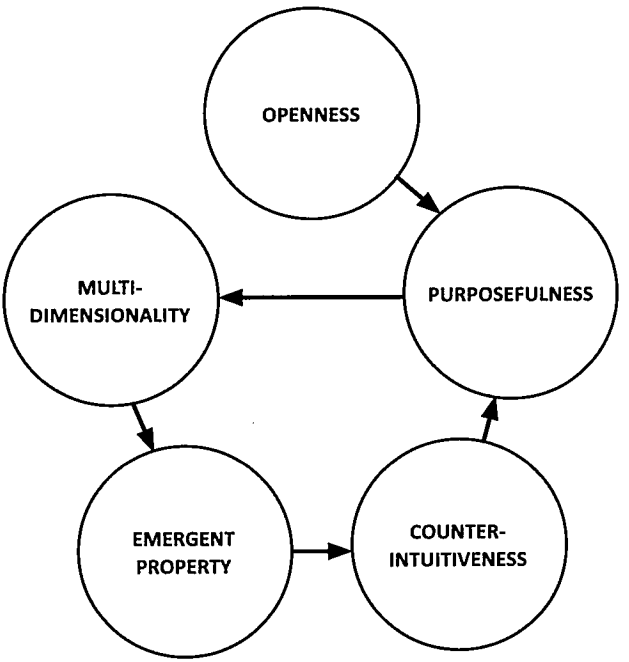

FIGURE 1. Systems Principles
Source: Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity*, 29.

Openness means that the behaviour of complex adaptive systems can be understood only in the context of their environment. The system, therefore, consists of all the interactive sets of variables that could be controlled by participating actors. Meanwhile, the environment consists of all those variables that although affecting the systems behaviour, could not be controlled by it. The system boundary thus becomes an arbitrary, subjective construct defined by the interest and level of ability and/or authority of the participating actors.[33]

Purposefulness. A purposeful system is one that can produce not only the same outcomes in different ways in the same environment but different outcomes in both the same and different environments. It can change ends under constant conditions. This ability

to change ends under constant conditions is what exemplifies free will. Such systems not only learn and adapt, they can create.

Multi-Dimensionality is the ability to see complementary relations in opposing tendencies and to create feasible wholes with unfeasible parts. The principle of multi-dimensionality maintains that the opposing tendencies not only co-exist and interact, but also form a complementary relationship. The complementary relationship is not confined to pairs. More than two variables may form complementary relationships, as the trio of freedom, justice and security demonstrate.

Emergent Property. Emergent properties are the property of the whole, not the property of the parts, and cannot be deduced from the properties of the parts. However, they are the property of the interactions, not the sum of the actions of the parts and therefore, have to be understood on their own terms. Relying exclusively on an analytical approach fails to produce an understanding about emergent properties. The use of systems thinking is required to produce this understanding.

Counter-Intuitiveness means that actions intended to produce a desired outcome may, in fact, but not necessarily, generate opposite results. This phenomenon stands on a level of complexity that is also beyond the reach of the analytical approach.

War and conflict certainly manifest innumerable examples of these principles at work. Thus, for example, all wars are bounded in one way or another, separating them to a degree from the rest of the global environment that continues to influence their conduct. As you descend the hierarchy, more concrete, yet arbitrary, boundaries are established such as theatres of war and theatres of operations, etc. In terms of purposefulness, strategists and operational artists are constantly trying to learn, and subsequently create the conditions that lead to the achievement of strategic and political

objectives. The third principle of multi-dimensionality is illustrated by the Clausewitzian contention that defence is the stronger form of war with a negative aim; whereas, offence is the weaker form with a positive aim. Complementary relationships among security, governance and development is another example. One, amongst many, emergent properties in the General System of War and Conflict is the fact that at the tactical level manoeuvre is a function of fire and movement, whereas at the operational level it is a function of mass and mobility. The establishment of a stable, prosperous, perhaps even more democratic country, from a failed or failing state can also be seen as emergence. So too could the combination of unexploded ordnance, simple technology such as cellular telephones and committed people to create a deadly and effective opposing force. Finally, for a very great many people, the phenomenon of insurgency and civil war in Iraq, despite the decisive overthrow of Saddam Hussein, was definitely counter-intuitive.

Reductionism and analysis are not as useful with interactively complex systems because they lose sight of the dynamics between components. The study of interactively complex systems must be systemic, rather than reductionist, and qualitative rather than quantitative, and needs to use different heuristic approaches (modelling-design) rather than analytic problem-solving.

It is, therefore, extremely important to recognize the distinct difference between analytical thinking and systems thinking. Analysis is a three step process. First, it takes apart that which it seeks to understand. Then it attempts to explain the behaviour of the parts taken separately. Finally, it tries to aggregate understanding of the parts into an explanation of the whole. Systems thinking uses a different process. It puts the system as a whole in the context of the larger environment of which it is a part and studies the role it plays in the larger whole.

The analytical approach has remained essentially intact for nearly four hundred years but systems thinking has already gone through three distinct generations of change. The first generation of systems thinking (operations research) dealt with the challenges of interdependency in the context of mechanical (deterministic) systems. The second generation of systems thinking (cybernetics and open systems) dealt with the dual challenges of interdependency and self-organization (neg-entropy) in the context of living systems (ecology, for example). The third generation of systems thinking (design) responds to the triple challenge of interdependency, self-organization and choice in the context of socio-cultural systems.[34]

Systems thinking is the practice of thinking that takes a holistic view of complex events or phenomena seemingly caused by a myriad of isolated, independent and usually unpredictable forces or factors. Systems thinking views all events and phenomena as "wholes" interacting according to systems principles as discussed earlier. These principles underlie vastly different events and phenomena. Systems thinking recognizes that systems (organized wholes) ranging from soap bubbles to galaxies, ant colonies to nations, can be better understood only when their wholeness (identity and structural integrity) is maintained, thus permitting the study of the whole instead of the properties of their components. As a modelling language, systems thinking illustrates cause and effect relationships that cannot be adequately explained by the subject-verb-object constructions of natural languages like English.

As with the concept of a complex adaptive system, systems thinking is a meta-subject. It is employed using specific systems thinking methodologies such as those advocated by Barry Richmond, Russell Ackoff and Jasmid Gharajedaghi.[35] A particularly useful methodology is Soft Systems Methodology developed by Professor Peter Checkland and his colleagues at the University of Lancaster

in the United Kingdon (UK).[36] Each of these various methodologies, but especially SSM, have contributed to the varieties of systemic operational design studied in the US, UK and Australian militaries. However, before discussing the requirement for, and utility of, such a methodology based on SSM, Section Three will demonstrate the nature of war and conflict as a complex adaptive system; that is to say, the General System of War and Conflict.

SECTION THREE
The General System of War and Conflict

War and conflict are most usefully viewed as a complex adaptive system – the General System of War and Conflict. This meta-system comprises a hierarchy of systems ascending from the tactical to the operational to the strategic and ultimately to the policy or political level, as depicted below.

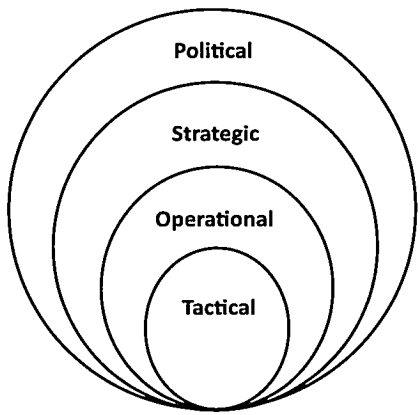

FIGURE 2. The General System of War and Conflict

There are numerous actors interacting at every level in the hierarchy of the overall system, and the number of major actors and other important factors increases as one moves up the system. At the same time each level interacts with the others, directly or indirectly, thus, increasing complexity even further. As one rises through the system, emergent properties are identified; such as, for example, the emergence of manoeuvre at the operational level being that of a function of mass and mobility as opposed to fire and movement at the tactical level of the hierarchy.

