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# LEARNING TO UNDERSTAND CONFLICT AS A COMPLEX ADAPTIVE SYSTEM IN THE CONTEMPORARY OPERATING ENVIRONMENT: AN EXAMINATION OF THE JCSP 38 AND THE PROFESSIONAL MILITARY EDUCATION OF THE CANADIAN FORCE'S FUTURE SENIOR LEADERS

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## JCSP 38

## Master of Defence Studies

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## PCEMI 38

## Maîtrise en études de la défense

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CANADIAN FORCES COLLEGE - COLLÈGE DES FORCES CANADIENNES

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MASTER'S IN DEFENCE SCIENCE ESSAY

# Learning to Understand Conflict as a Complex Adaptive System in the Contemporary Operating Environment: An Examination of the JCSP 38 and the Professional Military Education of the Canadian Force's Future Senior Leaders

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# CONTENTS

**LIST OF FIGURES**

**LIST OF TABLES**

**ABSTRACT**

Conflict today is being viewed as a complex adaptive system (CAS). This perspective of conflict within the context of the contemporary operating environment (COE) transcends traditional linear views of conflict nested within the Newtonian paradigm thus demanding an intellectual shift in how conflict is perceived. From a Canadian Forces' (CF) perspective this necessitates a Professional Military Education (PME) for its officer corps that develops cognitive competencies which permits them to understand conflict as a CAS. Systems thinking represents one such cognitive competency that is central to this understanding.

The Joint Command and Staff Programme (JCSP) is a major component of the PME, during which the CF's future senior officers receive their third Developmental Period (DP 3). An examination of JCSP 38 reveals that the PME that CF officers receive during this programme provides them with inadequate opportunities to develop the cognitive competencies that they require to apply systems thinking to deal with conflict as a CAS. This situation is evidenced by the linear approach taken in delivering formal learning activities on systems thinking methodologies, the lack of focus with respect to the practical application of systems thinking methods during learning activities and exercises, and a general lack of a common understanding of systems thinking methodologies. Addressing these deficiencies demands a better articulation of thinking methods in relation to process, increased emphasis on educating CF officers on systems thinking, and more experimentation to validate new methodologies within exiting processes to generate a wider interest in the CF in these alternative methods of thinking.

> *In recent years it has become widely recognised in the military that war is a complex encounter between complex systems in complex environments. Complex systems are formed of multiple interacting elements whose collective actions are difficult to infer from those of the individual parts, predictability is severely limited, and response to external forces does not scale linearly with the applied force. It is reasonable to postulate that warfare can better be executed by those who understand complex adaptive systems than those who focus on simple, linear, transparent classically logical Newtonian constructs.*[1]
>
> *Yaneer Bar-Yam*

## INTRODUCTION

Today conflict is being viewed as a complex adaptive system (CAS); a phenomenon characterized by interactive behaviour and unpredictability. Recognizing conflict in the context of a CAS permits it to be viewed as a system whose perceived complexity is a function of the number of entities it comprises, the relationships between those entities, and the rate at which they change.[2] This notion of conflict has become more prevalent as evidenced by the search by academics and military professionals for a new way to conceptualize, examine and contend with the threats and missions within the Contemporary Operating Environment (COE) within which military operations, up to and including warfare, is conducted.[3] Consequently, it has served to

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[1] Yaneer Bar –Yam, "Complexity of Military Conflict: Multi-Scale Complex Systems Analysis of Littoral Warfare" (New England Complex Systems Institute, 2003): 1; http://www.necsi.edu/projects/yaneer/ ssg _ necsi _3 _litt.pdf; Internet; accessed 1 February 2012.

[2] Jim Storr, "Short Orders," *British Army Review*, no. 145(Autumn 2008): 52-53.

[3] The writings of the following preeminent military professionals and academics share this perspective: Colin S. Gray, "*The 21st Century Security Environment and the Future of War*," *Parameters* (Winter 2008); Colonel Bernd Horn, "Complexity Squared: Operating in The Future Battlespace," *Canadian Military Journal* 4, no.3 (July 2008); Lieutenant-General Andrew Leslie et al., "Developing a Comprehensive Approach to Canadian Forces Operations," *Canadian Military Journal* 9, no. 1 (August 2008); and Paddy Ashdown, *Swords and Ploughshares: Building Peace in the 21st Century*, (London: Weiderfield and Nicolson, 2007). For the purpose of this paper the term "conflict" is inclusive of all the operations that fall along the spectrum of conflict in accordance with the Canadian Forces Joint Forces Publication, Canadian Forces Operations (CFJP 01). This includes all military operations and activities from peace support operations to major combat operations.

challenge the view of conflict as seen through the lens of classical analytic, linear and reductionist methods of thinking.[4]

The military historian Colonel Bernd Horn asserts that in order to be effective in the COE, "military professionals must be adaptive and agile in both thought and action, as well as adept at critical thinking and sound reasoning – all the benefits of education."[5] It is perspectives such as Horn's which have generated calls for military professionals to develop cognitive skills which transcend linear, reductionist constructs rooted in Newtonian tradition.[6]

The notion of conflict as a CAS and the implication that this conceptualization has for cognitive skills has been gaining acceptance as an important consideration within the military profession.[7] This requires an intellectual shift in the mindset of how conflict is perceived. From a Canadian Forces' (CF) perspective it necessitates a Professional Military Education (PME) for its officer corps that develops their cognitive competencies which, in turn, permits an understanding of conflict as a CAS.

There are three cognitive competencies identified within the CF Leadership Development Framework (LDF): creativity, systems thinking and behavioral flexibility. While all three can

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[4] John F. Schmitt, "A Systemic Concept for Operational Design," (2006): 16;www.mcwl.usmc.mil/schmitt_design_v1_0_with_bibliography.pdf; Internet; accessed 1 April 2012. Horst W.J. Rittel and Melvin M. Weber, "Dilemmas in a General Theory of Planning," *Policy Sciences*, no. 4 (Amsterdam: Elsevier Scientific Publishing Company, 1973), 156. Schmitt and Rittel et al. raise questions about the usefulness of applying linear and analytic thinking to complex problems of today.

[5] Bernd Horn, "A Rejection of the Need for Warrior Scholars?," *Canadian Military Journal* 11, no.2 (Spring 2011): 48.

[6] Josh Kerbel, "Thinking Straight: Cognitive Bias in the US Debate about China: Rethinking Thinking," https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/csi-studies /studies/ vol48no3/article03.html; Internet; accessed 11 December 2012. Kerbel explains that the Newtonian tradition is linked to the theory of relativity and quantum mechanics and is best associated with Sir Issac Newton's Laws of motion.

[7] Christopher R. Paparone, Ruth A. Anderson, and Reuben R. McDaniel Jr., "Where Military Professionalism Meets Complexity Science," *Armed Forces and Society* 34, no. 3 (April 2008): 433-449.

assist CF officers in understanding conflict as a CAS within the COE, it is systems thinking that specifically prepares officers for this reality. Unlike analytic and linear constructs nested in the Newtonian tradition, systems thinking is a methodology that provides a more holistic view of conflict in the COE. It is a method that endeavours to "rationalize complexity" by focusing on the complex interplay between entities within an environment that serve to make conflict a CAS.[8]

The Canadian Forces College's (CFC) mission is to "prepare senior military and civilian leaders to meet the complex security challenges of the future."[9] One of the programmes offered by CFC is the Joint Command and Staff Programme (JCSP). JCSP is described as a "10-month, programme for selected, recently promoted majors and lieutenant-commanders" where "students receive education which emphasizes the complex nature of the Combined, Joint, Interagency security challenges of today."[10] Moreover, this programme represents a major component of the PME that a CF Officer receives during Developmental Period 3 (DP 3).[11] The PME philosophy, according to Colonel Randall Wakelam, a former Director of Curriculum at CFC, is one that "acknowledges the need for an awareness of contemporary issues and doctrine, but has put equal emphasis on developing an individual's ability to deal with complexity and ambiguity [in the

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[8] Craig Dalton, "Systemic Operational Design: Epistemological Bumpf or the Way Ahead for Operational Design?" (Fort Leavenworth, Kansas: School of Advanced Military Studies United States Army Command and General Staff College, 2006), 26.

[9] Canadian Forces College, "Vision and Mission of the Canadian Forces College," http://www.cfc.forces.gc.ca/263-eng.html; Internet; accessed 16 December 2011.

[10] Canadian Forces College, "Professional Education Revitalization at the CFC ," http://barker/pmerevit_e.html; Internet; accessed 16 December 2011.

[11] Department of National Defence, *The Canadian Forces Professional Development System Document*, (Ottawa DND Canada, 2010), 34. According to DP 3 is an advanced developmental period within the CF Officer DP continuum that is focused on developing and preparing Majors/Lieutenant-Commanders and Lieutenant-Colonels/Commanders for higher rank and more complex appointments. This DP is explained in further detail in part 5.

COE]."[12] Through an examination of JSCP 38, this paper will show that the PME, which the CF's future senior leaders receive during their DP 3, does not provide them with adequate opportunities to develop the cognitive competency of system thinking that they require for understanding conflict as a CAS in the COE.

**OUTLINE**

Chapter 1 introduces two methods of thinking that can be used for problem solving: linear thinking and systems thinking. An examination of these two methods of thinking reveals competing views on how conflict is perceived.

Chapter 2 describes the nature of a CAS. It first describes the general characteristics that make a system both complex and adaptive, then using John Holland's theoretical construct; it explains two key properties of a CAS: aggregation and non-linearity.[13] Both the general characteristics and key properties permit an understanding of the implications associated with these properties, specifically, the interactive and unpredictable behavior which belies the nature of a CAS. It also allows for an appreciation of the complexity of the problems generated by a CAS which defy linear thinking aligned with Newtonian traditions.

Chapter 3 identifies the sources of conflict that generate complexity in the COE and briefly examines how these sources of conflict contribute to make the COE itself a CAS. This examination highlights the consequences that these sources of conflict have on the problems with

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[12] Randall Wakelam, "Dealing With Complexity and Ambiguity," *Strathrobyn Papers*, no. 4 (2010): 12; http://www.cfc.forces.gc.ca/237/280-eng.pdf; Internet; accessed 13 March 2012.

[13] John Holland, *Hidden Order: How Adaption Builds Complexity* (Reading, Massachusetts: Addison-Wesley Publishing Company, 1995), 10.

which we must contend, as well as the implications that this has on traditional ways of thinking about the COE and moreover, the conflict trends themselves that make it so complex.

Chapter 4 builds on Chapter 3 and discusses the concept of conflict as a CAS through an examination of three theoretical perspectives: Carl von Clausewitz's Paradoxical Trinity;[14] John Boyd's OODA Loop,[15] and Shimon Naveh's Essential Triad.[16] These theoretical perspectives show that conflict is a CAS and, in so doing, reveal the implications that this portrayal of conflict has on the way military professionals think about it. Specifically, they highlight the inherent limitations associated with viewing conflict through linear, analytic, and reductionist thinking that is aligned with the Newtonian paradigm, while implying the potential merits for a different method such as systems thinking.

Chapter 5 examines three concepts to show how systems thinking is a cognitive competency that is central to understanding conflict as a CAS. This includes an examination of the CF Competency Profile within the Leadership Development Framework (LDF),[17] Christopher Paparone's et al.,[18] eight essential leadership tasks and Stephen Zaccaro's[19] requisite

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[14] Carl von Clausewitz, *On War*, ed. and trans by Michel Howard and Peter Paret (Princeton: Princeton University Press, 1976).

[15] Frans Osinga, Science, Strategy and War: The Strategic Theory of John Boyd (London: Routledge, 2007).

[16] Shimon Naveh, *In Pursuit of Military Excellence: The Evolution of Operational Theory* (London: Frank Cass Publishers, 1997).

[17] Department of National Defence, *Canadian Forces Qualification Standard Officer Developmental Periods 1 to 5* (Kingston: Canadian Defence Academy: 2010), 1-3.

[18] Christopher R. Paparone, et el., *"Where Military Professionalism Meets Complexity Science*…," 440-446.

[19] Stephen J. Zaccaro, *Models and Theories of Executive Leadership: A Conceptual/Empirical Review and Integration*, (U.S. Army Research Institute for Behavioral and Social Sciences: October 1996), xvii-xxvi.

executive leadership characteristics. These three concepts are used to build a simple framework of cognitive competencies that sees systems thinking as key for understanding conflict as a CAS.

Using the simple framework developed in Chapter 5, Chapter 6 examines the curriculum of JCSP 38 in order to assess the degree to which the cognitive competency of systems thinking has been integrated into the PME that CF officers receive within DP 3. The analysis of JCSP 38 includes both formal and informal learning activities offered during the programme. The chapter concludes with recommendations on a way ahead with respect to the PME that CF officers receive during DP 3 which can assist in developing their cognitive competencies associated with systems thinking.

## CHAPTER 1 – METHODS OF THINKING

In order to examine the cognitive competencies required to understand conflict as a CAS, it is first appropriate to explain the basic methods that can be utilized for thinking about problems. Thinking generally refers to a human intellectual exercise to seek a solution to a problem.[20] Two common methods of thinking include linear thinking and systems thinking. Linear thinking, which is central to the Newtonian paradigm, attempts to solve problems in a linear, analytic and reductionist manner. In contrast, systems thinking, originating from general systems theory (GST), looks at problems through a more holistic approach that emphasizes relationships between components of the problem. Linear and systems thinking not only offer unique methods for thinking about problems, but also represent competing views on conflict. This chapter briefly examines how each of these methods can assist in understanding problems

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[20] Tim Jepson, "What is Thinking," http://www.ourcivilisation.com/smartboard/ shop/ jepsonrw/chap2.htm; Internet; accessed 3 April 2012. Another useful definition of thinking is "any intellectual activity involving an individual subjective consciousness."

and, by extension, how they can influence our perceptions of conflict. This in turn aids in understanding the applicability of these methods of thinking about conflict as a CAS.

**Linear Thinking and the Newtonian Paradigm**

The Newtonian paradigm is rooted in the theory of relativity and quantum mechanics and is directly linked to Sir Issac Newton's laws of motion compiled over 300 years ago.[21] Newton's laws of motion are three physical laws describing the relationship between the forces acting on a body and its motion due to those forces.[22] According to these laws of motions, the natural world functions in a rational and predictable manner that can be described using mathematical and geometric solutions.[23] The Newtonian paradigm views the universe as "thoroughly deterministic" and one which can be understood through analytical, linear and reductionist thinking.[24] In other words, natural life can be arranged into a linear construct.

Steven Rinaldi, a physicist and US Air Force officer, states that "linearity is the cornerstone of the Newtonian paradigm."[25] Under this paradigm Rinaldi asserts that there are three ramifications for military thinking, specifically as it regards understanding conflict:

> Firstly, [conflict] is deterministically predictable, as effects are in principle calculable from their underlying causes.

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[21] Issac Newton, *The Mathematical Principles of Natural Philosophy*, 3rd ed., Trans. Andrew Motte (London: Middle Temple Gate: 1719):19-21; http://books.google.ca/books?id=Tm0FAAAAQAAJ&pg=PA19&redir_esc = y#v=onepage&q&f=false; Internet; accessed; 3 April 2012. The three laws of motion were first compiled by Sir Isaac Newton in his work *Philosophic Naturalis Principia Mathematica*, first published in 1687.

[22] *Ibid*., 20-25.

[23] Antoine Bousquet, *The Scientific Way of Warfare: Order Chaos on the Battlefields of Modernity* (New York: Columbia University Press, 2009), 45.

[24] *Ibid*., 46.

[25] Steven M. Rinaldi, "Complexity Theory and Air Power: A New Paradigm for Airpower in the 21 Century," *Complexity, Global Politics and National Security*, ed. David S. Alberts and Thomas Czerwinski, 119-137 (Washington: National Defense University, 1997), 120.

> Reductionism is a second consequence of the Newtonian paradigm. Reductionism is a methodology for solving problems. Basically, the problem is broken into its constituent pieces, and each piece is solved separately, and then added back together to obtain the overall solution to the problem.
>
> A third consequence of the Newtonian paradigm is the view of systems as closed entities, isolated from their environments. Outside events do not influence such a system; the only dynamics are those arising from its internal workings. The analyst thus has an inward focus.[26]

The Newtonian paradigm thus provides a simple and idealized framework for viewing conflict.[27] This follows suit with military consultant and writer John Schmitt's assertion that "Newtonian [conflict] is linear: a direct and proportional connection can be established between each cause and effect."[28] Furthermore, because conflict is considered to be isolated from the outside, it induces a more analytical and methodical approach for analyzing problems. That is, the problems encountered in conflict can be resolved by breaking them up into individual parts and solving them separately and their solutions added up.[29] Hence, it appears to be a method of simplification that imposes certainty and limits on conflict.[30] Thus, conflict is an entity where the whole is equal to the sum of its parts.[31]

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[26] *Ibid*., 120.

[27] *Ibid*., 120.

[28] John F. Schmitt, "Command and (Out of) Control: The Military Implications of Complexity Theory," Complexity, *Global Politics and National Security*, ed. David S. Alberts and Thomas Czerwinski, 106-118 (Washington: National Defense University, 1997), 107.

[29] Bousquet, *The Scientific Way of Warfare*…, 46.

[30] Martin Van Creveld, *The Transformation of War* (New York: The Free Press, 1991), 7.

[31] Alan Beyerchen, "Clausewitz Nonlinearity, and the Unpredictability of War," *International Security* 17, no. 3 (Winter 1992-1993): 62; http://www.jstor.org; Internet; accessed 23 March 12.

**Systems Thinking**

Systems thinking is a method (i.e. a way of viewing a problem) for making sense of how things influence one another as part of a whole. In comparison to linear thinking, systems thinking is a relatively new concept. The term originates from Bertalanffy's General System Theory (GST) which first appeared in his book titled "General System Theory: Foundations, Development, Applications" in 1968. GST postulates that "the world is a system of subsystems all interconnected and interdependent to form a wholistic or holistic system; that within any system is an infrastructure that is analogous across systems, irrespective of physical appearance."[32] GST is thus a science of "wholeness" which emphasizes interconnectedness and interdependencies within a system.[33] It is the emphasis on a holistic approach focused on interconnectedness and interdependencies that GST places on the study of systems which is central to systems thinking.

Peter Senge, a renowned scholar in system thinking, states that the essence of system thinking is "seeing inter-relationships rather than linear cause-and-effect chains, and in seeing processes of change…."[34] West Churchman, who is considered one of the founding fathers of "systems approach"[35] provides similar commentary in the form of the following question:

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[32] Lynn M. Stuter, Systems Theory (September 1998); http://www.learn-usa.com/transformation_process/roa004.htm; Internet; accessed 23 February 12.

[33] Ludwig von Bertalanffy, *General Systems Theory: Foundations, Development Applications* (New York: George Braziller Inc., 1969), 37.

[34] Peter M. Senge, *The Fifth Discipline: The Art of Practice of The Learning Organization* (New York: Doubleday-Currency, 1990), 73.

[35] The terms systems thinking and systems approach are often used interchangeably. Both refer to a methodology for viewing problems in a holistic manner. For the purpose of this paper the term systems thinking will be used exclusively when referring to methods and or models of this nature.

> How can we design improvement in large systems without understanding the whole system, and if the answer is that we cannot, how is it possible to understand the whole system?[36]

The central concept of systems thinking, according to Peter Checkland, a Professor Emeritus of Systems in Lancaster University Management School, is the importance of making sense of the interactions and relationships between components that generate the emergent properties of the whole.[37] Lieutenant-Colonel (Retired) Dr. Bill Bentley, an associate professor at RMC, reinforces these views defining systems thinking as "the practice of thinking that takes a holistic view of complex events or phenomenon seemingly caused by a myriad of isolated, independent and usually unpredictable factors or forces."[38] In summary, systems thinking is a holistic approach that attempts to make sense of complexity and or complex problems by focusing on the interactions of its components.[39] The emphasis on interactions assists in aggregating those factors which influence a problem and, in doing so, it assists in "framing" those aspects of the problem which can be resolved.[40] This is an acknowledgement that some problems, especially those of a complex nature, cannot be remedied with a specific solution. In essence, system thinking acknowledges that some complex problems cannot be understood in

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[36] West C. Churchman, *Challenge to Reason*, (New York: McGraw-Hill, 1968), 1, quoted in Werner Ulrich, Reminiscences, Retrospectives, and Reflections, *Journal of Organisational Transformation and Social Change* 1, no. 2-3, 199-219 (2004): 199; http://wulrich.com/downloads/ulrich_2004d.pdf; accessed 3 February 2012. Ulrich refers to Westman as the "grand old man" of the systems approach in his tribute to Westman on his death.

[37] Peter Checkland, *Systems Thinking, Systems Practice* (John Wiley and Sons, Ltd: New York, 1999), 3.

[38] Bill Bentley and Scott M. Davy, "Military Decision Making and Soft Systems Methodology," *Decision-Making: International Perspectives* (Canadian Defence Academy Press; 2009), 25.

[39] The concept of complex problems will be examined in detail in the Chapter 2.

[40] United States, Department of Defense, Army Field Manual 5.0 – The Operations Process (Washington, DC: U.S. Government Printing Office, 2010). The term "framing" is used extensively with the Design methodology which has been developed by the US Army for campaign planning. Design incorporates aspects of systems thinking to assist in defining and or bounding complex problems to develop approaches for the resolution.

their entirety, at best; only aspects of these problems can be understood and framed for resolution.

The manner in which systems thinking views complex problems also has implications on how conflict is perceived. Through the lens of systems thinking conflict is viewed as a complex dynamic process that is under constant flux.[41] Schmitt elaborates on this perspective suggesting that:

> [Conflict] is clearly a hierarchy of complex systems nested one inside another. From the largest military formation down to the individual rifleman, war consists of agents adapting to their environments—which include enemy agents—and in the process changing the environments of all the other agents.[42]

In this sense, conflict is as much about relationships between agencies and systems in the operating environment as it is their individual actions. Moreover, it is not just about military actions themselves, but how they affect other agents or actors. However, the complexity of the relationships between agents engaged in conflict, coupled with the overall complexity of the environment proper, is such that a complete understanding of conflict "will never occur".[43] The problems encountered during conflict do not always fit into a neat and tidy solution box that permits them to be solved through simple deconstruction and reassembly. Instead they must be viewed, as much as possible, through a holistic understanding of relationships between all pertinent factors and agencies to the conflict. This assists in identifying those problems that can

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[41] Schmitt, *"Command and (Out of) Control: The Military Implications*…, 103.

[42] *Ibid*., 106.

[43] Dan McCauley, "Design Thinking and the Development of Real Options for Decision-Makers," *Small War Journals* (November 2011): 8; http://smallwarsjournal.com/sites/default/files/896-mccauley.pdf; Internet; accessed 3 February 2012.

actually be bound and resolved. Conflict is thus accepted as a phenomenon where its whole is not equal to the sum of its parts.[44]

**Summary**

The two methods of thinking discussed in this chapter represent different ways of viewing problems and, by extension, conflict. Linear thinking is central to the Newtonian paradigm. Within this paradigm the universe, and by inclusion, conflict, is linear and deterministically predictable. That is, the whole is equal to the sum of the parts. To this end, conflict can be analyzed using linear and reductionist methods of thinking. Conversely, systems thinking, which is born from GST, adopts a more holistic approach to problems where components of a problem are best understood in context to each other and their environment. Accordingly, conflict is a complex and dynamic system which cannot be completely understood, but can only be made sense of because the relationships between the components of the problem are such that one cannot fully understand the entire problem. As such, they are required to be framed in order to make sense of. To this end, it attempts to frame those aspects of the problem that can be resolved.

Systems thinking and linear thinking are different ways for examining and solving problems. Both methods of thinking have their strengths and weaknesses, however, the differences between these two methods are such that they provide divergent views of a problem, which could conceivably result in generating different solutions to the same problem. These differences become more readily apparent when viewed in the context of complex adaptive systems.

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[44] Thomas J. Czerwinski, *Coping with the Bounds: Speculations in Military Affairs* (Washington: CCRP, 1998), 14.

## CHAPTER 2 – THE NATURE OF COMPLEX ADAPTIVE SYSTEMS

The concept of a Complex Adaptive System (CAS) is at the core of complexity theory, which is a meta-discipline whose subject matter can be applied within virtually any other discipline such as biology, economics, sociology, or physics.[45] Indeed, CAS embraces all facets of life, from organisms, ecosystems and economies to social organizations from individuals to nations.[46] Regardless of the discipline within which a CAS is found, they all reflect certain characteristics. The vast majority of literature on CAS draws from the writings of American scientist, John Holland, who is considered a pioneer in the field of complexity and non-linear science.[47] Holland offers seven "basic" characteristics common to all CAS. These seven basics include four properties and three mechanisms.[48] The four properties include: Aggregation, Non-Linearity, Flows and Diversity while the three mechanisms consist of tagging, internal models, and building blocks.[49] Although all are important, this paper will concentrate on two key properties: Aggregation and Nonlinearity.[50] These two properties figure prominently within

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[45] Peter Checkland, *Soft Systems Methodology: A 30-Year Retrospective* (New York: John Wiley & Sons Ltd.,1999), 23.

[46] Bousquet, *The Scientific Way of Warfare*…, 175.

[47] Santa Fe Institute, "History of the Santa Fe Institute," http://www.santafe.edu/about/history/; Internet; accessed 23 April 2012. The Santa Fe Institute, which was founded in 1984, endeavoured to develop theoretical frameworks to what they referred as dynamic nonlinear systems. Holland, who was one of the intellects drawn to the research of complexity being done at Santa Fe, is recognized by the Institute as a "pioneer in genetic algorithms and adaptive computation," in relation to this field of study. There a number of theorists whose writings recognize Holland's pre-eminence. M. Mitchell Waldrop, *Complexity: The Emerging Science at the Edge of Order and Chaos* (New York, N.Y.: Simon and Schuster, 1992), 145. Waldrop, who is an acclaimed science writer, makes reference to "complex adaptive agents", which he cites as a term coined by Holland.

[48] For the purpose of this paper a property is a characteristic of a CAS, while a mechanism can be seen as the way in which the CAS works.

[49] Holland, *Hidden Order: How Adaption Builds Complexity* …, 10- 37. Holland provides lucid explanations on the seven basics that are all common to CAS.

much of the literature on complexity.[51] For the purpose and scope of this paper, an understanding of these properties is sufficient for gaining a basic understanding of a CAS.

**What Makes a System Complex and Adaptive?**

Before delving into the two properties of a CAS it is important to understand the basic characteristics which make a system both complex and adaptive. Alex Ryan, a complex systems scientist, offers a typical definition of a system "as a set of [agents] with relations between them."[52] The agents of a system could be any assortment of things, such as a microorganism, a person, a community, or a nation.[53] Agents will arrange themselves through establishing relationships with one another based on something in common. This commonality could be anything from their colour to their behaviour. Thus, a system is a group of agents that form a collective relationships based on their common features. A sub-system(s) can be formed through the grouping of agents in a system through more detailed relationships.

A system is considered to be complex when it is comprised of many interrelated agents where changes in some of the agents, or their relations, affect change in other agents in the

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[50] Some theorists refer to emergence vice aggregation as one of the four properties of a CAS. However, for the purpose of this paper aggregation will be used.

[51] Alan Beyerchen, "Clausewitz Nonlinearity, and the Unpredictability of War," *International Security* 17, no. 3 (Winter 1992-1993): 59-90. James N. Rosenau, "Many Damn Things Simultaneously: Complexity Theory and World Affairs" Complexity, Global Politics, and National Security, ed. David S. Alberts and Thomas J. Czerwinski 32-43 (Washington, DC: National Defense University, 1997); John F. Schmitt, *Command and (Out of) Control*... All of these authors allude to the properties of CAS as conceived by John Holland's writings.

[52] Alex Ryan, "A Multidisciplinary Approach to Complex Design," (Doctoral thesis, University of Adelaide, 2007), 48.

[53] Robert Alexrod and Michael D. Cohen, *Harnessing Complexity, Organizational Implications of a Scientific Frontier* (The Free Press: New York, 1999), 4. For the purpose of this paper the term "agent" will be used throughout. Axelrod and Cohen state that an "agent is an animate object that can reflect a number of properties, such as "location—where the agent operates; capabilities—how the agent can affect the world; and memory—what impressions the agent can carry forward from its past".

system and the entire system displays features that are different from those of its agents.[54] Thus, it is the interrelationships of the agents that make the system complex.[55] As well, most complex systems are organized in hierarchical levels (i.e. sub-systems), with each level nested on the one below it.[56] This architectural feature is illustrated by a *matryoshka* doll, also known as a Russian nesting doll, which is a set of dolls of decreasing size that can be placed one inside the other.[57]

A complex system is considered adaptive when each agent in the system demonstrates a capacity to adapt to its environment.[58] Basically, the environment includes all agents with which an agent or group(s) of agents (i.e. systems and sub-systems) can interact. In a CAS an agent can acquire information about its environment as well as its own interactions with the environment.[59] With this information, the agent identifies patterns in the environment that permit the creation of a "schema" that governs the actions of the agent with other agents.[60] Once more, the interactions between agents are undertaken without any central control.[61] Because there is no single entity in

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[54] Robert Jervis, "Complex Systems: The Role of Interactions," *Complexity, Global Politics, and National Security*, ed. David S. Alberts and Thomas J. Czerwinski 20-21 (Washington, DC: National Defense University, 1997), 20.

[55] *Ibid*., 22.

[56] Herbert A. Simon, "Near Decomposability and Complexity: How a Mind Resides in a Brain," *The Mind, The Brain, and Complex Adaptive Systems*, *Santa Fe Institute Studies in the Sciences of Complexity* 22, ed. Harold Morowitz and Jerome L. Singer (Addison-Wesley Publishing Company, 1995), 25.

[57] Wikipedia, "Matryoshka Doll,"http://en.wikipedia.org/wiki/Matryoshka_doll; Internet; accessed 23 March 2012.

[58] Holland, *Hidden Order*…, 7-8.

[59] Murray Gell-Mann, *The Quark and the Jaguar: Adventures in the Simple and the Complex* (London: Little Brown and Company, 1994), 17.

[60] *Ibid*., 17. Robert Alexrod and Michael D. Cohen, *Harnessing Complexity, Organizational Implications of a Scientific Frontier* (The Free Press: New York, 1999), 4. Gell-Mann indicates that the term "schema" is taken from psychology, and "refers to a pattern used by the mind to grasp an aspect of reality." Once more, the boundaries of a complex adaptive system are based on a population of agents who can employ the schema used by another. Alexrod et al. refer to an agent's response as a strategy. For the purpose consistency this paper, Gell-Mann's term "schema" will be used throughout.

charge, agents have a high degree of autonomy and freedom of action. As a result, there are endless possibilities for the variability in agent characteristics and behaviour and consequently an inability to accurately predict their outcome.[62] Thus, for a system to be complex and adaptive it must be a comprised of interconnected autonomous agents that are constantly interacting with other agents and adapting to the environment.[63]

**The Properties of a Complex Adaptive System (CAS)**

Aggregation

As agents adapt to the environment their interactions create properties of the system which the individual agents themselves do not possess. This phenomenon reflects the central property of a CAS known as aggregation.[64] According to Holland aggregation can be explained through two aspects: how the agents are aggregated within a CAS and what CAS do when they aggregate.[65]

The first aspect concerns how agents are aggregated. This is known as self-organization which is the grouping of agents of similarity in a system just as one might categorize military equipment such as armored fighting vehicles, rotary wing helicopters or naval frigates.[66] The aggregation of agents is a way of simplifying complexity and that serves as a basic building

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[61] Holland, *Hidden Order*…, 39.

[62] Robert R. Maxfield, "Complexity and Organization Management," *Complexity, Global Politics, and National Security*, ed. David S. Alberts and Thomas J. Czerwinski 78-98 (Washington, DC: National Defense University, 1997), 80.

[63] Melanie Mitchell, *Complexity: A Guided Tour* (New York: Oxford Press University, 2009), 13.

[64] Harold Morowitz, *The Emergence of Everything* (New York: Oxford University Press, 2002), 23.

[65] Holland, *Hidden Order*…,10.

[66] *Ibid*., 10.

block used to form the hierarchical organization typical of a CAS. Although the reference to hierarchical organization infers an element of reductionism it is not a fixed, rigid structure, due to the adaptive and interactive nature of the agents. As agents adapt and interactive so too can their hierarchical standing in the CAS.[67]

Holland points out that the formation of an aggregate can also act as an agent at a higher level. This higher level agent is known as a meta-agent.[68] Like agents, these meta-agents can aggregate to form an emergent aggregate, which, in turn, can be used to form meta-meta agents. This is similar to the way sub-systems and sub-sub-systems are formed within a system. For example, an infantry soldier is a CAS comprised of an aggregation of agents. The infantry soldier, along with nine other soldiers, can act as meta-agents to form an infantry section. This infantry section, in turn, can act as (meta-meta agents) to form part of a platoon (a higher level emergent aggregate), which is itself comprised of three sections. Once more, the platoon can be used to form an infantry company, and so on. This nesting of organizations typifies the hierarchical organization within a CAS much like the Russian nesting doll analogy described above. Each emergent aggregate (i.e. section, platoon, company, etc…) that is formed is nested inside the next higher level. One might presume that if all the agents are performing the same function within a hierarchical organization, like soldiers within a platoon; that this situation would result in a linear system; however this is not the case. It must also be mentioned that agents can be organized through relationships much the same way opposing political parties can form a coalition government based on a common political objective of defeating a minority ruling government.