An explicit recognition of the complex nature of war and conflict has most recently been very well articulated by a leading US military theorist, Brigadier-General (retired) Huba Wass de Czega:

> Recent missions and their contexts have exceeded in novelty and complexity any that the US Armed Forces have experienced. Their novelty makes experience-gained intuition and published doctrine less reliable. Their complexity is not the more familiar kind, the complexity of "detail" or structure such as those encountered in such complicated operations such as D-Day or Operations Desert Shield and Desert Storm but of a more difficult variety, the complexity that arises out of the interactions between the various elements of a problem over time and due to subtle relationships between cause and effect. It would be a mistake to suggest that this kind of complexity is only a property of irregular warfare or insurgency. This is a general condition and there is no returning to "traditional" warfare.[37]

In the General System of War and Conflict, the highest level in the hierarchy, policy, is defined as "the expression of the desired end state sought by the government and guidance for the employment of the instruments of power." Crucially important here is Clausewitz's insightful observation that the main lines along which military events progress, and to which they are restricted, are political lines that continue throughout the war and into the subsequent peace. This is so because, as Clausewitz defined it, war is merely the continuation of policy with the admixture of other means. The "logic" of war is supplied by policy, whereas, the "grammar" is supplied by strategy, operational art and tactics.

The strategic sub-system is the dominant one below the level of policy because it is here that the conflict's political goals are defined in instrumental terms useful for the military and other non-military actors. This is usually a problematic process since the criteria for politics are subjective, ambiguous and indeterminate while those for the military tend to be objective, concrete and

relatively time-limited. Strategy is, thus, the bridge between policy and the operational sub-system.[38] It is the process of interacting with the strategic level, directly or indirectly, which causes the operational level commander to form his/her unique perspective. For the operational commander alone, to be successful, he/she must conceptualize a military or multi-agency condition or conditions that will ultimately achieve the strategic goals.

Strategy is defined as the art of distributing and applying military force, or the threat of such action, to fulfil the ends of policy.[39] There are four dimensions of the strategic system – operational, logistical, social and technological – and all interact in a complex manner but it is largely the social dimension (i.e. the human factor) that injects non-linear complexity into the system. What makes strategy so difficult for the uninitiated is that it is virtual behaviour; it has no material existence. It is an abstraction, though it is vastly more difficult to illustrate virtually than are other vital abstractions.[40] A useful way of thinking about strategy in this way is that once the policy objectives have been set, strategy is the function that delivers the theory of victory. This cognitive theory[41] is "tested" once the force and other elements of national power are set in motion at the operational and tactical levels. Retired Israeli Brigadier-General Shimon Naveh makes essentially the same point when he states that strategy is primarily concerned with shaping future realities and strategists rely on concepts as tools for both interpretation of circumstantial contexts and design of future realities. "Thus strategy is a constant dialectical play transforming political situations and producing new states of knowledge."[42] Therefore, if there is a single idea which best captures the essence of strategy, it is its instrumentality. So long as one never forgets that strategy is about the consequences of *the use of force and the threat of its use*, and not about such use itself, one will keep to the straight and narrow.

Strategists understand that there are logically associated strategic orientations best suited to achieve any selected political objective. The development of the theory of two kinds of strategy begins with Clausewitz himself. According to the Prussian master:

> Since war itself can be thought of in two different ways – its unlimited form or one of the more limited forms it can take – two different concepts of strategy arise.
>
> In the unlimited form of war, where everything results from necessary causes and one action rapidly affects another, there is, if we may use the phrase, no intervening neutral void. Since war contains a host of interactions, since the whole series of engagements is, strictly speaking, linked together, since in every victory there is a culminating point beyond which lies the realm of losses and defeats – in view of all these intrinsic factors of war, we say there is only one result that counts: final victory. Until then nothing is decided, nothing won and nothing lost. In this form of war we must always keep in mind that it is the end that crowns the work. Within the concept of unlimited war, then strategy is indivisible and its component parts, the individual victories, are of value only in their relationship to the whole.
>
> Contrasting with this extreme view of the connection between successes in strategy, is another view, no less extreme, which holds that strategy consists of separate successes, each unrelated to the next as in a match consisting of several games. The earlier games have no effect upon the later. All that counts is the total score and each separate result makes its contribution toward this total.[43]

If the objective requires the unconditional surrender of the adversary, as in the two world wars of the 20th Century, then the

strategy employed seeks to overthrow the opponent through the destruction of all sources of resistance, material and psychological. The strategic goal is decisive military victory. Individual actions and victories are important only insofar as they contribute to the final overall military victory. This is what Clausewitz termed the strategy of annihilation.

If, on the other hand, the objective sought does not, should not, or could not, require decisive military victory, that is, rendering the opponent supine, the strategic system best suited is a more complex one combining battle with non-battle means such as diplomacy, ongoing negotiations, economic means, etc., simultaneously or sequentially. This is the bi-polar strategy. In the strategy of annihilation, diplomacy, economics and other forms of national power are used but they are integrated into, and remain subsidiary to, the flow of military operations. In the bi-polar strategy these means are employed in parallel with military operations, with the latter frequently being subsidiary to these other efforts on the non-battle pole. In the bi-polar strategy, the military operates on both poles.

Clearly, modern operations involving "whole of government" or "comprehensive" approaches are being conducted in accordance with the bi-polar strategy. All strategy is a complex endeavour but the bi-polar strategy is more complex, involving innumerable actors – a truly complex adaptive system. This complexity is transmitted down through the hierarchy through the operational level and into the tactical.

It may be helpful to envisage the very different natures of these two different kinds of strategy through an analogy with the games of *wei qi* (way chee) and chess. *Wei qi*, China's most enduring game, is often referred to in the West as "Go." *Wei qi* translates as "a game of surrounding pieces" and as its title implies, it involves

a concept of strategic encirclement. The board, a grid of nineteen by nineteen lines, begins empty. Players each have 180 pieces, or stones, of equal value at their disposal. The players take turns placing stones on any point of the board, building up positions of strength while working to encircle and capture the opponent's stones. Multiple contests take place simultaneously in different regions of the board. The balance of forces shifts incrementally with each move, as players implement strategic plans and react to each other's initiatives. At the end of a well played game, the board is filled by partially interlocking areas of strength. The margin of advantage is often slim, and to the untrained eye, the identity of the winner is not necessarily immediately obvious.

Chess, on the other hand, is about total victory. The purpose of the game is checkmate, to put the opposing king into a position where he cannot move without being destroyed. The vast majority of games end in a total victory achieved by attrition, or more rarely, a dramatic skilful manoeuvre. The only possible other outcome is a draw, meaning the abandonment of hope for victory by both parties.

If chess is about the decisive battle, *wei qi* is about the protracted campaign. The chess player aims for total victory. The *wei qi* player seeks relative advantage. In chess the player always has the capability of the opponent in front of him/her all of the pieces are always fully deployed. The *wei qi* player needs to assess not only the pieces on the board but the reinforcements the opponent is in a position to deploy. Where the skilful chess player aims to eliminate an opponent's pieces in a series of head-on clashes, a talented *wei qi* player moves into "empty" spaces on the board, gradually mitigating the strategic potential of the opponent's pieces. Chess produces single-mindedness, *wei qi* generates strategic mobility.

Once leaders understand that the strategic system is a dynamic, non-linear feedback system they must see strategic thinking as

involving the following five mental tasks, all associated with the notion of systems thinking:

- Developing a new mental model for each new situation rather than applying the same general prescription to many situations.
- Reasoning by analogy and intuition about qualitative irregular patterns rather than analysis and quantification.
- Thinking in terms of a whole, interconnected system, including relationships in it rather than as separate parts.
- Focusing on the learning process and on the mental models governing the process rather than the outcomes.
- Becoming aware of the effects of group dynamics on thinking and learning, and trying to minimize dysfunctional group dynamics.

The interface between policy and strategy is the realm of civil-military relations. Issues of civil control of the military and structures and processes for effective communication across this boundary are always important ones. It is here that politics, military strategy and other elements of national power come together to form national security strategy. In the process of dialogue that should occur on the strategic bridge, both the soldier and the civilian politician need to adjust their preferences so as to meet the demands of the other. But a key function of the dialogue is to ensure that the spokespeople for policy and military power each respect the core integrity of the logic or grammar of the other.

The operational level system is nested within the strategic system in the General System of War and Conflict. It is also a bridge between strategy and tactics, where the coherent accomplishment of strategic objectives through the employment of tactical

resources is achieved by the conduct of major operations and campaigns. Tactics, focusing mainly on the mechanical dimension of conflict, lack the cognitive tools needed to merge and direct the numerous engagements towards achieving the strategic aim. Conversely, strategy, leaning primarily on abstract definitions of aims and policies lacks the ability to translate its intentions into mechanical terms. Only at the operational level can the abstract and mechanical extremes be fused into a functional formula through the maintenance of cognitive tension. The cognitive tools necessary are, in essence, systems theory and systems thinking. Commanders, staffs and leaders in this operational system employ operational art; the component of military theory concerned with the theory and practice of designing, planning, conducting and sustaining major operations and campaigns, to achieve their aims.

Operational art is a creative enterprise operating in a complex system which comprises one reciprocal discourse between the National Command Authority and the operator-designer focusing on the design of the operational concept and another reciprocal discourse between the operator-designer and the commanders of the tactical components concentrating on the detailed planning of the manoeuvre scheme. Like strategy, the operational system exhibits all of the characteristics of a complex adaptive system. Operational commanders must, therefore, accomplish the same five mental tasks at their level as strategic leaders have at theirs.

Tactics are the final nested sub-system in the General System of War and Conflict. Tactics are obviously important because only they deliver concrete success within the context set by operational art and strategy. Any applied military activity is inherently tactical, organized by operational art, but, as discussed above, the consequences of all military activity are the realm of strategy. The factors of fear, danger, fatigue and extreme physical and mental exertion are either unique to the tactical system or, at least, their

effects are greatly magnified there. Tactical manoeuvre, as already mentioned, is a function of fire and movement and is strongly influenced by technology. Tactics have, in fact, been altered as much, if not more, by technology than strategy and operational art.

At the tactical level in the hierarchy of the General System of War and Conflict, activities remain quite complicated but are less complex than at higher levels. The system tends to linearity and analytical modes of thinking, decision-making and planning are generally appropriate. However, as General Wass de Czega cautions, today, unlike the past when only commanders at the operational and strategic levels had to cope with ill-structured problems, the requirement to deal directly with complexity is required daily at increasingly lower levels in the military hierarchy (i.e. the tactical). This has significant ramifications for the CF's professional development system and the use of systems thinking to deal with this complexity will be necessary for officers and senior NCOs at the higher tactical level as well.[44]

In complex adaptive systems like the General System of War and Conflict, as discussed earlier, the functions of communication and control are central to the system's operation. In the General System of War and Conflict these functions are accomplished by commanders, leaders, staffs and staff systems, and the use of appropriate technologies to link all of the elements together. Generally speaking, command and leadership in the tactical system are direct and more or less face-to-face. In the operational and strategic systems these function are more indirect and are accomplished through system-wide directives and policies.

In addition, strategic and operational control must usually be understood in substantially different terms than in the tactical system. This certainly is the case in joint and combined operations

but is especially true in "Whole of Government," comprehensive, or what the Army calls JIM(P) (Joint, Interagency, Multinational, Public) operations. Conventional, traditional military command and control structures and systems simply do not exist. In fact, these circumstances frequently exist in a bi-polar strategy at the tactical level as well, as with, for example, the operation of a Provincial Reconstruction Team (PRT) or in Operational Mentoring and Liaison Team (OMLT) operations. The new terms referred to involve political interaction and complex learning. Complex learning and political interaction are the only forms of control capable of operating in complexity and what is called "bounded instability"[45] and of dealing with situations of open-ended change. Commanders understand that in these circumstances leadership relies on relationship building over role defining, loose coupling over standardization, learning over knowing, self-synchronization over command and control and emergent thinking over planning based on estimates.

To succeed, strategic and operational leaders must also control their organizations during all kinds of change. The forms of control they need to use, however, are dictated by the nature of these changes. Applying planning forms of control to short-term, predictable change is not only possible but essential. But because the details of the long-term future are completely unknowable, leaders have to adopt a different form of control. This kind of control also relies on self-organizing political interaction and complex learning. Leaders who use these processes are not abandoning concern for the long-term. They are simply showing a realistic recognition of the ambiguous and uncertain nature of the long-term future. Complex learning and political interaction, in fact, produce behaviour that is just as coherent and controlled as that produced by planning and hierarchical command and control structures. Control, that is, ensuring that behaviour stays within, or moving towards, acceptable bounds, can only be achieved indirectly.

The most promising approach involves establishing to the extent possible a set of initial conditions that will result in the desired behaviour. In other words control is not achieved by imposing a parallel process, but rather emerges from influencing the behaviour of independent agents.[46]

Over long periods of time, and in a specific geo-political context, the interactions among the levels of the General System of War and Conflict produce a given strategic culture. Such a culture can be described as a nation's (or security community's) "way of war." The concept of a strategic culture refers to the socially transmitted habits of mind, tradition and preferred methods of operation that are more or less specific to a particular geographically based security community. It is a product of a particular national historical experience that has been shaped by more or less unique, though not necessarily unvarying, geographic context. Each strategic culture is inclined to erect what purports to be general theories on the basis of national historical experiences and circumstances. In short, strategic culture is defined as:

> An integrated system of symbols (argumentation, structure, languages, analogies, metaphors, etc.) that acts to establish pervasive and long-term strategic preferences by formulating concepts of the role and efficacy of military force in political affairs. The strategic culture thus established reflects national preconceptions and historical experience as much as it does purely objective responses to any given threat environment.[47]

Strategic culture is a long term, slow growth phenomenon, not particularly dependent on specific individuals or even any single significant event, with five major factors contributing to the evolution of a particular strategic culture.

Geography is the most fundamental of the factors that condition national outlooks on security problems and strategic solutions.

Historical experience influences strategic culture almost as much as geography.

Religion, ideology and culture taken together comprise something the Germans have captured in a single word – *Weltanschauung* (worldview). The influence of this concept on strategic culture is both elemental and vast.

Governance and the structure of military institutions play a crucial role in the development of a strategic culture.

Technology and how it advances and is perceived socially and is integrated into military organizations deeply impacts strategic culture.

Assessing and understanding our own and our adversary's strategic culture will always be a key factor when approaching war and conflict when the concept of "design" is applied to the General System of War and Conflict.

When war and conflict are conceived as a complex adaptive system, as described in this section, the guidance provided by systems theory must be followed. This means that methodologies derived from the science of complexity are most appropriate when preparing for and conducting operations throughout the system. One especially important approach is modelling or "design," as discussed in the next section.

SECTION FOUR
Design and Planning

Traditional military planning has always applied principles from the Industrial Age because the problems it addressed were seen through the analytic lens developed during that era. However, as David Alberts and Richard Hayes note, "the assumptions underpinning analytical thinking fail when a genuinely complex situation occurs as in a complex adaptive system."[48]

In the military context, the best demonstration of over-reliance on analytical thinking lies in operational planning. The five stages of operational planning, reflected in both the CF Operational Planning Process (OPP) and North American Treaty Organization's (NATO) Bi-lateral Strategic Command (Bi-SC) Guidance on Operational Planning are intended to be cyclical in order to adapt and evolve with changing circumstances, but are ill-suited for the complex adaptive systems that Alberts and Hayes describe. The stages of the OPP are Initiation, Orientation, Course of Action (CoA) Development, Plan Development, and Plan Review, where a plan or operations order is the output.

This is a demonstration of the use of stage models in problem-solving. Stage models include four generic steps in sequence: define the problem, generate a course of action, evaluate the course of action, and execute the course of action. The components of this planning model are themselves reasonable, but are grounded in their assumption of linearity.[49] The Orientation phase as it currently exists in doctrine is especially ill-conceived to manage the complex (and therefore non-linear) operational environments in which the Canadian Forces currently find themselves. Too little emphasis is placed in current doctrine on design or as it is known in the CF OPP manual, "Mission Analysis." The sole reference to the vital task of exploring and understanding the environment and relationships within a problematical situation is as follows:

> All missions must be analyzed in the context of their relationship to the system of systems that will exist in the theatre of operations. There are many methods currently in use that can assist in this process depending on the time available and the complexity of the situation. Concepts such as Systemic Operational Design, Strange Analysis and Operational Net Assessment all aim at developing a complete understanding of the environment that will aid decision-making. Once the relationships of the mission to the environment are established, each influencing factor (tasks, intention, etc) is quantified by its relative significance and impact on achieving the desired effects on the system or the enemy. When information is unavailable or circumstances are likely to be unpredictable, it will be necessary to make assumptions.[50]

This is insufficient. In Canadian doctrine, this is only a minor reference to a design process that should not only precede the planning stage, but be equally important to it.[51] Instead, the Operational Planning Process, like its American counterpart the Military Decision-Making Process, exists in a Newtonian, mechanistic[52] environment, where problem solving exists in a linear sequence of actions and reactions. In effect, current operational planning represents an Industrial Age way of thinking.