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[67] This aspect of aggregation is discussed in detail below.

[68] *Ibid*., 10.

The action of self-organizing agents within a CAS speaks to the second aspect of aggregation – what CAS do when they aggregate.[69] As mentioned above, agents that are sufficiently related combine to pattern themselves as part of an orderly whole. This patterned behaviour is an adaptive response that not only creates an orderly whole, but causes the agents themselves to acquire new attributes. This can be seen as a reflexive response by a CAS as its searches for "stability in the instability that characterizes the periods of [aggregation]."[70] What results, Holland states, is "the emergence of complex large-scale behaviours from aggregate interactions of less complex agents."[71] Similarly, Yaneer Bar-Yam, President of the New England Complex Systems Institute, explains this occurrence as an "emergent complexity" which is premised on the idea that the "behaviors of many simple parts interact in such a way that the behavior of the whole is complex."[72] Essentially, these interactions have a synergistic effect on the CAS where the whole is greater than the sum of its parts. This phenomenon can be seen in the theory of manoeuvre warfare. This theory seeks to shatter an adversary's cohesion and will to fight, usually by avoiding his strengths and targeting his vulnerabilities.[73] Given this focus, it is possible to achieve results that are disproportionate to the energy expended and the resources invested into the effort. Therefore, a series of manoeuvres and actions against an adversary's fighting system at one level can generate cumulative effects that erode his capability at another level. This interaction, as subtle as it may seem at times, makes predicting the

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[69] Rosenau, *Many Damn Things*…, 37.

[70] Emilian Kavalski, "The Fifth Debate and the Emergence of Complex International Relations Theory: Notes on the Application of Complexity Theory to the Study of International Life," *Cambridge Review of International Affairs* 20, no. 3 (September 2007): 439.

[71] Holland, *Hidden Order*…, 11.

[72] Bar-Yam, *Complexity of Military Conflict*…, 1.

[73] Department of National Defence, B-GL-300-001/FP-001, *Land Operations* (Ottawa: DND Canada, 2008), 5-66.

outcomes of conflict all the more difficult and vexing. However, this is at the heart of systems thinking, which attempts to predict through the examination of relationships within and between systems.

The example above highlights one of the perplexing features in a CAS. That is, self-organization in a CAS (i.e. the interactions of agents that generate new large-scale behaviour of a CAS) does not necessarily result in a complete transformation of the system itself. Instead they create subtle behavioural changes that evolve over time while the system retains certain properties from its original start state. While the essential system structures remain intact its emergent properties begin to "accumulate and mature" from within. The CF Transformation (2005-2008) illustrates this aspect of aggregation. At the core of the force-wide transformation was the restructuring of the CF operational command and control (C2) architecture which saw the organization and stand-up of four operational commands to generate efficiencies and meet the operational realities of the post-Cold War environment.[74] Indeed, the fundamental changes to the CF operational C2 structure that occurred during this period changed how the CF does business, in terms of its internal structures and processes, but the CF has not been metamorphosed into a completely new organization. In this case, the CF transformation was much like the self-organization of a CAS. Although the hierarchical organizations may have changed to permit evolution and adaptation, on the surface the CF appeared unchanged.

Aggregation is a truly unique and elusive property of a CAS. The manner in which a CAS self-organizes, specifically the continuous interactions between agents, defies detailed prediction of CAS behaviour. Consequently, complete knowledge of the agents themselves is

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[74] Michael Jeffery, *Inside Canadian Forces Transformation: Institutional Leadership as a Catalyst for Change* (Kingston, Ontario, Canadian Defence Academy Press, 2009), 29-31.

not sufficient to infer details of the system's aggregate properties.[75] To paraphrase von Bertalanffy, this aspect of aggregation represents the "constitutive characteristics" of a CAS which depend on the specific relations within the system; thus, an understanding of these characteristics requires not only knowing the parts, but the whole system.[76] It appears then that only aspects of a CAS can be bound and solved. This perhaps requires that assumptions be made about the behaviour of a CAS, which, even then, may still only provide partial truths.

Michael Mauboussin, a Chief Investment Strategist at Legg Mason Capital Management of New York, remarks that aggregation "disguises cause and effect in that we don't really know what is going on."[77] Harold Morowitz, who has written extensively on the thermodynamics of living systems, reflects on the impact that aggregation has on understanding CAS:

> The reductionist approach leads us continually to seek solutions at lower and lower hierarchical levels. To move conceptually in the other direction, we must apply pruning algorithms and seek for emergent properties or entities that become the agents for advancing another hierarchical level.[78]

The challenge with aggregation is that it makes it impossible to generate a detailed prediction of CAS behaviour through linear, reductionist analysis. This unpredictability is a hallmark attribute of CAS. In essence, simplifying a CAS by breaking it into individual agents does not permit the prediction of its behaviour. Rather, "simplification" of a CAS is achieved through an aggregation of its agents. This aggregation does not necessarily permit the prediction of cause and effect; it merely it assists in bounding aspects of the CAS.

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[75] Jervis, *"Complex Systems: The Role of Interactions* …, 23.

[76] von Bertalanffy, *General Systems Theory*…,55.

[77] Michael J. Mauboussin, "Embracing Complexity," *Harvard Business Review*, September 2011, 89.

[78] Harold Morowitz, *The Emergence of Everything* (New York: Oxford University Press, 2002), 14.

Non-Linearity

The property of non-linearity maintains that the overall inputs and outputs of a system are not proportional.[79] Because agents of a CAS are interrelated, the action of an individual agent in generating a schema can impact on the behaviour of other agents that are likewise engaged in developing their own schema in an effort to either sustain their daily routines, or to modify their behaviour to adapt to changes in the environment. A schema results from an agent's interaction(s) with other agents in a system. The schema influences an agent's behaviour and the manner with which it interacts with other agents in the environment. An agent's behaviour creates a chain reaction, in that it impacts the schema of another agent, and so on. Thus a small and seemingly inconsequential input can generate a disproportionately large output, while an inordinately large input may result in only a small output. Therefore, the interactions between the agents make the CAS sensitive to inputs and may result in disproportionate outputs.

This reflects the characteristic of a positive feedback loop which reacts to disturbances in a system by amplifying them, thus pushing the system away from its original starting point.[80] It works in similar fashion to the savings in a bank account (A) when compound interest (B) is added to the balance (Figure 1). The compound interest imported into the account causes growth in monetary value from the original deposit.

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[79] Holland, *Hidden Order*…, 122.

[80] Bousquet, *The Scientific Way of Warfare*…,165.

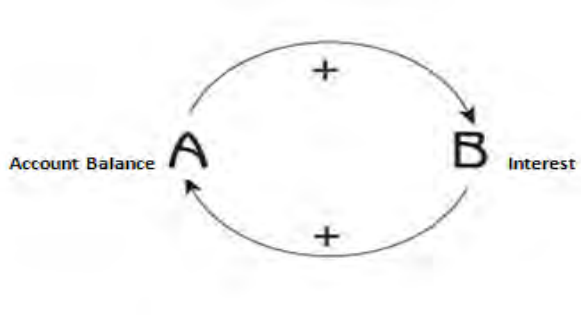


**Figure 1: Example of a Positive Feedback Loop**
Source: Gerald G. Marten, *Human Ecology: Basic Concepts for Sustainable Development,* http://www.gerrymarten.com/human-ecology/tableofcontents.html; Internet; accessed 23 February 2012.

The sensitivity to initial inputs and conditions assists in understanding the unpredictability of CAS. This feature is commonly referred to as the "Butterfly Effect" that originated from the work of Edward Lorenz, a meteorologist and mathematician, while attempting to predict weather patterns using numerical computer models.[81] Lorenz discovered the butterfly effect when he entered the wrong numerical value into his model. Despite the minute difference in value entered the final output was significant, so that it produced a completely different weather scenario. Thus, the butterfly effect relates to a sensitivity to initial conditions; where a seemingly inconsequential change at one place in a nonlinear system can result in disproportionately large outcome at a later stage.[82] The formation of a hurricane in Florida is contingent on whether or not a butterfly flaps it wings in Nova Scotia weeks earlier is a common theoretical example which suggests these initial sensitivities. A more pertinent example relates to the term "strategic corporal" coined by General Charles C. Krulak, a former

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[81] James Gleick, *Chaos: Making a New Science* (Boston: Penguin, 1988), 9-30.

[82] Peter Dizikes,"When the Butterfly Effect Took Flight," *Technology Review* (March-April 2011), http://www.technologyreview.com/article/32322/; Internet; accessed 23 April 2012.

commandant of the United States Marine Corps.[83] Krulack explains that the decisions made by a corporal in an operation can, in a very short time frame, "have far-reaching strategic effects capable of jeopardizing the mission."[84] This example shows how "microscopic state differences can lead to macroscopic state changes over relatively short time scales."[85] It is this sensitivity to initial conditions that hampers the ability to observe and forecast CAS behaviour with any degree of precision.

Within a CAS the interactive nature of agents and their relationships with each other make it impossible to understand the system through reductionist methods.[86] This is the emergent quality of non-linearity. Rosenau relates this "to the power of small events" where the "slightest change can give rise to very different outcomes."[87] For this reason Thomas Czerwinski, a professor in the School of Information Warfare and Strategy, National Defense University, maintains that "the whole is neither quantitatively equal to the sum of the parts, nor is it qualitatively recognizable to its constituent agents."[88]

The interactions and relationships between agents within a CAS make it impracticable to extrapolate and predict a CAS with any great accuracy. This, in turn, prevents the replication of the exact results of an input or an output, while inhibiting the ability to observe and link causes

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[83] Alex Ryan and Anne-Marie Grisogono, "Hybrid Complex Adaptive Engineered Systems: A Case Study in Defence," *Defence Science and Technology Organisation*, 2; www.necsi.edu/events/iccs/openconf/ author/papers/ f173. doc; Internet; accessed 13 February 2012.

[84] *Ibid*., 2.

[85] *Ibid*., 2.

[86] Jervis, *Complex Systems: The Role of Interactions*…, 2.

[87] Rosenau, *Many Damn Things*…, 2.

[88] Czerwinski, *Coping with the Bounds: Speculations in Military Affairs*…,1.

and effects. Given these features of non-linearity, the application of neat mathematical equations to predict CAS behaviour becomes difficult if not impossible to do and ultimately misleading.

Thus simple and linear mathematical models cannot always be used as reliable guides when examining CAS. In affirmation of this statement, James Clark Maxwell, a renowned scientist of the nineteenth century, asserted that we "must rely on statistical probabilities or approximate solutions."[89] It seems then that scientific approaches based on analytical, linear and reductionist thinking may founder when confronted with the phenomena like a CAS and its interactive and unpredictable behaviour.

**Complex Problems**

So why it is that simple and linear models are so constrained in predicting CAS behaviour? One of the principal reasons stems from the nature of the problems that are generated by the interactive and unpredictable behaviour of a CAS. Many of these problems are described as complex problems. A complex problem is one for which an attempt to create a solution alters the understanding of the problem.[90] Essentially, the nature of a complex problem is such that it cannot be resolved by a specific solution.

The theoretical underpinnings of complex problems can be traced to a treatise written by urban designers, Horst W.J. Rittel and Melvin M. Webber, who examined the inherent difficulties of confronting problems of governmental planning, specifically, social policy. Their thesis was premised on the argument that the nature of planning problems, also known as

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[89] Robert H. Kargon, *The Life of James Clerk Maxwell [1882]* (New York: Johnson Reprint Corporation, 1969): 440-442, quoted in Alan Beyerchen, *"Clausewitz, Nonlinearity and War…*," 64.

[90] Rittel et al., *"Dilemmas in a General Theory of Planning* …, 160.

"wicked" problems, was such that they could not be "definitively described."[91] As a result, conventional scientific bases, like those aligned with the Newtonian paradigm, developed to deal with what Rittel et al. describe as "tame" problems are bound to fail. Rittel et al. describe these problems as those found within the field of natural sciences which are "definable and separable and may have solutions that are findable."[92] As an aside, there is no universally accepted term among complexity theorists used to identify complex problems.[93] For the purpose of this paper and for the sake of consistency, the term complex will be used to denote "wicked" problems while complicated problems will refer to those which can be solved by breaking them down and reassembling them.

Alan Okros, Deputy Director of Academics at CFC, provides a useful explanation to distinguish between complicated problems and complex problems: A complicated problem is one which has many variables whereas a complex problem is one with many unknowns.[94] Much of the available data exists as symptoms of the problem.[95] Likewise, military theorist and retired U.S. Military General Huba Wass de Czege, contends that "complicated systems are composed of numerous parts and structures, all logically separable from their environment," while "complex systems are made up of dynamic, interactive, and adaptive elements that cannot be

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[91] *Ibid*., 155-169.

[92] *Ibid*., 160.

[93] Schmitt, "A Systemic Concept…, 8-9. Schmitt, refers to wicked problems as complex operational problems. Dan McCauley, "Design Thinking and the Development of "Real" Options for Decision-Makers," *Small Wars Journal* (2001), 11; http://smallwarsjournal.com/jrnl/art/design-thinking-and-the-development-of-%E2%80%9Creal%E2%80%9D-options-for-decision-makers; Internet; accessed 23 April 2012. McCauley describes wicked problems as ill-structured and or chaotic.

[94] Alan Okros, "Leadership in Canadian Military Context," *Monograph Series – Leadership* (Canadian Forces Leadership Institute, Canadian Defence Academy, 2010), 9.

[95] K.J. Radford, *Complex Decision Problems: An Integrated Strategy for Resolution* (Reston, Virginia: Reston Publishing Company, Inc., 1977), 4.

separated from interaction with their environments."[96] Although Wass de Czege refers to systems, this quote infers that the nature of complex problems resemble those of complex systems.

An example of a complicated problem could be something as simple as solving a mathematical problem using a formulae. Here, the mission is clear: to solve the problem using the given formulae. What is also clear is whether or not the problem can be solved. Complex problems, in contrast, lack the clarity and definition that permit the formulation of clear solutions as well as a definitive understanding if the problem can be solved. An example of a complex problem can involve a political issue such as a government's decision to deploy forces to protect its vital economic and/or security interests. In this case, the nature of the security problem may arise from one of many interdependent sources such as competition for natural resources, or ethnic or religious tensions, which no single solution can address.

The challenge of dealing with complex problems is increased by the social complexity in the environment of the problem. The greater the number of persons involved in solving the problem the more diverse their intellectual and social background, the more likely they are to see the problem in divergent ways. Basically the problem solver becomes part of the problem.[97] Peter Senge's dictum that "today's problems come from yesterday's 'solutions'" substantiates this view.[98] In this view, a complex problem cannot be solved through traditional linear analysis,

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[96] Huba Was de Czege, "Systemic Operational Design: Learning and Adapting in Complex Missions," *Military Review*, (January –February 2009), 3.

[97] Interview with Alan Okros and Maj Taylor, 03 1030 hrs Mar 2012.

[98] Senge, *The Fifth Discipline*…, 57.

because the "problem definition evolves" as new potential solutions are implemented and as new agents are introduced into the system as a consequence of attempts to solve the problem.[99]

The interactive and unpredictable behaviour generated by the CAS properties of aggregation and non-linearity means that the agents within a CAS are constantly adapting to the environment. Because the agents of a CAS are constantly adapting, it stands to reason then, that so too are the problems produced by a CAS. To this end, the class of problems are reflective of complex problems which cannot be solved, but only "resolved over and over again."[100] At best, only aspects of the problem can be bound and understood. It is thus fitting, as Jeff Conklin points out, that Rittel et al. would start their paper speaking about the requirement for attacking problems of this nature in a "systemic way."[101]

**Summary**

A CAS is a system of interrelated individual agents that are capable of adapting to the environment and affected by each other to differing degrees. Two key properties that distinguish a CAS from a linear system are aggregation and non-linearity. Aggregation is a system's capacity to aggregate agents, or self-organise. However, the manner in which systems self-organize involves interactions that have a synergistic effect on the system where the whole becomes more than the sum of its parts. Non-linearity occurs when the overall inputs and outputs of a system are not proportional to each other, while the behaviour of the agents within the system makes it impossible to comprehend a system by summing its whole. These features

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[99] Rittel, et al., *"Dilemmas in a General Theory of Planning*…, 160

[100] *Ibid*., 160.

[101] Jeff Conklin, "Rethinking Wicked Problems: Unpacking Paradigms and Bridging Universes (Part 1 of 2)," *NextD Journal*, Next Design Leadership Institute (2007), 6; http://issuu.com/nextd/docs/conv28; Internet; accessed 3 March 2012.

inhibit the replication of results of an input or output as well as the ability to observe cause and effects. Taken together, the properties of aggregation and non-linearity stress the importance of understanding the interactive behaviour of a CAS. It is the interactive behaviour that creates the unpredictability of a CAS. The unpredictability that is reflective of CAS behaviour makes it difficult to provide a precise meaning and confounds our ability to understand CAS through analytical, linear and reductionist thinking. This understanding is made even more difficult by the complex problems that this behaviour produces. These types of problems can at best be bound through system methods.