Beginning in the 1970s, as the Information Age began to take form, complexity theorists began to argue that dealing with complex systems required an approach that began with designing after which planning could be effectively employed. As Charles Churchman demonstrated in *The Design of Inquiring Systems* (1971), the best way to learn about a complex system is to create a design of it.[53] In his treatment of strategy formation and strategic thinking Henry Mintzberg makes a similar case, arguing that formal planning and the associated forces that encourage it may

discourage the very mental state required to achieve new strategies – a state of openness and easy flexibility that encourages people to step back from operating reality and question accepted beliefs. In short, strategic planning may prove incompatible with real strategic thinking.[54] Mintzberg goes on to point out that, in fact, strategic thinking equals systems thinking and indicates that only systems thinking methodologies, such as designing, are suitable. According to Gharajedaghi, design, along with participation, iteration and second-order learning, is at the core of the concept of systems methodologies.[55] This idea of design is defined specifically by the International Technology Education Association as an iterative decision-making process that enables the production of plans by which resources are converted into products or systems that meet human needs and wants or solves problems.

The idea of "design then plan" is gaining acceptance in many militaries today. According to Brigadier-General Huba Wass de Czega:

> The creative, non-linear and idiosyncratic but vital cognitive work of senior commanders is generally called military art, strategic thinking or operational art. Generals who possess the experience and genius for this art do it well. Sometimes their genius is finding the right people to help them with it – an informal command team. What they do is not really "planning." It is creating an abstract framework of ideas that summarize the essential elements of a situation, describes what is to be achieved and outlines the approach so that planning can begin. It is strategic and operational design. There is no linear process for this essential creative contribution.[56]

Designing focuses on learning about an unfamiliar problem and exploits that understanding to create a broad approach to managing it. Starting with a blank sheet, designers frame the problem

and give it structure. Designers usually record their design in some kind of graphic or pictorial representation. Planning, on the other hand, is heavily analytical and requires more independent and functionally specific work.[57] The relationship between design and planning is depicted below.[58]

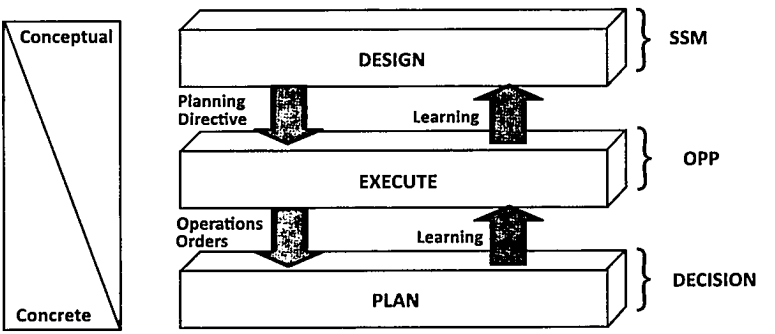

FIGURE 3. Operational Design, Planning, and Execution
Source: Adapted from Stephan Banach, "The Art of Design: A Design Methodology," 105-115.

This process, it must be emphasized, is iterative and recursive and does not end. Intervention in the execute phase changes the situation and requires the cycle to continue.

Soft Systems Methodology is a design tool that has been applied over the past 40 years to hundreds of complex situations in both the public and private sectors. It can be readily adapted to the military context and is compared below to the design construct being proposed in the US. Before turning to this detail, however, it is instructive to examine the theory of US Air Force Colonel John Boyd and locate the design/plan process in his system.

Boyd was one of the first modern military theorists to recognize that war and conflict should always be viewed as a complex adaptive system. Inspired by his experience in aerial combat in the Vietnam War and drawing extensively on the emerging scientific

and other scholarly literature on the subject of complexity, he constructed a very sophisticated theoretical construct known simply as the OODA Loop. As described by his colleague and co-theorist Chuck Spinney, "...the OODA Loop is the product of a co-evolutionary interaction. Since all co-evolutionary processes embody positive as well as negative feedback loops, the OODA Loop is necessarily a non-linear system and will exhibit unpredictable emergent behaviour – in short, a complex adaptive system."[59]

OODA stands for Observe – Orient – Decide – Act and seeks to model the decision-making cycle a combatant goes through when engaged in war fighting at any level in the General System of War and Conflict. It is effectively a cognitive theory that can be applied in many situations, which accounts for its current enthusiastic adoption in business management literature as well as its resurgence among military analysts in the West, at least.

One of the preeminent strategic theorists of our time, Colin S. Gray, praised Boyd and endorsed his "Loop" as follows:

> Boyd's Loop can apply to the operational, strategic and political levels as well as the tactical. Boyd's theory claims that the key to success in conflict is to operate inside the opponent's decision cycle. Advantages in observation and orientation enable a tempo in decision-making and execution that outpaces the ability of the foe to react effectively in time. This seemingly simple tactical formula was duly explained and copiously illustrated by Boyd in many briefings within the US defence community over the course of 20 years. The OODA Loop may appear too humble to merit categorization as grand theory but that is what it is. It has an elegant simplicity, an extensive domain of applicability and contains a high quality of insight about strategic essentials, such that its author well merits

honourable mention as an outstanding general theorist of strategy.[60]

In the observation phase, the actor (or system) absorbs information from the environment, his/her situation within it, and the actions of the adversary. The orientation phase requires the actor to interpret the information through a framework of synthesis and analysis which creates meaning, discerns existing opportunities and threats and provides a range of responses to plan for and execute. Next in the decision phase, the actor commits to a course of action which is subsequently carried out in the following phase. Not only does the actor return to the observation phase on the basis of the new information following from the action phase, but feedback loops are operating between all stages in the cycle and the observation phase as the actor continually absorbs new information in order to adjust his/her frameworks and behaviour accordingly.[61]

While at first glance the OODA Loop resembles a typical cybernetic loop whereby a system adjusts its behaviour to incoming information from its interaction with its environment in order to meet the desired objective, the crucial difference is the stage Boyd described as the most important – orientation. Orientation actually exerts "implicit" guidance and control over the observation and action phases as well as shaping the decision phase. Furthermore, the entire loop (not just orientation) is an ongoing, many-sided implicit cross-referencing process of projection, empathy, correlation and rejection in which all elements in the Loop are simultaneously active. In this sense the Loop is not truly a cycle and is presented sequentially only for the convenience of exposition.

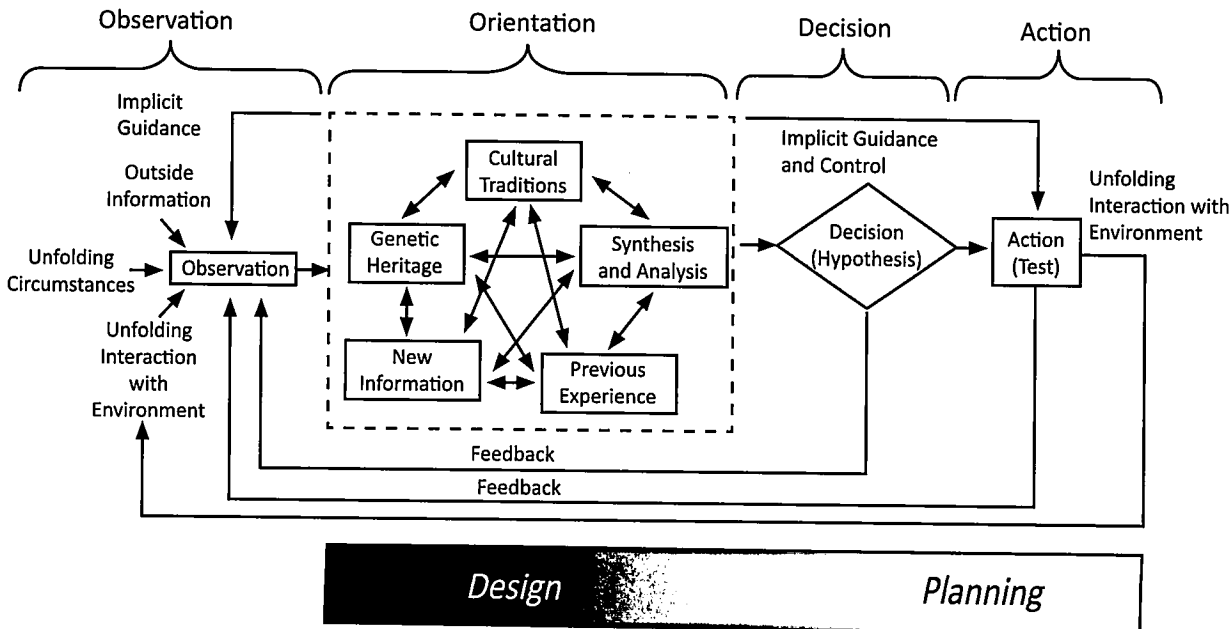

FIGURE 4. OODA Loop
Source: Adapted from Bousquet, *The Scientific Way of Warfare*, 187.

With the orientation phase, Boyd allows for the framework itself to be modified through the comparison of observations of the external world with the system's internal framework, and thus for the system to act in new unforeseen ways. He distinguishes between two different processes that occur during orientation: analysis (understanding the observations in the context of pre-existing patterns of knowledge) and synthesis (creating new patterns of knowledge when existing patterns do not permit the understanding needed to cope with novel circumstances). At the tactical level this process actually involves a decision-making process known as Recognition Primed Decision-Making where the decision is not based on a rationalistic, linear approach, but rather occurs when the actor perceives patterns previously experienced and adjusts those patterns mentally to adapt to the current situation. However, in more complex circumstances at the operational and strategic levels, synthesis and learning are achieved over extended periods of time through systems thinking and applied systems methodologies.[62] It is precisely here that the design-plan paradigm comes into play. Design is the methodology that enables synthesis and, once this has been accomplished, planning can commence in the analysis phase.

Today, complexity theory has permeated the military doctrine community to a much greater degree than was the case when Boyd helped pioneer this path over 20 years ago. In contemporary language, the distinction that Boyd made between synthesis and analysis is reflected in the distinction between design and planning. It is widely acknowledged that complex adaptive systems often create or pose what are referred to variously as "wicked problems," "unstructured problems," or simply "messes." They are what the American mathematician Warren Weaver called problems of "organized complexity," as opposed to problems of "simplicity," amenable to analytical solutions or "disorganized complexity" amenable to statistical solutions.[63] Understanding the

short and long-term consequences of a complex action in its totality requires building a dynamic model to simulate the multi-loop, non-linear nature of the system. The model should capture the critical time lags and relevant interactions among major variables and actors.[64] This is Design.

Designers seek to choose and manage rather than predict the future. They try to understand rational, emotional and cultural dimensions of choice and to produce a design that satisfies a multitude of functions. The design methodology requires that designers learn how to use what they already know, learn how to realize what they do not know, and learn how to learn what they need to know. Finally, producing a design requires an awareness of how activities of one part of a system affect and are affected by activities in other parts. This awareness requires understanding the nature of interactions among parts.

Rather than trying to figure out all the chains of causality, the non-linear designer looks for nodes where feedback loops join and tries to capture as many of the important loops as possible in the system's "picture." Rather than shaping the model to make a forecast about future events or to exercise some central control, the non-linear designer is content to perturb the model, trying out different variables in order to learn about the system's critical points and its resistance to change. The designer is not seeking to control the system by quantifying it and mastering its causality. "The designer wants to increase her/his 'intuitions' about how the system works so the designer can interact, and plan within it, more effectively."[65]

As stated earlier, design is an iterative decision-making process that enables the production of plans by which resources are converted into products or systems to manage problematical – and at times complex – situations. In the US military over the past ten years or so, especially in the Army and Marine Corps, various

approaches to a design methodology have been proposed. All are based on a growing appreciation for systems theory and systems thinking. Two of the most influential methodologies are Systemic Operational Design pioneered by Brigadier-General Shimon Naveh and Soft Systems Methodology developed originally in the UK by Professor Peter Checkland of the University of Lancaster. Retired United States Marine Corps (USMC) Major John Schmitt has developed a modified version of SSM which appears to be the preferred model for further development in the US Army.[66]

Systemic Operational Design (SOD) has been a popular application of systems thinking into a military operational context. Pioneered by Shimon Naveh, former head of the Israeli Defence Force's Operational Theory Research Institute, and James Schneider, and Tim Challans among others at the School of Advanced Military Studies in Fort Leavenworth, it is a philosophical, critically-based approach to operations often seen as an alternative to the now-defunct Effects-Based Approach.[67] According to Naveh, SOD is a process of inquiry that produces both a framework rationalizing strategic complexity and a framework for planning action in accordance with the logic of that complexity.[68] This will seem very familiar when Soft Systems Methodology is described below, and appropriately so, as SOD is a military, operational application of SSM. When contrasted with the examples of operational planning already investigated, SOD makes extensive and explicit use of the abstract concept of design to inform the planning process,[69] whereas in the Operational Planning Process, this informing is little more than an afterthought.

A Systemic Operational Design process is not meant to replace the operational planning stage. Rather it complements it to render a more fulsome concept of action to be taken. As stated earlier, the idea of operational design is rooted in Soft Systems Methodology, and this methodology is applicable to the management of any

complex problematical situation, not solely in the military operational context as it appears with SOD. It is primarily the concept of operational design associated with SOD that has been extracted and incorporated into current US military doctrine.[70]

SSM is a learning system, a system of inquiry. It makes use of models of purposeful human activity to explore "wicked problems." Comparing models with the perceived real world structures a discourse between conflicting interests which enable decisions to be made to take action to improve the situation. In other words, SSM is an organized process that articulates a social learning process by structuring discussion of a problem situation – discussion being based on models of concepts of purposeful activity (built on explicit worldviews) – in order to decide on actions that should be taken to improve a given situation.

SSM is, in the language of social theory, a shift from one philosophy and sociology to a different philosophy and sociology. It is a move from Positivism and Functionalism to Phenomenology and Interpretive Sociology. The nature of this shift is one away from a static view of social reality as "something out there" which can be studied objectively by an outside observer as if social reality were similar to natural phenomenon, to a process view which sees social reality as something being continuously constructed and reconstructed by human beings.[71] SSM is thus an advanced third generation version of systems thinking that recognizes that learning and acting in socio-cultural contexts (like war) requires that the process be fully informed by the major human sciences and their philosophical underpinnings.

The design process as it is being developed, for example in US military doctrine, can be mapped directly onto the SSM process that provides better, more rigorous, detailed methods and techniques to arrive at the model (design) that can be used by planners to enable executable action to be taken.

In the Design process, the first step is Framing (or Structuring) the problem – developing a shared appreciation of the situation among the command team. In SSM this is referred to simply as "Finding Out" about the ill-structured problem. This process is structured around three analyses. The first is a "stakeholder" analysis which identifies all of the major actors in the situation and their relationship to one another. The second is a "social" analysis that establishes an understanding of the values, norms and roles at play in the situation. The third is a "political" analysis, in the sense of finding out where power lies in the system – with which individuals, groups or communities. A key component of this overall analysis is clearly a sound understanding of the strategic cultures at play, as described earlier in this section.