The importance of understanding the concept of CAS cannot be overstated. Their properties of nonlinearity and aggregation generate interactive and unpredictable behaviour to which no human endeavour is immune. This includes the domain of conflict within the COE.

## CHAPTER 3 –THE CONTEMPORAY OPERATING ENVIRONMENT

> *Clearly the early 21st Century has been witness to the development of an international environment marked by considerable uncertainty, volatility and increasingly rapid change. Old familiar "rules of the road" have faded, new ones are beginning to emerge, and events are unfolding at a speed and pace often exceeding the ability of decision-makers to effectively react. Not surprisingly, many analysts now claim that today's world is more chaotic and unpredictable than at any other period in history.*[102]
>
> *Dr. Peter Gizewski*

These were Dr. Peter Gizewski's opening remarks in a paper prepared for the Annual Meeting of the Canadian Political Science Association, at Carleton University in Ottawa in 2009.

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[102] Peter Gizweski, Army 2040: The Global Security Environment: Emerging Trends and Potential Challenges," Prepared for the Annual Meeting of the Canadian Political Science Association, Carleton University Ottawa, Canada (27 May 2009), 1.

Gizewski, a Defence Scientist and Strategic Analyst with the Department of National Defence (DND), was attempting to survey the ongoing conflict trends and offer some insight into their implications on the COE.[103] Indeed, the evolution of the COE can be attributed to the emerging threats and sources of conflict which have come to the fore in the 21st Century. These sources of conflict have manifested themselves such that the COE reflects the interactive and unpredictable behaviour of CAS. This has made the CF take stock of how it conceptualizes the COE and the sources of conflict which contribute to its complexity. As Gizewski remarks the "rules of the road" are indeed changing as they regard the COE and so too is the way that we think about it.

This chapter shows how the sources of conflict contribute to complexity in the COE. Specifically, it shows how these sources of conflict, together, generate features that make the COE resemble a CAS. Such a characterization of the COE highlights some of the implications on the manner in which we think about conflict.

Much of the substantiation for this argument originates from literature attempting to describe the emerging sources of conflict which have gained prominence in the 21st Century. Robert Kaplan's, *The Coming Anarchy*,[104] and Samuel Huntington's, *The Clash of Civilizations*,[105] represent two of the most influential works which articulate emerging security threats since the end of the Cold War.[106] Together, Kaplan and Huntington point to a number of

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[103] *Ibid*., 1.

[104] Robert D. Kaplan, *The Coming Anarchy* (New York: Random House, 2000).

[105] Samuel P. Huntington, *The Clash of Civilizations and the Remaking of World Order* (New York: Simon and Schuster Inc, 1996).

[106] These books are but two examples which speak to the sources of conflict that shape the international security environment.

trends that characterize conflict within the COE, specifically; intra-state conflict, transnational crime, a resurgence of ethnic and religious strife, terrorism and globalization.[107]

Richard N. Hass, President of the Council of Foreign Relations, contends that these sources of conflict have introduced a large number of new actors that are able to exert their influence on both the regional and global stages.[108] He postulates that this trend has created a "nonpolar international system" where "power is now found in many hands and in many places."[109] This diffusion of power among more actors creates a global context that lacks predictable fixed structures and relationships.[110] This view aligns with Holland's view that conflict is set in the context of social, political or organizational systems, and features "a dynamic network of many agents acting in parallel, constantly acting and reacting to what other agents are doing."[111]

All of these sources of conflict described above indicate an increasingly interconnected, interdependent, and uncertain world. This global interconnectedness makes it difficult to predict problems with any great accuracy in the COE. Political strategists Charlie Edwards and Simon Parker elaborate with the following examples:

> Today cartoons shown in Danish newspapers create civil unrest on the streets of London, drugs from the poppy fields of Afghanistan lead to violence on Glasgow estates, and regional instability in the Middle East raises the price of petrol in the UK.[112]

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[107] *Ibid*.

[108] Richard N. Haass, "The Age of Nonpolarity," *Foreign Affairs* 87, no. 3 (May-June 2008), 50.

[109] *Ibid*., 45.

[110] *Ibid*., 56.

[111] Mitchell N. Waldrop, *Complexity: The Emerging Science at the Edge of Order and Chaos* (New York: Simon and Schuster, 1992), 145.

These lucid examples demonstrate how the interconnectedness between actors in the COE contributes to its unpredictable behaviour. Specifically, these examples speak to the COE's sensitivity to inputs and the non-proportional outputs that they can create, a reaction similar to that seen in a CAS. Emilian Kavlaski, an academic who has conducted extensive research on international relations, security studies and complexity theory, echoes this interpretation stating that these sources of conflict create "massive uncertainty" in international relations.[113] Within this uncertain context, Kavalski asserts that the pattern of international life can thus be defined as a CAS.[114] As such, proponents of this definition suggest that international life is a complex, interconnected system that is constantly self-organizing and adapting to new challenges.[115]

Another frame of reference within which conflict is viewed within the COE and that characterizes the properties of a CAS originates from Fourth Generation Warfare (4GW).[116] This novel theory recognizes the environment, the majority of which is inhabited by non-state actors, as one which reflects "extreme non-linearity and extreme dispersion."[117] According to Chris Smith, an officer of the Australian Defence Force, theorists of 4GW "stress the trend toward wars among the people in which multiple non-state actors with divergent aims… [engage] …in ambiguous wars of exhaustion," which creates a mix of "awkward conflicts and

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[112] Charlie Edwards and Simon Parker, Futures Thinking (and how to do it)," Demos (2006), 5; http://demos.co.uk/files/Demos_report_the_case_for_a_national_security_strategy.pdf; Internet; accessed 23 March 2012.

[113] Kavalski, "*The Fifth Debate*…, 435.

[114] *Ibid*., 444.

[115] *Ibid*., 444.

[116] Vincent J. Curtis, "The Theory of Fourth Generation Warfare," *Canadian Army Journal*, Vol. 8.4 (Winter 2005), 1.

[117] *Ibid*., 18.

messy humanitarian problems."[118] William S. Lind, an American expert in military affairs who was one of the first proponents of 4GW, explains its impact on the COE: "The distinction between war and peace will be blurred to the vanishing point. It will be nonlinear, possibly to the point of having no definable battlefields or fronts."[119] In this context the types of military operations along the spectrum of conflict appear blurred and indistinguishable. British Army General Rupert Smith's seminal work, The Utility of Force: The Art of War in the Modern World amplifies this paradigm:

> War no longer exists. Confrontation, conflict and combat only, in Iraq, Afghanistan, the Democratic Republic of the Congo and the Palestinian Territories—and states still have armed forces which they use as a symbol of power. Nonetheless, war as cognitively known to lost non-combatants, war as battle in a field between men and machinery, war as a massive deciding event in a dispute in international affairs: such war no longer exists.[120]

These assertions above suggest that the nature of the COE and the conflicts therein appear to be under a constant state of flux such that they reflect the emergent properties which, in turn, make the COE "a messy, untidy reality."[121] The "dynamics of the global environment" explains Sandra Martinez, a recognized expert in institutional and organizational change, "are influenced by interactions between agents:" to the extent that "novel higher-level systemic patterns and structures emerge whose properties and capacities cannot be predicted by

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[118] Christopher R. Smith, "Design and Planning of Campaigns and Operations in the Twenty-First Century," Study Paper no.320 (Canberra: Land Warfare Studies Centre, 2011), 37-38.

[119] William S. Lind *et al*., "The Changing Face of War: Into the Fourth Generation," *Marine Corps Gazette* (October 1989) 22-26.

[120] Rupert Smith, *The Utility of Force: The Art of War in the Modern World* (New York: Vintage Books, 2007), 3.

[121] Colin S. Gray, "The 2l" Century Security Environment and the Future of War," *Parameters* (Winter 2008-2009), 23.

knowledge of the individual components of a system."[122] As a consequence, these sources of conflict generate complexity and, by extension, complex problems which transcend conventional military wisdom and the traditional, linear ways of thinking to address them. Craig Dalton, a Colonel in the Canadian Army, explains this paradigm shift:

> While many, if not all, of these [sources of conflict] have been present in earlier epochs, what makes the COE unique is the fact that these [sources] directly influence the nature of the military problem and lend the COE a degree of complexity heretofore absent.[123]

This acknowledgment is also apparent in the *Canadian Army's Land Operations 2021: The Force Employment Concept for Canada's Army of Tomorrow*. This capstone document depicts conflict within the future security environment as a complex web of interactions that creates volatility and uncertainty.[124] The document also recognizes that "conflict engagement" in the COE will require that its members possess, among other critical skill sets, the intellectual competency, adaptability and resilience to cope with the complex problems they confront.[125]

Colonel Howard Coombs, an assistant professor at the Royal Military College, also acknowledges the difficulty in discerning the complex nature of the COE within which military leaders operate. Coombs contends that these circumstances will require "well-educated military leaders who use developed cognitive skills in an intellectually agile and practiced fashion to

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[122] Sandra M. Martinez, "Leadership for Complexity and Adaptability," in *Securing Freedom in the Global Commons*, ed. Scott Jasper, 159-173 (Stanford, California: Stanford University Press, 2010), 159.

[123] Dalton, *"Systemic Operational Design: Epistemological Bumpf or the Way Ahead for Operational Design?...* , 24.

[124] Department of National Defence, "Land Operations 2021: The Force Employment Concept for Canada's Army of Tomorrow," Directorate of Land Concepts and Design (Kingston, Ontario: Army Publishing Office, 2007), 4-7.

[125] *Ibid*., 7.

delineate the complex problems of the current security environment…"[126] In essence, the sources of conflict within the COE make it resemble the features of a CAS which, in turn, generates complex problems that defy analytic, linear, and reductionist thinking. This is in accordance with defence scientists, David Alberts and Richard Hayes, who assert "the assumptions underpinning analytical thinking fail when genuinely complex situation occurs as in a [CAS]."[127] In this context, it requires that CF leaders have a PME that helps them develop a repertoire of cognitive skill sets beyond linear thinking that enable them to cope within this environment.

**Summary**

The COE is a complex, nonlinear and adaptive phenomenon that exhibits the same properties as those of a CAS. These properties reflect the numerous sources of conflict that have introduced new actors into fold of the COE. This has not only increased the level of interplay between actors in the COE, but also the level of complexity within it. The nature of this interactive behaviour is unpredictable and generates complex problems that cannot be solved by traditional and linear methods of thinking.

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[126] Howard G. Coombs "The Evolution of Canadian Forces Staff Education, and Operating in a Post-Cold War World, Canadian Military Journal 11, no. 3 (Summer 2011): 54.

[127] David Alberts and Richard Hayes, Planning: Complex Endeavours (Department of Defense, CCRP, 2007) 16, quoted in Bill Bentley and Scott M. Davey, "The Paradoxical Trinity: War as a Complex Adaptive System and to Approach it Using Systems Thinking and Design," *Canadian Forces Leadership Technical Report* (2009), 30.

## CHAPTER 4 – THEORETICAL PERSEPCTIVES ON CONFLICT AS A COMPLEX ADAPTIVE SYSTEM

> *Conflict is so inconceivably complex that we cannot predict its course or its outcome in any useful way, nor in any sensible detail. Anybody who does not believe that statement has not read military history and has not understood Clausewitz.*[128]
>
> *John Storr (LCol Retired)*

There are innumerable insights and lessons which can be drawn from the study of military history. This retrospection also provides military theorists and thinkers the foundation on which to formulate their interpretation of the nature of conflict today and tomorrow. Notwithstanding the nuances between theoretical interpretations of conflict, there appears to be one immutable feature that belies the nature of this phenomenon - the persistence of complexity.

As a respected defence analyst, John Storr's quote asserts above, Clausewitz's treatise "On War" provides testament to this claim. Moreover, it is through a close examination of this major work that the perspective of conflict as a CAS can be drawn. Alan Beyerchen's statement that "On War" is "suffused with an understanding that every war is inherently a non-linear phenomenon" supports Storr's interpretation.[129] There are a number of other notable military strategists and academics whose writings also reflect this perspective. An examination of John Boyd's OODA Loop, and Simon Naveh's Essential Triad provide useful interpretations for supporting the conceptualization of conflict as a CAS. John Boyd's construct of the OODA Loop,[130] views conflict as a competition between competing decision cycles, while the essential

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[128] Storr, "*Short Orders*…, 53.

[129] Beyerchen, *"Clausewitz, Nonlinearity and War*…, 61.

triad, which was developed by modern military theorist Shimon Naveh, conceives conflict as a battle between opposing fighting systems, each of which is seeking to destroy their opponents systems.

Referencing the characteristics of a CAS, specifically the properties of aggregation and non-linearity described in Chapter 2, this chapter draws on the writings of Carl von Clausewitz, John Boyd and Simon Naveh for conceptualizing conflict as a CAS. In doing so, it shows three important themes. The first shows the importance that interactions play in understanding conflict as a CAS and the unpredictability that these interactions produce as part of this phenomenon. The second provides the theoretical underpinnings which support the assertions made in Chapter 3 concerning the sources of conflict and how they contribute to make the COE a CAS. Finally, it reveals how the interactive and unpredictable behaviour of conflict brings into question the Newtonian view of conflict and, with it, the utility of the linear, analytical and reductionist thinking to discern this behaviour.

**Clausewitz's Paradoxical Trinity**

After almost 200 years Clausewitz's treatise "On War" continues to inform military doctrine and theory. One dictum from this influential work which remains prominent is his insight into the complexity of conflict. From these insights inferences can be made regarding those properties that contribute to make conflict a CAS, mainly: non-linearity and aggregation. It is also from these insights that an appreciation can be developed on the inherent limits of applying analytical, linear and reductionist reasoning to conflict.

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[130] The OODA Loop stands for Observe-Orient-Decide-Detect and is a an interactive decision-making process that a combatant goes through when engaged in conflict. Bousquet, *"The Scientific Way of Warfare* …, 187-188.

Clausewitz's interpretation of conflict as a CAS is evident throughout his writings. Perhaps the most obvious is his declaration that war is comprised of three dominant tendencies: violence, hatred and enmity; uncertainty and chance and probability; and political purpose.[131] According to Clausewitz these "dominant tendencies always make war a paradoxical trinity," where violence, hatred and enmity are attributable to the military; uncertainty, chance and probability are associated with the people; and political purpose is related to the state.[132] Clausewitz contends that these three tendencies "are like different codes of law, deep-rooted in their subject and yet variable in their relationship to one another."[133] Given this relationship, he continues that "our task therefore is to develop a theory that maintains a balance between these three tendencies, like an object suspended between three magnets."[134] Despite the theoretical construct of the law of magnetism, Bentley contends that this analogy is appropriate because "in the real world an object suspended between three magnets will oscillate in unpredictable, non-linear ways, exhibiting some of the characteristics of a complex system."[135] This conception of conflict as a trinity comprised of three elements (i.e. the military, the people, and the state) is illustrated in Figure 2. Despite the trinity's orderly appearance, the non-liner interactions between the three elements within it translate into a complex and adaptive system.

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[131] von Clausewitz, *On War* … 89.

[132] *Ibid*., 89.

[133] *Ibid*., 89.

[134] *Ibid*., 89.

[135] Bentley, "The Paradoxical Trinity: War as a Complex Adaptive System and How to Approach it Using Systems Thinking and Design," Canadian Forces Leadership Institute (Kingston: Canadian Defence Academy, 2009), 10.

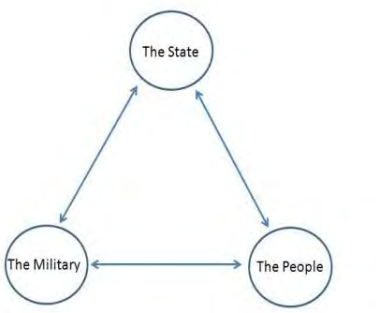


**Figure 2: Carl von Clausewitz's Paradoxical Trinity.**
Source: Author's Interpretation of Clausewitz's Paradoxical Trinity.

Dr. Antulio Echevarria, Director of Research for the U.S. Army War College, echoes a similar interpretation of Clausewitz's three elements suggesting that they form a "wondrous trinity" which "conveys the sense that the parts of conflict are distinct in their own right, yet at the same time each belongs to an indivisible whole."[136] Much like a CAS, conflict is a collection of unique interdependent agents that interact to form a whole.

Acceptance of the paradoxical trinity influences the manner in which conflict is viewed. To do this Clausewitz proposed:

> … to consider first the various elements of the subject, next its various parts or sections, and finally the whole in its internal structure. In other words, I shall proceed from the simple to the complex. But in war more than in any other subject we must begin by looking at the nature of the whole; for here more than elsewhere the part and the whole must always be thought of together.[137]

The importance placed on *the whole* infers the importance of understanding the relationships of the elements within a system. Echeverria too, states that *the whole* is intended to

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[136] Antulio J. Echevarria II, *Clausewitz and Contemporary War* (Oxford: Oxford University Press, 2007), 70.