An important technique employed in SSM in this phase is the creation of "rich" pictures of the situation as it emerges from the three analyses. The rationale for this is that the complexity of a human situation is always one of multiple interacting relationships. Finding out about a complex situation involves more than an exploration of objects within it. In complex problems, the relationships between objects in the system are also of the utmost importance. To meet this end a picture is a preferred method for demonstrating relationships; in fact, it is a much better medium for that purpose than linear prose. Hence, as knowledge of a situation is assembled it is recommended that the designer begin to draw simple pictures of the situation. These invariably become "richer" (more sophisticated) as the inquiry proceeds and so such pictures are never finished in any ultimate way. In making a rich picture, the aim is to capture, informally, the main entities, structures and viewpoints in the situation, the processes evolving, the current recognized problems and any potential ones.[72]

The second step in the Design process is to develop an agreed-upon starting hypothesis of the structure of the problem – a

hypothesis that will be revisited periodically as learning takes place. This is called a theory of action, a simple and suggestive insight about how to solve the problem. It is a creative spark that inspires the design team and provides focus to maintain coherence of the design effort.[73] The method employed in SSM is to develop an agreed Root Definition (RD). This is an hypothesis about purposeful action that describes what might be done to intervene and improve a "messy" situation. It is called a root definition because it is rooted in an agreed, explicitly stated worldview. In SSM an RD always takes the basic form: do what (P)? how (Q)? why (R)?

Frequently, the PQR formula will be sufficient to craft a workable RD, however, PQR can be enriched by considering six other important elements that can be included in the hypothesis. These are represented by the mnemonic CATWOE. "C" is the client or group for which action is to be taken either as beneficiaries or victims. Often, of course, the client is the adversary. "A" represents the individuals or groups who will carry out the action, or are otherwise involved. "T" is the transformation intended by the action to be taken. For example, transform a dangerous, insecure environment to one in which the population is safe and development can take place. "W" is the worldview that underpins, justifies or rationalizes the action being taken. "O" represents the owner(s) of the action who wield control over the transformative process, or, in other words, could stop it if they so choose. Finally, "E" is the overall extended environment in which the "system" will operate. This frequently represents various constraints that could affect the action.

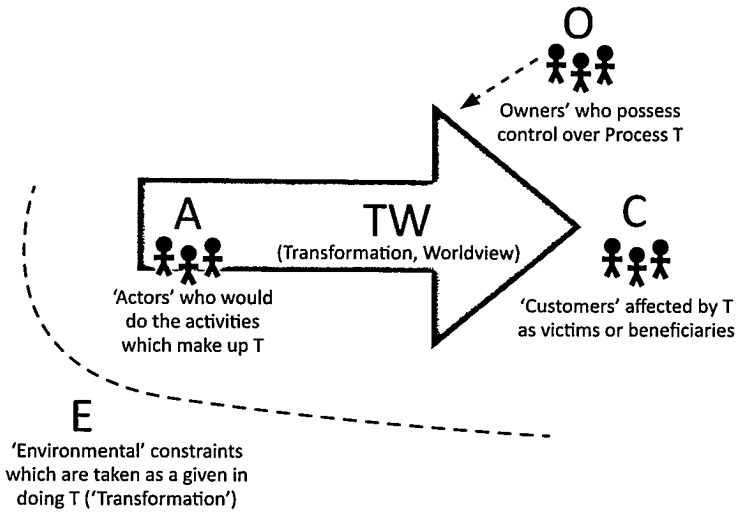

FIGURE 5. A visualization of the CATWOE mnemonic

Using CATWOE to fully develop the root definition, the final result is usually stated as: "A system, owned by some entity, to achieve what, using which resources for what purpose." At the operational level of war and conflict this phraseology should be altered to say: "A design to..." Such an RD refers to a campaign design which should always precede a detailed campaign plan.

Using the International Security Assistance Force (ISAF) Headquarters in Kabul, Afghanistan as an example, the RD or hypothesis could run along these lines: "An ISAF owned operation involving diplomatic, developmental and military actions, executed by contributing nations and indigenous forces to reduce conflict and stabilize the country in order to prevent it from again becoming a safe haven for terrorists." Note here that the transformation (T) proposed – reducing conflict and stabilizing the country – is motivated by a worldview that Afghanistan should not be allowed to revert back to being a training ground for terrorists. It is not a "W" that calls, for example, for a prosperous, democratic state,

although, of course, it could be written in this (perhaps overly) ambitious way.

At this stage in the SSM it is useful to look forward to the modelling or design phase and ask: what would be the measures of performance by which the operation of the system would be judged? Thinking of what these criteria would be really sharpens up the thinking about the purposeful activity being designed. Three criteria are relevant in every case and should always be named. These are:

- Criteria to tell whether the transformation (T) is working, in the sense of producing its intended outcome; i.e. criteria for efficacy.

- Criteria to tell whether the transformation is being achieved with optimal use of resources; i.e. criteria for efficiency.

- Criteria to tell whether this transformation is helping to achieve some higher level or long-term aim; i.e. criteria for effectiveness.

These three criteria will always be relevant in developing any design, but in particular circumstances other criteria might also apply, such as elegance or ethicality.

The third stage in the Design process is the design concept – the way the force will create the desired conditions – military theory and shared mental models come into play. Thus, this is a graphic and narrative design communicating the logic of how the intervention will occur and change behaviour in the system. Design teams must have the latitude to portray the design concept in a manner that best communicates its vision and logic. The design concept organizes and sequences goals and actions of intervention in time, space and priority.

In SSM this phase is known as model building and is described as putting together the activities needed to describe the transforming process; in other words, linking the activities needed to achieve the transforming process. Given the guidelines provided by PQR, CATWOE and the three Es (Effectiveness, Efficiency and Efficacy), this task is not that difficult. The main skills required are logical thinking and imagination. The most common error at this stage is to take your eyes off the conceptually-based root definition and start modelling some real world version of the purposeful activity being modelled. In a purely generic form an SSM model looks like this:

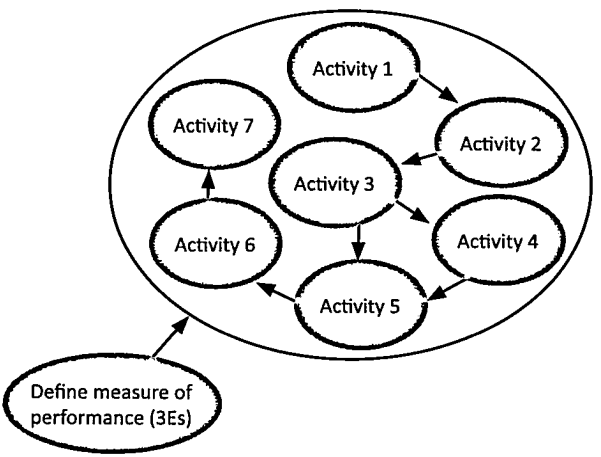

FIGURE 6. Generic SSM Model

Note that all activities are connected by arrows which specify the relationships between activities and actors. If one were modelling a particular counter-insurgency operation, examples of activities that would be depicted include the development of a strategic information operations (IO) concept and how it would operate from the political to the tactical level. Another activity would be the creation of a control concept that would accommodate all of the major actors, including indigenous forces. Certainly, a key activity would be the disruption of all enemy operations through both

kinetic and non-kinetic means. These, amongst others required, are not remarkable in themselves but it is the ongoing discourse in this phase that reveals assumptions, nuances and hidden relationships among the activities, that produces learning and systemic awareness.

Finally, when building a model in SSM, there is one more guideline worth noting. It is important to aim to capture the activities in the operational part of the model in the magic number seven plus or minus two (but break the rule if necessary). This famous phrase comes from a celebrated paper in cognitive psychology. George Miller, based on laboratory work, suggests that the human brain may have the capacity to cope with around seven concepts simultaneously.[74] Whether or not this is strictly true, it is certainly the case that a set of seven (plus or minus two) activities can be tackled holistically. If the number seems low this is not a problem. Any single activity in the overall model can, in itself become the source of a RD and then be modelled into seven plus or minus two activities.[75]

It is in the dialogue/discourse that takes place among the designers of the model, always including the commander, that real learning takes place in the modelling phase. Various activities are discussed and selected and their importance and interrelationships are teased out.

Once the model (or design) has reached a level of maturity where a reasoned decision can be made, the commander directs that planning can commence. In fact, planning could begin at a somewhat earlier stage as long as the process remains responsive to change. Once a plan is in place and is being executed the design phase will begin again because, as every experienced commander realizes, a plan will never survive the first shot fired.