[137] von Clausewitz, *On War*…, 75.

be viewed in terms of its relationships.[138] Continuing, Echeverria postulates that this view mirrors the modern definition of a "synthetic dialectic" which represents an analysis of "the ways in which a whole depends upon, because it interdepends with, its parts and how a new whole emerges from a synthesis of opposing parts."[139]

This emphasis on relationships and interdependence invokes an image of nonlinearity when viewed in the context of a CAS. Specifically, it implies that an understanding of warfare cannot be realized by simply breaking it into its individual parts, a characteristic which defies the property of additivity.[140] Clausewitz's assertion that "war should be conceived as an organic whole" reinforces this implication and suggests that an appreciation of conflict as a CAS demands that it be viewed holistically.[141]

A similar image of nonlinearity is provided by the unique political situation with which Clausewitz frames warfare:

> The same political object can elicit differing reactions from different peoples, and even from the same peoples at different times. We can therefore take the political object as a standard only if we think of the influence it can exert upon forces it is meant to move. The nature of those forces therefore calls for study. Depending on whether their characteristics increase or diminish the drive toward a particular action, the outcome will vary. Between two peoples and two states there can be such tensions, such as a mass of inflammable material, that the slightest quarrel can produce a wholly disproportionate effect—a real explosion.[142]

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[138] Echeverria, *Clausewitz and Contemporary War*…, 70.

[139] *Ibid*., 70.

[140] Tom Czerwinski, *Coping with the Bounds*…, 4. Additivity is a property of linear systems that implies that the whole is equal to the sum of its parts. Additivity is a reductionist tool that permits a complicated problem to be broken into its constituent parts. Once the problem has been fixed the system can be reassembled to its previous form.

[141] von Clausewitz, *On War*…, 607.

[142] *Ibid*., 81.

Beyerchen notes how this political framework can "elicit differing reactions" between entities that can create an explosive situation that generates unexpected variations in the outcomes in conflict.[143] This speaks to the characteristic of non-proportionality exhibited by a CAS where small inputs can result in a disproportional output from a system and vice versa.

The aspects of aggregation are exemplified through Clausewitz's metaphorical view of conflict as "nothing more than a duel on a larger scale" which as a whole can be "formed by imagining a pair of wrestlers."[144] According to Edward Smith, a senior analyst for network-centric warfare, this example suggests:

> complex adaptive opponents in which actions of each adversary continue to challenge and shape those of the other and which force that opponent to adapt and respond in ways that neither wrestler could fully envision before stepping into the ring.[145]

The duel between the wrestlers in an attempt to impose their will and establish their domination is reflective of the interactions between agents within a CAS as they endeavour to self-organise and establish some semblance of hierarchical order.

Beyerchen reinforces this interpretation citing Clausewitz's statement that warfare "is not the action of a living force upon a lifeless mass … but always a collision of two living forces." The focus on interactions suggests that warfare is not an endeavour involving inert objects. Rather, it is an exertion of energy and an entanglement of relationships between living entities similar to that which occurs in a CAS during the self-organization of agents.

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[143] Beyerchen, *"Clausewitz, Nonlinearity and War*…, 68.

[144] von Clausewitz, *On War*…, 75.

[145] Edward Smith, *Complexity, Networking, and Effects-Based Approaches to Operations*, (Washington: CCRP, 2003), 60.

Bousquet postulates that these interactions that occur during conflict lock "wills and forces" into a positive feedback loop that can create "run-away processes."[146] Clausewitz also saw feedback as a pervasive characteristic of conflict:

> [Military action] must expect positive reactions, and the process of interaction that results. Here we are not concerned with the problem of calculating such reactions […] but rather with the fact that the very nature of interaction is bound to make it unpredictable.[147]

This agrees with Schmitt's characterisation of conflict as a "complex, hierarchical system of feedback loops, some designed but many unintended and unrecognized."[148] Schmitt also maintains that "whether these interactions result in positive or negative feedback they are by definition nonlinear."[149] The fact that an action in warfare "produces not a single reaction, but dynamic interactions" exemplifies the non-linear and emergent properties of a CAS.[150]

The side effect resulting from these CAS properties is that they make observing causes and effects difficult and prediction impossible:

> 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.[151]

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[146] Bousquet, *The Scientific Way of Warfare*.., 196.

[147] von Clausewitz, *On War*…, 139, quoted in Beyerchen, *"Clausewitz, Nonlinearity and the Unpredictability of War*…, 73.

[148] Schmitt, *"Command and (out of) Control*…, 105.

[149] *Ibid*., 105.

[150] Beyerchen, *"Clausewitz, Nonlinearity and War*…,73.

[151] von Clausewitz, *On War*…, 595, quoted in Bousquet, *"The Scientific Way of Warfare*…, 197.

As this quote implies, Clausewitz acknowledged the disproportionate effects that small events could have in warfare. It also reveals his understanding that the nature of conflict as a CAS makes impossible the predicting of the trajectory and outcome of conflict through the employment of exact analytical solutions.

An aspect of warfare which contributes to this unpredictability stems from Clausewitz's concept of the "friction" of conflict. Beyerchen points out that Clausewitz's discussion on friction is firmly linked to the fact that conflict is a human endeavour. It is largely because of the human dimension that Clausewitz views war as a fundamentally nonlinear phenomenon.[152] Citing F.A. Hayek's Nobel lecture, Barry Watts, a senior fellow at the Center for Strategic and Budgetary Assessments, echoes these sentiments arguing that this "built-in feature of combat processes" does not permit the precise prediction of outcomes "with any certainty."[153] Instead, we are limited to "mere predictions of some of the general attributes" of war's emergent structures, but "not containing specific statements about the individual elements of which structures will be made up."[154] Thus, as long as conflict remains a human endeavour, friction and the inherent unpredictability that comes with it will persist as a permanent hallmark.

Clausewitz's treatise "On War" provides strong argument for classifying warfare as a CAS. This view is evidenced through his portrayal of conflict as a paradoxical trinity comprised of three forces; the people, the military and the state. These three forces form a system whose interactions make warfare both complex and adaptive. The emphasis on these interactions is reflected in the CAS properties of non-linearity and aggregation, and necessitates that warfare be

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[152] Beyerchen, *"Clausewitz, Nonlinearity and War* …68.

[153] Barry Watts, "Clausewitzian Friction and Future War, Revised ed., *McNair Paper* 68 (Washington DC: National Defense University), vi.

[154] *Ibid*., vi.

viewed and understood as a whole. It is these properties of a CAS which cause the continuous interactions and feedback within the system and influence its behaviour. The emergent properties of warfare are also linked to the human dimension. This pervasive feature of warfare creates friction which cannot be eliminated. Together, these CAS characteristics serve as undercurrents that make conflict a dynamic and unpredictable phenomenon. It also makes impossible the task of understanding conflict through analytic, linear and reductionist methods.

**John Boyd – OODA Loop**

John Boyd was a US fighter pilot during the Korean War, who was nicknamed "40 second Boyd" for his ability to defeat an opponent in less than 40 seconds.[155] Boyd became a preeminent military thinker who developed a cognitive theory focused on a combatant's decision-making process called the OODA loop.[156] The OODA loop stands for Observe-Orient-Decide-Act and it represents an iterative decision-making process that a combatant or combatant system goes through when engaged in conflict as depicted in Figure 3.[157] Each of the four phases of the loop, Observe-Orient-Decide-Act, are described in turn.

In the observation phase, the combatant takes in information from the environment, his/her situation in relation to it, and the actions of the adversary. During the orientation phase, the combatant interprets the information through an analysis to create meaning, identify existing opportunities and threats and to devolve responses that permit the initiation of action. During the decision phase, the combatant commits to a course of action that is undertaken during the

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[155] Bousquet, *"The Scientific Way of Warfare*…,187.

[156] *Ibid*., 188.

[157] *Ibid*., 188.

final phase. Upon completion of the action, the combatant returns back to the observe phase to determine the reaction of the environment that occurs as a consequence of his action(s). Once more, there are multiple feedback loops established between all phases in the cycle as new information is injected into the cycle and the combatant is required to adjust his analysis and behaviour/actions.[158]

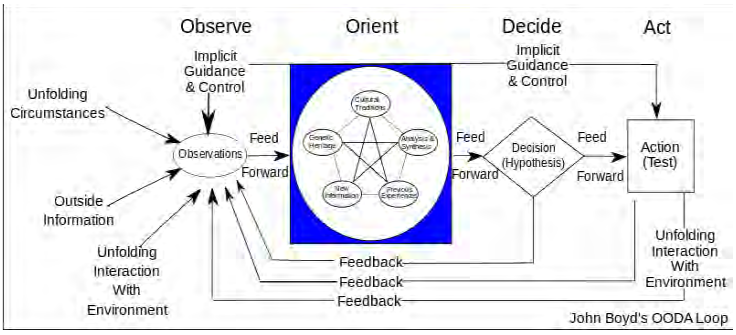


**Figure 3: John Boyd's OODA Loop.**
Source: Antoine Bousquet, The Scientific Way of Warfare (New York: Columbia University Press, 2009), 187.

This cycle is common during military operations, where a combatant's intent is to "get inside an opponent's OODA loop," to gain the advantage. He does this through the simultaneous destruction of the opponent's capacity to "sense, process, and act on information" while shielding his own ability to do so.[159] This allows the commander to seize the initiative and force his opponent into constantly reacting.[160] In doing so, an adversary's capacity to adapt with the changing environment is inhibited.

Rinaldi asserts that Boyd is among the first military theorists to directly state that his concepts represent complex adaptive systems.[161] In fact, he notes that the "OODA Loop Sketch

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[158] *Ibid*., 188-189.

[159] *Ibid*., 194.

[160] *Ibid*., 194.

and related insights represent an evolving, open-ended, far-from-equilibrium process of self-organization, [aggregation] and natural selection."[162] Chuck Spinney, a collaborator of Boyd's, elaborates on the OODA loop's connection between aggregation and non-linearity:

> … 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 emergent behaviour- in short, a complex adaptive system.[163]

Rinaldi notes that Boyd's model "has deep parallels to manners by which CAS process information and adapt to their environments."[164] Information processing is a key feature of complex systems, and enables their adaption to evolving environments. Recall Gell-Mann's theory of schemata described in Chapter 2: an agent acquires information about its environment and its own interactions within the environment to identify patterns in the information. The agent then rationalizes/reconciles that information into a schema or strategy that enables it to adapt to the environment.

The theme of adaptation is actually at the heart of Boyd's work. Frans Osinga, a Colonel in the Netherlands Air Force who wrote his doctoral thesis on the legacy of John Boyd, observes:

> Maintaining the ability to adapt while negating that to the opponent is the single all-embracing theme connecting the various parts of A Discourse. 'Adaptability is the power to adjust or change in order to cope with new and unforeseen circumstances', Boyd noted in

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[161] Rinaldi, *"Complexity Theory and Airpower*…, 130.

[162] John Boyd, "The Essence of Winning and Losing," unpublished notes (28 June 1995), 4, quoted in Rinaldi, *"Complexity Theory and Airpower*…, 130.

[163] Chuck Spinney, "Asleep at the Switch in Versailles, or Why did Slavo Cave," *Defense and National Interest* (September 1999), 23, quoted in Quoted in Bill Bentley, "Military Strategy, a Primer," *CANSOFCOM Professional Development Centre*. 17 Wing Winnipeg Publishing Office: Winnipeg, 2011, 29.

[164] Rinaldi, *"Complexity Theory and Airpower*…,130.

> Patterns, and 'in dealing with uncertainty it seems to be the right counterweight'.[165]

The processing and conversion of information by agents to develop strategies that permit them to adapt and evolve with their environment are necessary for creating the conditions of aggregation. Since war can be viewed as a struggle of opposing OODA loops the side that can adapt and generate the most "effective and evolutive" loop will prevail.[166] This requires creating conditions for aggregation through the adaption of agents.

However, creating the conditions of aggregation also produces dynamic effects which are non-linear in nature. Boyd's model is based on the presumption that the action(s) in one OODA loop causes an adversary to adapt and adjust their own OODA loop. The adversary's reaction creates an input into the environment that results in feedback by the opposition's OODA loop(s). The generation of feedback loops perpetuates itself and triggers the interactive behaviour between OODA loops. This speaks directly to the sensitivity of initial conditions that are a key feature of non-linearity and explains why the observed behavior within and between OODA loops can often seem so unpredictable. Therefore, warfare is more than a sequential turn of intended actions of opponents due to the dynamic actions and interactions which occur between them.[167] These interactions create an environment that is uncertain, ever-changing, and unpredictable, which, in turn, makes difficult its understanding using analytic, linear, and reductionist thinking.[168]

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[165] Osinga, *Science, Strategy and War*.., 273.

[166] Bousquet, *Scientific Way of Warfare*…, 194.

[167] Berychen, *"Clausewitz, Nonlinearity, and War*…, 73.

[168] Bousquet, *Scientific Way of Warfare*…,193.

Boyd's theory represents conflict as a CAS through competing OODA loops. Within this construct a combatant's OODA loop represents interacting processes of adaption, learning, and evolving that create conditions for emergent behaviour. The exchange between interacting processes of competing OODA loops changes the environment and results in feedback loops that are perpetuated by reactions between OODA loops. The feedback loops speak to a sensitivity to initial conditions within a CAS that stimulate non-linear behaviour that by its very nature is difficult to predict.

**Simon Naveh – The Essential Triad**

Simon Naveh is a retired Brigadier General in the Israeli Defence Force, and a modern military theorist, who blended general systems thinking with military theory to develop the operational art in modern warfare. Naveh proposed that all systems are comprised of an essential triad: the brain, its heart and its self-regulating agency as depicted in Figure 4. In the context of military operations the essential triad formed a fighting system that operated as follows: the heart represents the physical component that develops concrete objectives and detailed missions; the brain is the cognitive component and provides the coherent plan to achieve the concrete objectives; while the self-regulating agency of a fighting system provides it the capacity to overcome external disturbances and restore its equilibrium to permit it to achieve its final objectives.[169]

[169] Simon Naveh, *In pursuit of Military Excellence: The Evolution of Operational Theory*," (London: Frank Cass, 1997), 15.

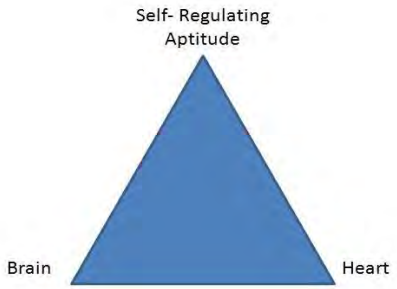


**Figure 4: Naveh's Essential Triad**
Source: Author's Interpretation.

Within this theoretical construct Naveh conceives conflict as a clash of two belligerent systems, each of whom is trying to defeat their opponent's system. This means that there are two consequences of this confrontation - a positive and negative. Faced with these consequences each military system's goal is to prevent their opposing system from attaining its goals, which constitutes a negative consequence of one's own aim.[170] Naveh contends that the ability of a system to separate the other system from its brain and heart, will lead to its inevitable collapse and disintegration.[171]

The essential triad shares similarities with Clausewitz's paradoxical trinity in that it represents a system of entities which interact to achieve objectives. Like the Trinity, Naveh's triad suggests that conflict is a complex affair created by the clash of fighting systems. Following this Naveh's interpretation of conflict also alludes to the properties of non-linearity and aggregation.

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[170] *Ibid*., 15.

[171] *Ibid*., 15.

As indicated above, the essential triad is comprised of the brain, heart and regulating agency which interact to generate a fighting system. Citing von Bertalanffy, Naveh states that "the essence of a system centres on the interaction between its components more than anything else."[172] Because this interaction is so important, Naveh claims that "amplifying the dynamism of the interaction" will inevitably increase the system's output.[173] Essentially, the interactions will have a synergistic effect on the system where the whole is greater than the sum of the parts.[174] This feature exemplifies the property of non-linearity and consequently makes measuring the system's behaviour quite problematic for analytic and linear constructs.

Naveh's image of a contest between two opposing fighting systems also bears a resemblance to Clausewitz's metaphor of the two wrestlers. As with the wrestlers, the fighting systems can be viewed as "complex adaptive opponents", which are constantly interacting, reacting and adapting to their environment in order to achieve their objectives. This image is reflected in comments made by Admiral William A. Owens, a former Vice Chairman, Joint Chiefs of Staff, on the emerging U.S. system of systems approach to conflicts:

> The conflicts we face will remain competitions among thinking, learning, and adaptive human beings. We need to recognize that any future opponent would diligently and intelligently try to counter capabilities the system-of-systems gives us.[175]

Much like Clausewitz's wrestler metaphor, Owen's emphasis on "competitions among thinking, learning, and adaptive human beings" reinforces the aspect of the property of

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[172] *Ibid*., 5.

[173] *Ibid*., 5.

[174] *Ibid*., 5.

[175] William A. Owens, "The Emerging U.S. System-of-Systems," *National Defense University Strategic Forum*, no. 63 (February 1996), 3.

aggregation. That is, conflict involves competing systems which are comprised of a collection of agents that have the capacity to learn and adapt. These adaptive agents continuously self-organise themselves along the various hierarchies within a system to collectively generate emergent properties that permit the system as a whole to evolve with its environment. Once again, the emergent properties which evolve as a result of the system's interactive behaviour make measuring and predicting the system's overall behaviour with any great precision an impossibility.

Naveh's conceptual model of the essential triad is based on the notion that warfare involves opposing fighting systems. The essential triad is comprises; the brain, heart and the self-regulating agency. These components are continuously interacting to generate strategies that permit it to adapt to its environment and overcome opposing fighting system. The interactions between these components generate a synergy that makes the interactions nonlinear. Once more, they involve adaptive agents that not only create emergent properties that permit the system to evolve, but also generate behavior that is difficult to anticipate and predict.

**Summary**

This chapter has shown that conflict can be conceptualized as a CAS. The examination of the writings of Clausewitz, Boyd and Naveh, provide compelling arguments for conceptualizing conflict in this context. All three interpretations reflect the properties of a CAS, specifically, non-linearity and aggregation as well the unpredictability that these properties create in conflict.

Clausewitz declares that conflict is comprised of three dominant tendencies: violence hatred and enmity; chance and probability; and political purpose. These three tendencies form a

paradoxical trinity analogous to three forces: the people, the state, and the state. The interactions between these forces make warfare both complex and adaptive. They also reflect the CAS properties of non-linearity and aggregation. These perceptions are further amplified by the human dimension in conflict and the friction that this pervasive aspect generates in warfare.

Boyd's conception of warfare as a competition between OODA loops where a combatant attempts to get inside its opponent's OODA loop. The side which can cycle through their OODA loop more rapidly and creatively can gain an advantage over their opponent and dictate the course of battle. A combatant's success relies on his/her ability to create the conditions for emergent properties which permit adaptation within the environment. This creates an input into the environment that generates feedback and interactive behaviour between OODA loops that is non-linear and unpredictable.

Naveh's essential triad conceives conflict as a battle between fighting systems, each composed of a heart, brain and self-regulating aptitude. The heart is the physical component that develops the objectives; the brain is the cognitive component that provides the plan to achieve the objectives; and the self-regulating aptitude enables a fighting system to maintain an equilibrium that permits the achievement of objectives. In this theoretical construct, conflict is a clash of belligerent systems where the intended goal is to separate an opposing system's constituent parts to prevent it from achieving its objectives. Similar to the paradoxical trinity, the interactions between the fighting systems which comprise the essential triad are what make conflict complex and adaptive.

All interpretations provided above view conflict as a CAS. Despite subtle nuances between these interpretations, they all depict conflict as a contest between systems. These systems emphasize two key features: interactions and unpredictability. Thus, conflict is a contest

involving interactions and relationships between numerous entities that inhabit the battle space. These interactions create friction and unpredictability, which are difficult to measure or predict with any degree of exactitude or precision. This calls into question the utility of the Newtonian view of conflict while implying the requirement for a more holistic approach allied with systems thinking.

## CHAPTER 5 – COGNITIVE COMPETENCIES FOR UNDERSTANDING CONFLICT AS A CAS

If systems thinking can be considered a more appropriate method for viewing conflict as a CAS in comparison to linear constructs nested in the Newtonian paradigm, then how prominently does it figure into CF officers' leadership development? The fact that systems thinking is listed as a cognitive competency within the CF LDF seems to signify this importance. If this is indeed the case, then how important is it in relation to other cognitive competencies in terms of the CF officer leadership development within DP 3, specifically, in assisting them in understanding the interactive and unpredictable behaviour of conflict?

These questions are of particular importance for CF officers as they enter into DP 3. DP 3 marks a critical period within a CF officer's professional development. It is during DP 3 that CF officers cross the threshold from tactical level activities and become immersed in a world of combined and joint operations at the operational level that are set in the strategic context. It is widely argued that as one ascends from the tactical to the operational level that the complexity of the problems faced also increase.[176] At the operational level there is a tendency for a more

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[176] Barry Watts, "Strategy for the Long Haul: US Combat Training, Operational Art, and Strategic Competence Problems and Opportunities." Center for Strategic and Budgetary Assessments. (Washington, DC: U.S. Government Printing Office, 2008), ix.

diverse range of actors to be engaged in conflict. With the increased and varied number actors, the more complex the interplay and interactions between them. This, in turn, tends to increase the unpredictability of the environment as well as the complexity of the problems within it, much like a CAS. Thus, if the emphasis of JCSP is to "prepare officers for complex nature of combined, joint and interagency security challenges of today", this suggests that CF officers require a set of cognitive competencies that enable them to operate effectively in this reality. In the context of a CAS, this suggests the need for a set of cognitive competencies for coping with interactive and unpredictable behaviour.

This chapter examines academic and professional literature in order to identify a common set of cognitive competencies that would allow future CF senior leaders to understand conflict as a CAS, in particular the unique features of its interactive behaviour and unpredictability. In doing so, it shows how systems thinking figures prominently as an essential cognitive competency for CF officers leadership development within DP 3.

In order to contextualize this examination, this chapter provides a brief description of DP 3 within the CF Officer DP continuum. It then defines a cognitive competency using the Leadership Development Framework (LDF) developed for the CF Officer General Specifications (OGS). This is followed by a review of the three cognitive competencies identified within the LDF: analytical/systemic thinking, creativity and behavioural flexibility. This review also looks at the Director General Military Personnel Research Analysis (DGMPRA) competency dictionary and the CF officer Qualification Standard (QS) to provide definition to the competencies and help establish their importance within the CF officer professional development framework. These cognitive competencies are then compared with Christopher Paparone's et al., eight key leadership tasks and Stephen Zaccaro's executive characteristics. The approaches of

these two authors are used to lend objectivity to the examination of those cognitive competencies detailed within the LDF and to confirm the importance of systems thinking. The perspectives provided by the LDF, Paparone et al., and Zaccaro are then examined and grouped to provide a common framework of cognitive tools within DP 3 which are seen to be the most appropriate for the CF's future senior leaders in understanding warfare as a CAS. Specifically, the framework will align cognitive competencies that are most appropriate in assisting these officers in understanding the interactive behaviour and relationships of a CAS and in dealing with the unpredictability that results from this interactive behaviour.

**The CF Officer Developmental Period Continuum**

The Canadian Forces Professional Development System (CFPDS) defines a DP as a time block "in a career during which an individual is trained, educated, employed and given the opportunity to develop specific occupational or professional skills and knowledge."[177] DPs are progressive and are designed to meet the professional developmental needs of an Officer.[178] There are five distinct DPs through which a CF officer can progress throughout their career. Each DP provides an officer with the training, education and experience to ensure he/she can be effectively employed in that DP, but can also progress to the next DP level.[179] The knowledge and skills an officer receives during a DP is progressive and delivered in a graduated format as illustrated in Figure 5.

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[177] Department of National Defence, Canadian Forces Professional Development System Document (CFPDS), Version 27 (Kingston: Canadian Defence Academy, 2010), 34.

[178] *Ibid*., 34.

[179] *Ibid*., 34.

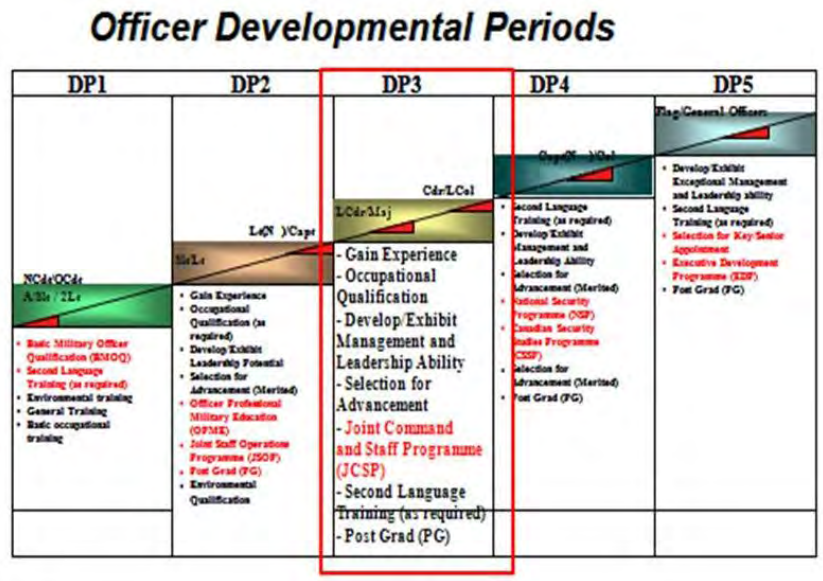


**Figure 5: CF Officer Professional Development Period Continuum.**
Source: Department of National Defence, Canadian Forces Professional Development System Document (CFPDS), Version 27 (Kingston: Canadian Defence Academy, 2010), 37.

DP 3 is an advanced developmental period within the DP continuum. This DP is focused on the development and preparation of Majors/Lieutenant-Commanders and Lieutenant-Colonels/Commanders for higher rank and more complex appointments. Training emphasizes "joint operations and is conducted with officers from the other environments as well as from other countries to prepare senior officers for joint operations, exercises and appointments to joint staffs or foreign exchange assignments."[180] It also includes the study of command and control issues at the operational level of war to prepare them as senior officers for unit command. The PME received at this level is conducted at CFC in Toronto, specifically on JCSP.[181] It is the PME provided by JCSP that is the focus of the examination of cognitive competencies within the DP 3.

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[180] *Ibid*., 34.

[181] *Ibid*., 34.

**Cognitive Competency**

Before examining specific cognitive competencies within the DP 3 it is first appropriate to provide a definition of a cognitive competency. Dr. Robert Walker, a researcher scientist with the Canadian Forces Leadership Institute (CFLI), offers a useful definition of a competency for the CF as "a set of characteristics, skills and other abilities which may vary among individuals and which underlie effective leader performance."[182] Similarly, Line St-Pierre, a defense scientist with Chief Military Personal (CMP), states that a competency is a "demonstrable and observable knowledge, skills, behaviours or characteristics that enable effective performance."[183] Based on these two perspectives a competency is a skill set which can be shown by an individual and seen through an individual's actions in the performance of a task within a specific context. So what then constitutes a cognitive competency?

The basis for this answer lies in the CF OGS. The CF Officer OGS is a cornerstone document that describes the common performance and professional development requirements that all CF officers are expected to achieve and maintain during their military careers.[184] Integral to this quality control document is a framework for the development and support of CF officers in their roles as military leaders known as the LDF.[185] The LDF was developed by CFLI in 2006 to capture the intent of the OGS and to outline a progressive professional development path for

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[182] Robert Walker, "The Professional Development Framework: Generating Effectiveness in Canadian Forces Leadership," *Canadian Forces Leadership Institute Technical Report 2006 -01* (Kingston: Canadian Defence Academy, 2006), 51.

[183] Dr. Line St-Pierre, e-mail to Major S.W. Taylor, 22 February 2012. Dr. St. Pierre has done substantial research for Director General Military Personal Research and Analysis (DGMRA) to develop a CF Leadership Competency Profile with a view to operationalizing the Leadership Development Framework (LDF). Refer to "The Canadian Forces Leadership Competency Profile: A Review and Comparison with other Public Service Competency Dictionaries and Profiles," April 2010.

[184] Department of National Defence, A-PD-055-002/PP-001 *Canadian Forces Officer General Specification* (Ottawa: DND Canada, 2009), 1-1.

[185] *Ibid*., 1-1.

officers over the course of their careers.[186] This framework provides a broad definition for cognitive competencies as those that consist of creative and critical thinking for rationalizing problems and making decisions.[187] Pascale Michelon, a "Sharp Brains" Research Manager for Educational Projects, states that cognitive competencies are the "brain-based skills" required to perform any task from the simplest to the most complex.[188] The Canadian Forces Professional Development System (CFPDS) also states that cognitive competencies are "developed from linear, analytic thinking to systems thinking in order to cope with complexity."[189] Based on these interpretations a cognitive competency can be considered to be an observable and demonstrable set of intellectual tools for analyzing and synthesizing problems in a critical and creative manner in order to assist in decision-making. So how are these cognitive competencies organized for each DP level?

The LDF is broken into five progressive levels which are aligned with the CF Officer DPs one through to five as depicted in Table 1.

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[186] *Ibid*., 2-6.

[187] Canadian Defense Academy website, "Professional Development of Leaders: A Professional Development Framework & A Leadership Development Framework" http://www.cda.forces.gc.ca/cfliilfc/Howtodevelopleaders-eng.asQ; Internet; accessed 25 Feb 2012.

[188] Pascale Michelon, "A Brain Teaser for Each Cognitive Competency," http://www.sharpbrains.com/resources/1-brain-fitness-fundamentals/brain-functions-perception-attention-memory-and-more/;Internet; accessed 25 February 2012.

[189] Department of National Defence, *Canadian Forces Professional Development System Document*… , 18-19.

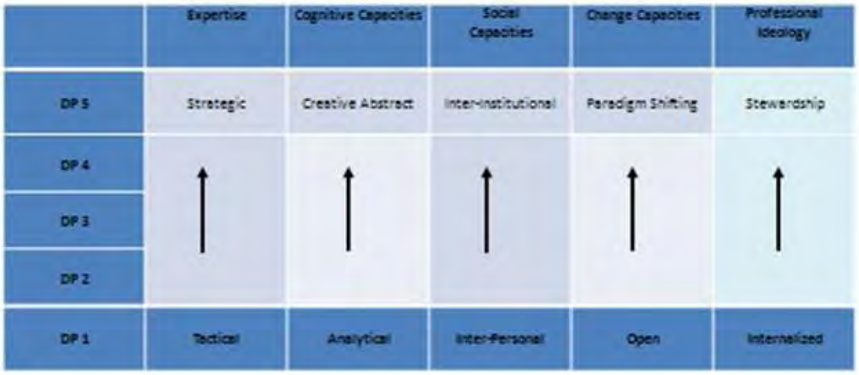


**Figure 1: The Professional Leadership Framework**
Source: Qualification Standard Officer Developmental Periods 1 to 5.

This framework comprises five domains or meta-competencies: Expertise, Cognitive Capacities, Social Capacities, Change Capacities, and Professional Ideology.[190] These five meta-competencies represent groupings of related competencies that are required of all CF leaders at a certain DP level.[191] Together, they form a competency profile, which is a list of key competencies that are needed to successfully perform in a specific job at a specific level.[192] Furthermore, each level within the LDF provides the foundation for each successive and higher level of leadership.[193] Therefore, an officer is expected to have mastered the components/competencies within a level in the framework before progressing to the subsequent level.

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[190] Department of National Defence, *Officer General Specification*…, 3-6.

[191] *Ibid*., 3-6.

[192] Cheryl Burgess, "The Canadian Forces Leadership Competency Profile: A Review and Comparison with other Public Service Competency Dictionaries and Profiles," *Director General Military Personnel Research and Analysis Technical Note* (April 2010), 1.

[193] Department of National Defence, A-PA-005-000/AP-006, *Leadership in the Canadian Forces: Leading the Institution* (Ottawa: DND Canada, 2007), 131.

**Cognitive Competencies within DP 3 for Understanding Conflict as a CAS**

Having defined a cognitive competency, it is necessary to focus attention on those competencies listed within the LDF that are emphasised at the DP 3 level and that provide CF officers with the tools required to understand conflict as a CAS. Specifically, the cognitive tools required to understand the interactive and unpredictable behaviour of conflict.

A study of the LDF reveals three cognitive competencies that provide these intellectual skill sets: analytic/systemic thinking, creativity and behavioural flexibility. However, the initial competency profile within the LDF was developed as a generic list which had no rank specificity. As a result the LDF does not provide specific definitions for these competencies for the DP 3 level.

Since 2010 the DGMPRA has been investigating the establishment of different competency dictionaries which are tailored for each rank level. The draft competency dictionary currently under development by DGMPRA lists analytic/systemic thinking and creativity as meta-competencies under the cognitive domain. The dictionary provides a general description of each of these competencies. The first competency, analytic/systemic thinking, is described as follows:

> CF leaders analyze situations and problems in order to make timely, yet sound decisions and recommendations. They organize and integrate information from various sources, extracting and linking key elements. They consider all relevant interconnected organizational components and relationships in their analysis and decision process. CF leaders identify and evaluate possible solutions in order to advance sound recommendations and strategies at the short-, medium-, and long-term range.[194]

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[194] Director General Personnel Research and Analysis, *Draft Competency Dictionary*, (December 2011), 18.