CONCLUDING REMARKS

Throughout its history Canada has been involved episodically in war and conflict. Political decisions have been made that have perennially placed the Canadian military under the strategic and operational control of other non-Canadian states and/or organizations. Canada has delivered outstanding tactical results without having to think very much about how these operations were conceived or organized. Reflecting this state of affairs, the Canadian-born Colin Gray actually coined the memorable term *strategic theoretical parasitism*[76] Like so much else, the end of the Cold War radically modified this paradigm. Throughout the 1990s and particularly the last nine years, for Canada and the Canadian Forces have had to begin thinking about grappling with strategy and the operational level of war and conflict as well as the tactical dimension.

CF doctrine has been slow to adjust to this change in our strategic culture. It still largely fails to reflect the fact that Canada now operates throughout the General System of War and Conflict. In these circumstances, officers and NCOs must understand it as a complex adaptive system amenable only to systems thinking, systems methodologies and some form of design-plan concept.

To create appropriate doctrine and put it into practice the professional development system must develop officers who understand complexity and systems theory beginning as early as possible. Certainly, at the Development Period (DP) 3 level (Intermediate), they should be required to study the subject intensely and begin developing the knowledge and skills necessary to execute the "OODA" Loop at both the operational and strategic levels of war and conflict. This development would then continue in the DP 4 level (Advanced) through both education and experiential appointments to senior command staffs. The required knowledge in

these areas must be seen as an integral part of the theory-based body of specialized knowledge at the core of the profession of arms. General and Flag officers are responsible, as stewards of the profession, to ensure that the system is in place to achieve this goal.

On the year-long DP 3 course, it is reasonable to propose that a short module of perhaps one or two weeks be developed to expose all officers to systems theory and complexity theory. This would include a two-day workshop on Soft Systems Methodology in its generic form and an exercise where it is applied in a military context. Subsequently, the design-plan concept would be applied, in various ways throughout the course. As discussed earlier in this monograph, this learning experience will also impact directly on issues of command and control and leadership treated elsewhere on the course. Building on this foundation DP 4 would aim to broaden and deepen these cognitive, modelling and planning skills at the strategic and politico-strategic levels.

Supplementing this universal approach in the formal CF professional development system, those officers with a particular affinity for systems thinking could attend available courses and workshops such as at the University of Lancaster in the UK or the New England Systems Institute in Boston, Massachussets in the US. Finally, Defence Research and Development Canada and the Canadian Forces Leadership Institute should significantly increase their collaboration in this area, developing and producing concepts and doctrine that are suitable in an applied sense to inform formal CF doctrine.

As the pool of officers with these new cognitive capacities grows, doctrine will be modified through their specific employment as doctrine writers at all levels. Similarly, the design-plan concept will be increasingly employed at senior headquarters. A corollary

benefit will be enhanced inter-operability with some of our major allies. Above all, however, will be the emergence of commanders equipped to deal with the kinds of unavoidable complexity that permeate the General System of War and Conflict. No "wicked" problem can ever be "solved" in any final way but the use of systems thinking is the only route that enables decisions to be made and adequate action to improve to be taken.

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Dr. Bentley has a B.A. in Political Science from RMCC, a Master's degree in International Relations from the University of Western Ontario, a Master's degree in History from the University of Kansas and a Doctorate from the University of Western Ontario.

NOTES

1 Yaneer Bar-Yam, "Complexity of Military Conflict: Multi-scale Complex Systems Analysis of Littoral Warfare. New England Complex Systems Institute, 2003, 1. <http://nesci.org/projects/yaneer/ssg_NESCI_3_Ltt.pdf>.

2 There are exceptions to this trend as some military decision-makers make instinctive use of systems thinking. Yet as this monograph will demonstrate, Canadian Forces doctrine and its professional development system do not adequately enforce the use of systems thinking to deal with complex issues.

3 Maurice Cranston, *The Romantic Movement* (Oxford: Blackwell, 1994), 59.

4 Allan Bullock (ed), *The New Fontana Dictionary of Modern Thought* (London: Harper Collins, 1999), 767.

5 For a complete discussion of these issues see Robert Richards, *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002) and Richard Holmes, *The Age of Wonder: How the Romantic Generation Discovered the Beauty and Terror of Science* (NY: Pantheon Books, 2008).

6 For excellent discussion of this debate see Steven J. Gould's *The Hedgehog, the Fox and the Magister's Pox* (2003) and E.O. Wilson's *Consilience* (1998).

7 W.B. Gallie, *Understanding War* (London: Routledge, 1991), 43.

8 On this point see Alan Beyerchen, "Clausewitz and the Non-Linear Nature of War: Systems of Organized Complexity," in Hew Strachen and Andreas Herberg-Rothe (eds) *Clausewitz in the Twenty-First Century* (Oxford: Oxford University Press, 2007).

9 Colin Powell, *My American Journey* (NY: Ballantine, 1995), 207.

10 Rupert Smith, *The Utility of Force* (London: Allan Lane, 2005).

11 Alan Beyerchen, "Clausewitz, Non-Linearity and the Unpredictability of War." *International Security*, Vol. 17, No. 3 (Winter 1992), 82.

12 Quoted in Philip Lawrence, *Modernity and War: The Creed of Absolute Violence*. (Basingstoke: Mac Millan, 1997), 22.

13 Barry Watts, "Clausewitzian Friction and Future War," McNair Paper 18, Institute for National Security Studies (National Defense University, Washington, D.C., 2004), 78.

14 Mark Taylor, *The Moment of Complexity: Emerging Network Culture*. (Chicago: Chicago University Press, 2001).

15 Romanticism: An overwhelming international tendency which swept across Europe and Russia at the end of the 18th and beginning of the 19th centuries in reaction against earlier neo-classicism, mechanism and rationalism. More than simply a return to nature, the realm of imagination or feeling, it was a synthesizing temper that transformed the entire character of thought, sensibility and art. Allan Bullock (ed.) *The New Fontana Dictionary of Modern Thought* (London: Harper Collins, 1999), 767.

16 W. B. Gallie, *Philosophers of Peace and War: Kant, Clausewitz, Marx, Engels and Tolstoy* (Cambridge: Cambridge University Press, 1978), 56.

17 Antoine Bousquet, *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity*. (NY: Columbia University Press, 2009), 85.

18 Dr. Bill Bentley, *"...like a beam of light from the past": Clausewitz and On War* (CFLI Technical Note, 2008-01, April, 2008) see also Robert Richards, *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe* (Chicago: University of Chicago Press, 2002) and Alison Stone, *Petrified Intelligence: Nature in Hegel's Philosophy* (NY: SUNY, 2005).

19 John Lynn, *Battle: A History of Combat and Culture From Ancient Greece to Modern America* (Boulder: Westview Press, 2003), 182.

20 Carl von Clausewitz, *On War*, translated by Michael Howard and Peter Paret, 87.

21 In other words, "a world like this," attributed to James Clark Maxwell, stating that positivist science was impossible to recreate in real world conditions. "It is a metaphysical doctrine that from the same antecedents follow the same consequents. No one can gainsay this. But it is not of much use in a world like this, in which the same antecedents never again concur, and nothing ever happens twice." Peter Harman, *The Natural Philosophy of James Clerk Maxwell* (Cambridge: Cambridge University Press, 2001), 206.

22 Mitchell Waldrop, *Complexity: The Emerging Science at the Edge of Order and Chaos* (London: Viking, 1992), 145.

23 *On War,* 135.

24 Ibid., 169.

25 Ibid., 595.

26 Ibid., 67.

27 Ibid., 75.

28 Ibid., 607.

29 John Holland, *Hidden Order: How Adaptation Builds Complexity* (Reading, MA.: Addison-Wesley Publishing, 1995), 145.

30 Jeffery Goldstein, "Emergence as a Construct: History and Issues," *Emergence, Complexity and Organization*, Vol. 1, No. 1 (1999)

31 Murray Gell-Mann, *The Quark and the Jaguar* (London: Little Brown, 1994) 55. The relationship between such "schema" and the models produced through Soft Systems Methodology is described in Section Five.