It is worth noting that this meta-competency includes both analytic and systemic thinking. As stated earlier, analytical thinking solves a problem in a logical, step-by-step manner by breaking it into its component parts, solving the parts and reassembling the solutions into a whole. Conversely, systems thinking is a holistic approach to problem solving focusing on relationships between a system's components as opposed to the components themselves.[195] Lieutenant-Colonel Richard King, an officer with the Australian Defence Force who advocates for the teaching of thinking skills, likens analytical thinking to convergent thinking where "we seek to identify the best option."[196] Systems thinking is akin to divergent thinking in which "we seek to broaden our understanding of the problem and generate a wide range of options." The fact that the draft dictionary emphasizes both analytical and systemic thinking suggests the importance of being capable of applying both approaches to generate novel solutions to problems.

The competency dictionary describes the second competency, creativity, as follows:

> CF leaders [ability to] respond to issues and challenges by generating new and innovative solutions to deal with them. They modify and expand on conventional methods and create imaginative new approaches through non-linear thinking and by obtaining fresh perspectives and information from a variety of non-traditional fields. CF leaders capitalize on diversity within the organization in order to profit from different perspectives. They encourage open-mindedness and creative thinking within the organization as a way to address issues and challenges and to capitalize on emerging opportunities.[197]

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[195] Checkland, *Systems Thinking, Systems Practice*…, 82.

[196] Richard King, "How the Army Learned to Plan but Forgot How to Think," *Australian Army Journal* 5, no. 5 (Summer 2008): 149.

[197] *Draft Competency Dictionary*…, 19.

King suggests that creativity is linked to a leader's ability to balance traditional, linear (or convergent) thinking and non-traditional (divergent) thinking. Therefore, the more adept a leader is at balancing these types of thinking, the more effective thinker he/she can become. This in turn contributes to the third cognitive competency, behavioral flexibility.

The third competency, behavioural flexibility, is also known as mental flexibility or fluid intelligence. Behavioural flexibility is a meta-competency nested within the domain of Change Capacities according to the LDF. However, it can be argued that any form of behaviour adjustment requires a certain level of cognition. In fact, the FM 6-22 which is the US Army's keystone field manual on leadership considers "flexibility of the mind" as an attribute associated with *Intellectual Capacity*.[198] The Max Planck Institute for Human Development reinforces this association. It states that "in an uncertain world, humans often rely on simple cognitive strategies (heuristics) when making decisions."[199] From this one can infer that an individual's ability to adapt his/her behaviour to cope with uncertainty is derived through cognitive processes. Seen in this light, behavioural flexibility can be treated as a cognitive competency. Thus, behavioural flexibility is a leader's capacity to know when to adjust his/her behaviour to respond to changes in the environment. This generates an awareness and sensitivity to environmental conditions that enable a leader to adapt his/her behaviour to uncertainty and change.[200]

Despite the lack of a precise definition for these three competencies within the LDF, some amplification and supplemental explanations can be found in the recently approved QS for

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[198] United States, Department of Defense, FM 6-22, *Leadership: Competent, Confident and Agile* (Headquarters, Department of the Army, October 2006), A-11.

[199] Max Planck Institute For Human Development website, http://www.mpib-berlin.mpg.de/en/research/adaptive-behavior-and-cognition; Internet; accessed 25 February 2012.

[200] *Ibid*.

the Officer Professional Development (PD).[201] The QS is defined as a "quality control document that describes, in operational performance terms, the required outcome of individual Training and Education (IT&E)."[202] The QS for CF officers is derived from the OGS and is the first of its kind for the CF Officer Corps, in that it provides a road map for officer PD in terms of Performance Objectives (POs) through DPs one to five.[203] While the meta-competencies within the LDF are not explicitly outlined in the POs, they are implicit within the performance conditions with a view to further identifying and refining these competencies within each PO.[204] Several of the POs within DP 3 detail requisite elements which relate to the three cognitive competencies described above and are outlined in Table 2 below.

| Performance Objective # | Title | Requisite Element |
|---|---|---|
| PO 016 | Develop DND as a Learning Organization | Foster a culture of creativity and innovation (B7.0.020) consistent with Leading People, pp. 81-82 by:<br>a. exploiting technologies, concepts and/or theories;<br>b. generating viable solutions that involve new and/or alternative approaches or ways of thinking about complex problems or issues; and<br>c. applying risk mitigation without stifling creativity. |
| PO 019 | Plans Operations IAW CF Doctrine | Apply the OPP (A3.2.010, A3.2.005) at the operational level in a JIMP environment IAW CFOPP Manual including:<br>d. generate and adapt ideas and concepts (D.2.0.020) IAW The Guide to Lateral Thinking;<br>e. applying systems thinking (D.2.0.015) IAW Leading the Institution Chap 2. |
| PO 020 | Demonstrate agility of thought and action (e.g. seize opportunities, adapt plans based on the current situation). | Develop agility of thought and action at the unit and formation levels IAW CFJP 01, Chap 2. |

**Table 2: Requisite Elements related to the Cognitive Competencies for DP3.**
Source: Qualification Standard for Officer Developmental Periods 1 to 5.

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[201] Department of National Defence, 4855-2 (SSO PD), *Approved – Qualification Standard Officer Professional Developmental Periods 1 to 5*, (Kingston: Canadian Defence Academy, 26 November 2010), 1.

[202] Department of National Defence, A-P9-050-000/PT-01 (1), *Manual of Individual Training and Education*, Volume 1, Supplement , 32.

[203] Department of National Defence, *Qualification Standard Officer Developmental Periods 1 to 5* (Kingston: Canadian Defence Academy, 16 October 2011), iii.

[204] *Ibid*., 1-4.

The POs 016 (Develop DND as a Learning Organization) and 019 (Plans Operations) emphasize the importance of linear, analytical, critical, creative, and systems thinking. This is linked to the meta-competencies of analytic/systemic thinking and creativity within the cognitive domain. It is interesting to note the contrasting approaches to problem solving within PO 019. The mix of contrasting approaches reinforces the importance of versatility with regards to problem solving. This speaks to PO 020 (Demonstrate Agility of Thought and Action) which stresses the importance of intellectual agility.

Together, the descriptions of the three meta-competencies provided within the draft dictionary for the LDF and the amplification provided within the recently approved QS for Officer DP are indicative of three key cognitive tools within the Officer DP 3 for understanding conflict as a CAS. The acknowledgment of systems thinking reflected within the cognitive competency analytic/systemic thinking, and to a lesser degree creativity, reflects intellectual skill sets required for understanding the interactive behaviour of a CAS. The focus on agility of thought to deal with ambiguity and uncertainty under behavioral flexibility reflects a competency that assists in adapting to and coping with unpredictability.

**Christoper Paparone, Ruth Anderson, and Reuben R. McDaniel Jr. Key Leadership Tasks**

A review of academic literature shows other coginitive competencies for understanding warfare that are similar to the three meta-competencies described in the LDF. Christopher Paparone et al., suggests eight leadership tasks that can be used to examine and understand the military as a CAS: relationship building, complicating, loose coupling, diversifying,

sensemaking, learning, improvising, and emergent thinking.[205] However, because all CAS generally share the same properties of aggregation and non-linearity, these leadership tasks can thus be considered complimentatry to those cogntitive competencies outlined in the LDF above in understanding conflict as a CAS. Furthermore, as shown in Chapter 2, a military organization can be seen as one of many agents which contribute to generate the emergent properties of conflict when viewed in the context of a CAS. Based on this relationship, it is suggested that the tasks proposed by Paparone et al., may also be applicable to understanding conflict as a CAS.

While all of these tasks are appropriate for understanding CASs, the following tasks stand-out with respect to understanding interactive behaviour (e.g. relationships) and coping with undpredictability. These tasks include relationship building, emergent thinking, and improvising and are paraphrased as follows:

> Relationship Building: CAS are defined not as a set of roles or individual nodes but as a set of interdependecies among agents. Management of relationships is more important than management of roles. Focus on roles will not be a good way to get people to work together when a major wedge between them is difference in values. Rather, the fundamental importance of relationships must be acknowledged;
>
> Emergent Thinking: Because CASs are emergent and their trajectory is unknowable, formal planning, with its reliance on forecasting and estimates, and the search for clear cause and effect relationships, is less than useful. Systems thinking, looking at issues holistically and focusing on relationships and feedback loops, is essential to understanding the nature of CASs; and
>
> Improvising: Improvisation is a necessary condition when the environment is complex, uncertain and unpredictable. The strategist must have the capacity to respond to unanticipated circumstances. Rather it is a balance of structure and flexibility.[206]

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[205] Paparone et al., *"Where Military Professionalism Meets Complexity Science*…, 440-446.

These three key tasks can assist in managing and understanding the complex nature of a CAS. Notwithstanding the overlap that exists between these key tasks, relationship building and emergent thinking can be viewed as tasks dealing with the interactive behaviour of a CAS while the task of improvising speaks to the ability to deal with the unpredictability.

**Zaccaro's Executive Characteristics**

Renowned organizational expert, Stephen Zaccaro, conducted extensive research into executive leadership for the US Army. The overall mission of his research was to "examine and test concept materials for doctrine development at the executive level" to provide recommendations for future military-based research on executive leadership.[207] His research culminated with a report titled *Models and Theories of Executive Leadership: A Conceptual/Emperical Review and Integration*. In the report Zaccaro proposes a model of leadership drawn from conceptual perspectives and empircal research. The leadership model is based on a taxonmy of five sets of charactersitics that are considered necessary for success, and include: Cognitive Capacities; Social Capacities and Skills; Personality; Motivation; and Expertise and Knowledge.[208] Two characteristics associated with the cognitive and social domains include metacognitive skills and behavioural flexibility which are summarized below:

> Metacognitive Skills: These skills are defined in terms of the skill applications of superordinate cognitive functions that control the application and operation of cognitive abilities and skills.

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[206] Paparone, et al., *"Where Military Professionalism Meets Complexity Science*…, 440-446. Bill Bentley, a research scientist with CFLI lists these characteristics in a monograph tiled "Military Strategy – A Primer" that was recently published in 2011 as part of the (CANSOFCOM) Professional Development Centre (PDC) Monograph Series.

[207] Zaccaro, *Models and Theories of Executive Leadership: A Conceptual/Empirical Review and Integration*…, xvii-xxvi.

[208] *Ibid*., 377.

> Metacognitive skills regulate and monitor the application of these skills in three general ways. First, they facilitate an understanding of the problem itself and its critical parameters. Second, they promote the search for and specification of effective solutions. Finally, these skills are used in monitoring solution implementation, generating feedback regarding such implementation, and adapting solutions to changing conditions. Such skills are more critical for unstructured, insight, or creative problems.
>
> Behavioral Flexibility: Because organizational environments are complex and dynamic, a solution that works in one problem scenario may be inappropriate or even counter-productive in another. Thus, executive leadership requires flexibility in behavior to respond effectively in significantly different ways across different organizational scenarios and in accordance with different, sometimes conflicting organizational goals. In essence, behavioral flexibility involves the ability to respond *equally well* to very different situational demands.[209]

There are several inferences which can be drawn from Zaccaro's executive competencies. A metacognitive skill can be viewed as the capacity to understand and deal with problems of varying degrees of complexity. The complexity of the problem will dictate the most suitable approach to deal with the problem and to provide the most appropriate solution. As such, the approach may entail the use of linear or non-linear thinking or both. From this perspective, meta-cognitive skills are similar to the meta-competency analytical/systemic thinking within the cognitive domain of the LDF. Likewise, Zaccaro's definition of behavioral flexibility refers to the capacity to adapt to uncertainties in the environment. Once again, this definition closely resembles the meta-competency, behavioral flexibility, that is described under the change capacity within the LDF.

Given the parallels between Zaccaro's executive characteristics and the meta-competencies described under the LDF the following conclusions can be made vis-a-vis their

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[209] *Ibid*, 377-382.

applicability to the properties of a CAS. The suggestion that metacognitive skills "are more crtical for unstructured, insight or creative problems" infers the use of methods like systems thinking for examining complex problems. The mention of the ability to respond "equally well to very different situational demands" advocates the capacity to cope with unpredictability of a CAS.

Hence, metacognitive skills are those which can be leveraged to implement approaches which aid in understanding relationships and interactions while flexible behaviour represents the capacity to cope with unpredictability.

**Cognitive Competency Framework**

The emerging conflict trends that serve to make the COE complex, and the resultant view of conflict as a CAS, suggests that using the existing Newtonian paradigm in an attempt to understand conflict as a complex problem may no longer be appropriate. This reality also brings into question the utility of analytic, linear and reductionist methods by which problems are examined using this paradigm. The CF's LDF meta-competencies, Paparone's key leadership tasks and Zaccaro's executive characteristics represent a range of cognitive competencies which can assist in understanding conflict as a CAS. That is, they assist with understanding the features of interactive behaviour and unpredictability as illustrated in Table 3 below. Taken together, the competencies highlighted within these three frameworks can be distilled into two essential cognitive competencies that can enhance a leader's understanding of conflict as a CAS: systems thinking and behavioural flexibility.

| Source | Cognitive Competencies | |
|---|---|---|
| | **Relationships/Interactive Behavior** | **Unpredictability** |
| CFLI LDF | Analytic/Systemic Thinking<br>Creativity | Behavioral Flexibility |
| Paparone's 8 Key Leadership Tasks | Emergent Thinking<br>Relationship Building | Improvising |
| Zaccaro's Requisite Executive Characteristics | Metacognitive Skills | Behavioral Flexibility |
| **Summary** | **System Thinking** | **Behavioral Flexibility** |

**Table 3: Cognitive Competency Framework**
Source: Author's Interpretation of cognitive competencies for understanding the interactive and unpredictable behaviour of a CAS.

Systems thinking provides a methodology that focuses on the interactions/relationships within a system, thus its interactive behaviour. Behavioural flexibility is the capacity to adjust one's own behaviour to adapt to changes and unpredictability in the environment. While it can be argued that understanding conflict as a CAS requires the mobilization of all cognitive competencies these two competencies standout with respect to comprehending its interactive and unpredictable behaviour. Although these cognitive competencies have been assigned under specific CAS characteristics it is argued that there is considerable overlap between these two competencies when addressing the interactive and unpredictable behavior of a CAS.

Both systems thinking and behavioural flexibility were emphasized in a CFLI report published in April 2008 titled "Broadsword or Rapier?" The purpose of the report was to determine how the CF could better prepare its senior leaders to effectively participate in current and future coalition operations to enhance its strategic effect.[210] One of the report's main recommendations emphasized "intellectual agility"[211] to deal with the emerging complexity of

[210] Bill Bentley, "Broadsword or Rapier? The Canadian Forces' Involvement in 21st Century Coalition Operations." *Canadian Forces Leadership Institute - CDS Critical Topic Project Report 6*. (Kingston: Canadian Defence Academy, 2008), 1.

the 21st Century, and the requirement for the CF "to develop members who can transcend deeply embedded cognitive orientation towards linear analytical and reductionist thinking."[212] This study also suggested that "methodologies such as Soft System Models (SSM) and Systematic Approaches to Operational Design, known as systems thinking, be introduced to officers at an early stage in their career."[213] The focus on systems thinking and intellectual agility can be seen as an acknowledgment of the critical importance that these cognitive competencies have in understanding the interactive and unpredictable nature of conflict.

**Summary**

A cognitive competency is an observable and demonstrable intellectual skill set for dealing with problems in a critical and creative manner to assist in decision making. Cognitive competencies are one of five meta-competencies which comprise the LDF within the CF OGS. An examination of the LDF shows three cognitive competencies for the CF Officer DP 3 which can assist in understanding conflict as a CAS from the perspective of its interactive and unpredictable behaviour. These three include: analytic/systemic thinking; creativity; and behavioral flexibility. These cognitive competencies are broadly defined within the DGMRA competency dictionary, which is further amplified by the recently published QS for CF Officer PD. A review of academic literature, specifically Paparone's et al., key leadership tasks and

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[211] Denise Huang et al., "Exploring the Intellectual, Social and Organizational Capitals at LA's BEST," CSE Technical Report 714, National Center for Research on Evaluation, Standards, and Student Testing (CRESST) University of California, Los Angeles (May 2007), 3. This technical report defines intellectual agility as the "ability to apply knowledge across contexts and situations, and to innovate and transform ideas that are critical to the success. It relies on the ability to synthesize information and piece them together in an original way." In essence, it is the capacity of an individual to modify their actions and strategy when confronted with problems.

[212] *Ibid*., 4.

[213] *Ibid*., 4.

Zaccaro's executive characteristics, also identify a number of common cognitive competencies. While there are variances in the descriptions these three perspectives consistently point to systems thinking and behavioral flexibility as critical cognitive competencies for understanding the interactive behaviour and unpredictability of a CAS. Systems thinking is a methodology that permits an understanding of interactive behaviour while behavioral flexibility entails the capacity to cope with unpredictability.