32 Jamshid Gharajedaghi, *Systems Thinking: Managing Chaos and Complexity* (London: Elsevier, 2009), 12.

33 The arbitrary bounding of a complex system is an important element of systems thinking. On one hand, it should not be overly simplistic and should reflect the system's sometimes infinite complexity. On the other hand, human comprehension requires a level of detail that does not overwhelm the user. In this sense, the user's grasp of a complex system depends on a balance between being understandable and complex.

34 See Russell Ackoff, *Redesigning the Future* (NY: John Wiley, 1974) for a complete discussion of the relationships among complex adaptive systems, systems thinking and design.

35 Barry Richmond, *An Introduction to Systems Thinking* (ithink software) High Performance Systems Inc., 2001 and Russell Ackoff, *The Art of Problem Solving* (NY: John Wiley, 1978).

36 See Peter Checkland, *Systems Thinking Systems Practice* (London: John Wiley, 1999) for an excellent account of the systems movement and a complete history of SSM.

37 Huba Wass de Czega, "Refining the Art of Command for the 21st Century." <http://www.operationaldesign.com/RESTRICTED/coursebook/coursebook.html>, accessed 02 April 2009, 1-2.

38 For a complete explanation of this metaphor of strategy as a bridge see Colin S. Gray, *The Strategy Bridge: Theory for Practice* (Oxford: Oxford University Press, 2010). See also Bill Bentley, *Military Strategy: A Primer* (Kingston: Canadian Defence Academy Press, 2011).

39 *Leadership in the Canadian Forces: Leading the Institution* (Kingston: Canadian Defence Academy, 2007), 41.

40 Colin S. Gray, *Fighting Talk: Forty Maxims on War, Peace and Strategy* (London: Praeger, 2007), 48.

41 See Richard Maltz, "The Epistemology of Strategy. Paper presented at the XX Annual Strategy Conference, US Army War College, Carlisle, Pennsylvania – 17 April, 2009 for a discussion of strategy as cognitive theory.

42 Shimon Naveh, "Discursive Command – Operators – Systemic Operational design: A New Framework for Strategic Epistemology." <http://home.no.net/tacops/taktikk/kadettarbeid/naveh.htm>.

43 *On War*, 582.

44 Huba Wass de Czega, 20.

45 See Ralph Stacey, *Managing the Unknowable* (San Francisco: Jossey-Bass, 1992) for a complete discussion of this concept.

46 David S. Alberts and Richard Hayes, *Power to the Edge* (Department of Defense, Command and Control Research Program, 2003), 206.

47 See Bill Bentley. "Canada's Way of War." In Robert W. Walker (ed.) *Institutional Leadership in the Canadian Forces: Contemporary Issues* (Kingston: Canadian Defence Academy Press, 2007) for a description of how this concept applies to Canada.

48 David Alberts and Richard Hayes, *Planning: Complex Endeavours* (Department of Defense, Command and Control Research Program, 2007), 16.

49 Gary Klein, *Sources of Power: How People Make Decisions* (Boston: MIT Press, 1999), 127-130.

50 Canadian Forces Joint Publication 5.0 (CFJP 5.0), The Canadian Forces Operational Planning Process, April 2008, 3-10.

51 A recent NATO Allied Command Transformation (ACT) experiment recommended changing the name of the "Orientation" stage in the alliance's OPP to "Mission Analysis and Operation Design" to place greater emphasis on design. A concerted, iterative design process is in effect

the goal of this technical report. See Analysis Report for the Operations Planning Process Experiment 2009, Headquarters Supreme Allied Commander Transformation (30 April 2009), 32.

52 Leading to the inaccurate but, popular term, "the machinery of war."

53 Gharajedaghi, 23.

54 Henry Mintzberg, *The Rise and Fall of Strategic Planning* (NY: The Free Press, 1994), 114.

55 Gharajedaghi, 16.

56 Wass de Czega, 9.

57 TRADOC Pamphlet 525-5-500 Commander's Appreciation and Campaign Design, 28 Jan 08, 13.

58 Adapted from the construct in Stephan Banach. "The Art of Design: A Design Methodology." *Military Review* (March-April 2009), 105-115.

59 Chuck Spinney, "Asleep at the Switch in Versailles, or, Why did Slavo Cave." *Defense and National Interest*, Sept. 6, 1999, 23. See also Frans Osinga, *Science, Strategy and War: The Strategic Theory of John Boyd*, (Abington, UK: Routledge, 2007) for a thorough discussion of Boyd's thought and the extent to which he was influenced by contemporary scientific developments in the fields of quantum mechanics and complexity theory.

60 Colin S. Gray, *Modern Strategy* (Oxford: Oxford University Press, 1999) 91. For an account of John Boyd's professional life and his influence in the US defence and military establishment see Grant T. Hammond, *The Mind of War: John Boyd and American Security* (Smithsonian Institution Press, Washington, D.C., 2001).

61 Antoine Bousquet, *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity* (NY: Columbia University Press, 2009), 186-190.

62 John Boyd, "The Essence of Winning and Losing" Unpublished Briefing, January, 1996.

63 Warren Weaver, "Science and Complexity," *American Scientist*, Vol. 36 (1948), 540.

64 Gharajedaghi, 50.

65 Ian King, *Social Science and Complexity: The Scientific Foundations* (Huntington, NY: Nova Science Publications, 2000) 54.

66 John Schmitt, "A Systemic Approach to Operational Design" Marine Corps Warfighting Lab <http://www.au.af.mil/au/awcgate/usmc/mcwl_schmidt_op_design.pdf>.

67 See Tim Challans, "Emerging Doctrine and the Ethics of Warfare" Joint Services Conference on Professional Ethics (JSCOPE) <http://www.usafa.edu/isme/JSCOPE06/Challans06.html#_edn7> for a comparaison of the two approaches. See also CANFORGEN 005/09 CFD 002 091621Z January 09 "CF Joint Doctrine Use of Effects Thinking in OP Planning," for CF policy regarding the removal of Effects Based Operations from US doctrine.

68 Shimon Naveh, "Questions of Operational Art", (Powerpoint presentation given at the School of Advanced Military Study, Fort Leavenworth on 17 January 2006), 9. Cited in Ketti Davison, "Systemic Operational Design (SOD):Gaining and Maintaining the Cognitive Initiative," School of Advanced Military Studies (AY 05/06), 31.

69 A useful analogy is used at the School of Advanced Military Studies: "Systemic Operational Design may be explained using an urban planning metaphor. The strategic sponsor is like the city government. The city government decides to initiate a project to achieve a specified aim. It informs the urban developer, the combatant commander, who enlists the aid an architect, or designer, to develop the concept. The discourse between the urban developer and the architect ensures that the design meets the specified aim. The design is then given to

the engineer, or planner. The planner transforms the abstract concept of design into the physical logic of a plan. The planner then gives this plan to the tacticians to execute." Ketti Davison, "Systemic Operational Design (SOD):Gaining and Maintaining the Cognitive Initiative," School of Advanced Military Studies (AY 05/06), 31.

70 Design has been referenced in Army doctrinal manuals such as Field Manual (FM) 3-24 *Counterinsurgency* (Chapter Four, Designing Counterinsurgency Campaigns), FM 3-07 *Stability Operations* (Chapter Four), and in its draft form, FM (Interim) 5-2 *Design*.

71 Phenomenology is the study of the nature of the phenomenon of meaning. Interpretive sociology is a school of sociology pioneered by Max Weber. Weber believed that man is a social animal suspended in webs of significance he himself has spun. Culture is these webs and the analysis of it, therefore is not an experimental science in search of law but an interpretive one in search of meaning.

72 Peter Checkland, *Learning for Action* (Chichester: John Wiley, 2006), 2.

73 Colonel Stephan Banach, "Educating by Design" *Military Review*, (Mar-Apr 2009), 102.

74 Checkland, *Learning for Action*, 46.

75 This relates to an earlier footnote explaining the balance between demonstrating complexity and relating information in a manner that can be grasped by the user. Therefore there is no right or wrong model, only one that has been arbitrarily chosen to have the appropriate level of detail.

76 Cited in David S. McDonough, *Canada's National Security in the Post-9/11 World Toronto* (Toronto: University of Toronto Press, 2012), 5.

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