## CHAPTER 6 – AN EXAMINATION OF JCSP 38

Both systems thinking and behavioural flexibility represent essential cognitive competencies for understanding conflict as a CAS. Notwithstanding the importance placed on both of these competencies, this paper will examine those opportunities that exist within the PME that the CF's future senior leaders receive during their DP 3, specifically as they relate to the development of systems thinking. The JSCP represents the formal PME for CF Officers during DP 3. Using the simple theoretical framework developed in Chapter 5 this section examines JCSP 38[214] curriculum to assess the extent to which the programme provides CF officers with the opportunity to develop the cognitive competency of systems thinking that they require in understanding conflict as a CAS in the COE. To make this determination, this chapter is organized into six sections. The first section is a brief overview of JCSP. The second section describes and distinguishes between formal and informal learning using Murray Simons conceptual framework.[215] Working within this framework, the third section provides a

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[214] The selection of JCSP 38 for this examination is due mainly to the fact that the author was attending this programme at the time of the writing of this paper. As such, it provides the most up to date information that the author could draw upon for the analysis of the PME within the CF officer's DP 3.

traditional quantitative analysis of the formal learning of the systems thinking as shown by the JCSP 38 syllabus. The fourth section attempts to provide a more qualitative analysis of the informal learning opportunities that permits officers to develop/acquire these cognitive competencies. The fifth section, using the quantitative and qualitative analyses developed in earlier sections, assesses the PME offered at JCSP regarding the development of the cognitive competency of systems thinking. The final section offers recommendations to improve how a cognitive competency like systems thinking is delivered as part of the PME that CF officers receive during DP 3 for future considerations.

Prior to commencing the case study there are two caveats bounding this analysis that require mentioning. The first caveat is that the analysis provided below focuses primarily on the residential education programme and not the Distance Learning (DL) course. The second caveat submits that although the analysis of JCSP 38 attempts to provide an objective view of the programme there is a certain degree of subjectivity in the selection and interpretation of course material which must be factored into the overall assessment.

**An Overview of JCSP 38**

JCSP is a 10-month programme that is divided into four rotations. With the exception of the last rotation each rotation covers two courses. There are a total of seven mutually supporting courses that are run sequentially; Leadership and Ethics (LDR) – DS 541, Command and Management (COM) – DS 542, War and Society (WAS) – DS 543, Basic Joint Operational Planning (BOP) – DS 544, Component Capabilities (CPT) – DS 545, Advanced Joint

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[215] Murray Simons, "Holistic Professional Military Development: Growing Strategic Artists" (doctoral thesis, Massey University, 2009). Simons' biography can found at the following website: Faculty Members of RCM website http://www.rcmedu.ch/facultyprofiles.htm; Internet; accessed 6 March 2012.

Operational Planning (AOP) – DS 546, and National Security and International Affairs (SIA) – DS 547.[216] Each of these courses has a number of learning outcomes and objectives. A breakdown of individual course learning outcomes and objectives is outlined in Annex A. In addition to the PME focused curriculum this programme allows participants to enroll in the Master of Defence Studies (MDS) programme through the Royal Military College of Canada (RMC).[217]

**Formal and Informal Learning**

Murray Simons is a former learning and development officer with the New Zealand Defence Force who has written a doctoral thesis titled *Holistic Professional Military Development: Growing Strategic Artists*.[218] The thesis explores the holistic contribution of formal, non-formal, informal, self-directed, and incidental learning within the domain of professional military education.[219] According to Simons these five learning activities contribute to an individual's overall learning.[220] The examination of JCSP 38 will focus on formal and informal learning activities in order to, as much as possible, capture the full breadth of learning opportunities afforded students who attend this programme. For the purpose of this paper formal learning activities are those that are executed as part of the course (i.e. what is in the schedule).

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[216] Canadian Forces College, "JCSP 38 Syllabus Canadian Forces College (CFC) Joint Command and Staff Programme Residential," http://www.cfc.forces.gc.ca/118/231/cfc300-38_e.pdf; Internet; accessed 16 December 2011.

[217] Canadian Forces College, Master of Defence Studies — Research Project; http://barker.cfc.dnd.ca:2009/report/log_report_e.php?ActivityID=299;Internet; accessed 16 December 2011.

[218] Murray Simons, "Holistic Professional Military Development: Growing Strategic Artists" (doctoral thesis, Massey University, 2009).

[219] *Ibid*., i.

[220] *Ibid*., 31.

This primarily focuses on those activities written into the course syllabus. Informal learning however, consists of those unguided activities that are not detailed in the schedule. Simons places these informal learning activities under the banner of *hidden curriculum*.[221] That is to say, a students' learning goes beyond what is actually taught in a formal setting such as a classroom. However, informal learning can occur during programmed formal learning activities.[222] He asserts that although this area of learning is not well developed in military education, it forms part of an individual's holistic learning that can contribute to enhancing their cognitive agility.[223]

**Formal Learning Activities**

This section provides a quantitative analysis of those formal learning activities within the JCSP 38 syllabus as they relate to developing and enhancing the cognitive competencies of systems thinking. The quantitative analysis is based on the total time, in hours, allocated within the curriculum to learning methodologies like systems thinking. To lend some perspective to this analysis the allocation of time for systems thinking, in particular, is compared with that allocated to learning about linear thinking.

**Methods of Thinking and their relationship with the CF Operational Planning Process (CF OPP)**

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[221] *Ibid*., 16.

[222] *Ibid*., 149.

[223] *Ibid*., 16.

Before examining the formal learning activities within the JCSP 38 syllabus to determine time allocation for learning systems thinking, one must distinguish between a methodology, such as linear and systems thinking and a process like the CF Operational Planning Process (OPP). As stated throughout this paper, systems thinking and linear thinking are methods that can be used for thinking about problems. Conversely, processes, like the CF OPP, consist of a series of actions to prepare plans and orders for CF operations. Viewed together, methods of thinking, be they systemic or linear, emphasizes how to *think* and are methodologies that can be integrated into a process such as the CF OPP, which focuses on *doing*. This relationship is illustrated in Figure 6 below.

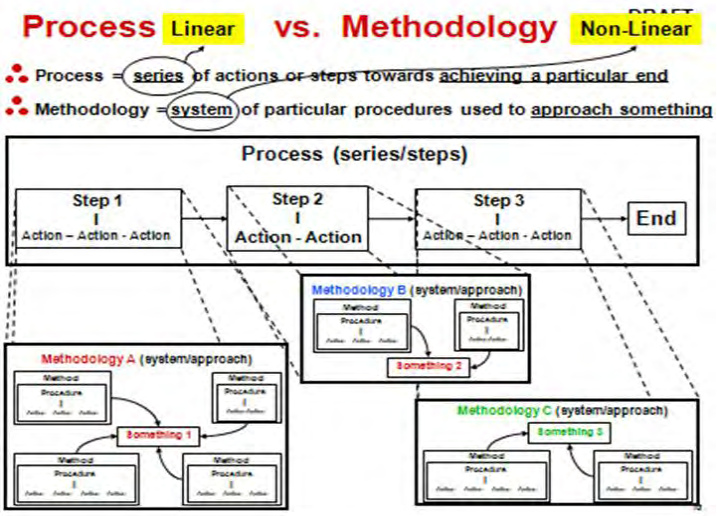


**Figure 6. Process versus Methodology.**
Source: Directorate of Land Concept Designs.

Notwithstanding the fact that CF OPP is a process, which may seem pedantically linear, there are elements embedded in the process, such as the Joint Intelligence Preparation of the Battlespace (JIPB) and mission analysis, which emphasize systems thinking.[224]

**Quantitative Analysis of Systems Thinking**

An initial review of the JCSP 38 syllabus reveals a number of formal learning activities within the programme's formal curriculum that are related to systems thinking. These formal learning activities can be observed mainly in courses and lectures that are directly related to systems thinking, and other courses such as the Basic Joint Operational Planning under (DS 544), and Leadership and Ethics (DS 541). Each of these aspects of formal learning are examined in turn.

Courses and Lectures Directly Related to Systems Thinking

There are a number of courses and lectures that are devoted to learning systems thinking. A breakdown of this content is captured in Table 4 below.

[224] Canadian Forces College Guide to CF OPP (2012), 2-17. This guide describes JIPB as an "analytical process used by joint intelligence organizations to produce intelligence assessments estimates, and other intelligence products in support of the joint force commander's decision making process." JIPB analyzes and synthesizes all dimensions of the battlespace to determine the adversary potential courses of actions. Canadian Forces Joint Publication (CFJP 5.0), B-GJ-005/FP-000, The Canadian Forces Operational Planning Process (2008), 4-4. CFJP 5.0 describes mission analysis as a cognitive activity which is intended to define the problem to be solved and the results to be achieved.

| Course Code | Course Title | Time Allocation | Remarks |
|---|---|---|---|
| DS 543/WAS/LD-6 | Into the Future: Emerging Operational Concepts | Six hours individual preparation time (IPT). 1 x 90-minute in-syndicate discussion chaired by a student, followed by 60-minute lecture and a 30-minute question period. | This lecture discusses the strengths and weaknesses of different operational concepts including Network-Centric Warfare, Effects-Based Operations, Rapid Decisive Operations, and Systemic Operational Design. |
| DS 800/ELE/OL-05 | Systemic Operational Design and the Operational Planning Process: Friends or Foes? | Approximately 3 hours IPT per discussion. 6 x three hour syndicate discussions. | The purpose of this elective is to provide students another tool that would help them to decide and plan in a more and more complex environment. |
| C/DS 800/ELE/OL-2 | Systems Thinking and Strategic Analysis (Seminar-1) | Three hours IPT 1 x 90-minute in-syndicate discussion chaired by a student. | This Seminar examines the concepts of systems thinking and "wicked" problems as central to addressing strategic issues that highlight integrative, holistic analysis, by viewing problems as parts of the overall system of interrelated component parts. |
| DS 544/OAP/LD-XX543 (TBC) | Alternative Approaches to OPP | No IPT. 90 minute lecture delivered by the Directing Staff. | This lecture includes an introduction to systems thinking. |

**Table 4. A summary of JCSP 38 course content dedicated to learning systems thinking.**
Source: JCSP 38 Syllabus

The most obvious aspect of the programme that is directly related to systems thinking is seen through the module titled "Systems Operational Design and Operational Planning Process (OPP): Friends or Foes?"[225] The aim of the course is to provide students with "another tool that will help them decide and plan in an increasingly complex environment".[226] However, this module is only offered as an elective on JCSP, does not form part of the core curriculum, and has a typical course load of 10 students. Therefore, only those students that take this elective receive any substantial exposure to systems thinking or, as LCol Lacroix-Leclair, a member of the CFC Directing Staff (DS) who teaches the module, aptly states "understanding and dealing with complexity."[227]

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[225] Canadian Forces College, "JCSP 38 Activities – Electives: Systemic Operational Design and the Operational Planning Process: Friends or Foes?, http://barker.cfc.dnd.ca:2009/report/ log_report_ e.php?ActivityID=677; Internet; accessed 9 January 2012.

[226] *Ibid*.

Aside from the aforementioned elective on systems thinking, the JCSP 38 curriculum offers only a few other formal learning opportunities within the programme that are directly related to learning systems thinking. For example, there is a lecture discussion (LD) titled "Into the Future: Emerging Operational Concepts" that speaks directly to the impact that emerging operational concepts and methodologies like Systemic Operational Design (SOD) will have on the art of war.[228] One of the lecture's main learning objectives is to provide students with a critical examination of SOD with emphasis on discerning strengths and weaknesses of systems thinking.[229] The readings also make reference to chaos and complexity theory and their impact and contributions to Revolutions in Military Affairs (RMA).[230] The Advanced Leadership elective also includes a seminar on "Systems Thinking and Strategic Analysis." The intent of this 90 minute seminar is to study concepts on system thinking and holistic analysis to deal with complex problems that are resident in strategic issues.[231] More recently, CFC incorporated a 90 minute lecture on "Alternative Approaches to OPP" which includes a basic introduction to systems thinking.[232]

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[227] LCol Jérôme Lacroix-Leclair, conversation, 19 December 2011. LCol Lacroix-Leclair has been teaching this elective since 2009. LCol Lacroix-Leclair indicates that the inclusion of this elective into the JCSP curriculum was initiated in 2005 through the efforts of individual educators from both the professional and academic faculty at the College. Because this elective is only a local initiative and not mandated as part of the core curriculum its continued inclusion in the JCSP curriculum is directly attributable to the individual efforts of faculty members who share an interest in this field of study.

[228] Course Outline*, "Systemic Operational Design and the Operational Planning Process: Friends or Foes?,"...,1*.

[229] *Ibid*., 1.

[230] *Ibid*., 1.

[231] Course Outline, "Advanced Leadership Topics,"…,3.

[232] LCol Terry Leigh, conversation, 19 December 2011. LCol Leigh indicates that this lecture will be included into the JCSP curriculum for the first time commencing 2012.

The formal activities captured in Table 5 represent those most directly linked to learning systems thinking.[233] Moreover, these four activities represent a time allocation of approximately 46 hours dedicated to systems thinking. For those students who take the elective on Systemic Operational Design this equates to approximately 40 hours.[234] Therefore, a student who does not take the electives on SOD or Advanced Leadership will dedicate on average approximately six hours directly related to learning about systems thinking.[235]

Basic Joint Operational Planning (DS 544)

There are also a number of formal learning opportunities within DS 544 that are dedicated to systems thinking. One of the key learning objectives of this course is "interpreting the operational art, including the stages of the CF OPP."[236] A review of the course modules of DS 544 indicates that this course allocates at least 48 hours to learning the CF OPP as outlined in Table 5.

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[233] Canadian Forces College, JCSP 38 Syllabus Joint Command and Staff Programme Residential, http://www.cfc.forces.gc.ca/118/231/cfc300-38_e.pdf; Internet; accessed 16 December 2011.

[234] This time allocation of 40 hours includes both individual preparation time (IPT) and discussion/lecture activities as detailed in Table 1. Approximately 2 hours for the lecture/discussion on "Into the Future: Emerging Operational Concepts" and 1.5 hours for the lecture "Alternative Approaches to OPP" and 36 hours for the SOD Elective.

[235] The six hours is broken down as follows: Approximately 2.5 hours for the lecture/discussion on "Into the Future: Emerging Operational Concepts" and 1.5 hours for the lecture "Alternative Approaches to OPP." An extra two hours has been factored in for IPT and APT.

[236] Canadian Forces College, "JCSP 38 Syllabus Joint Command and Staff Programme Residential," http://www.cfc.forces.gc.ca/118/231/cfc300-38_e.pdf; Internet; accessed 16 December 2011.

| Course Code | Course Title | Time Allocation | Remarks |
|---|---|---|---|
| DS-544/OAP/LD-1 | The CF Operational Planning Process | Programme Time: 3.0 hours<br>Preparation Time: 4.0 hours | To familiarize the student with the concepts behind operational art and, in addition, with operational planning. |
| C/DS544/OAP/TU-1<br>D1/DS544/OAP/TU-1<br>J/CF544/JSO/TU-1 | Operational Planning: Vikings' Revenge | Programme Time: 6.0 hours<br>Preparation Time: 3.0 hours<br><br>(3 x iterations)<br><br>Programme Time: 18.0 hours<br>Preparation Time: 9.0 hours | To familiarize students with stages I, II and parts of stage III of the CF OPP and the elements of operational design. |
| C/DS544/FUN/LD-6<br>D1/DS544/FUN/LD-6<br>J/CF544/JSO/LD-6 | Joint Intelligence Preparation of the Battlespace | Programme Time: 3.0 hours<br>Preparation Time: 6.0 hours | To interpret the Joint Intelligence Preparation of the Battlespace (JIPB) process at the operational level. |
| C/DS544/OAP/LD-2 | Campaign and Operational Design | Programme Time: 3.0 hours<br>Preparation Time: 2.0 hours | To develop an understanding of the concepts of operational art, operational planning, strategic-level Campaign Design and operational-level Operational Design. |

**Table 5. A summary of JCSP 38 course content dedicated to learning Systems Thinking as part of a process (i.e. CF OPP).**
Source: Canadian Forces College, "JCSP 38 Syllabus Joint Command and Staff Programme Residential," http://www.cfc.forces.gc.ca/118/231/cfc300-38_e.pdf ; Internet; accessed 16 December 2011.

It must be noted that one of the main teaching points of DS-544/OAP/LD-1 includes the introducing the role of the CF OPP as a problem solving methodology. As well, all of the DS 544 courses outlined in Table 5 include a supported learning objective C201e — "Demonstrate the ability for creative thinking and problem solving techniques." Together, this teaching point and supported leaning objective suggest that the DS 544 series on CF OPP does in fact cover aspects of systems thinking, which is inherent in systemic tools like mission analysis and JIPB.

It should also be mentioned that DS 544 includes a three hour written scenario-based exam to confirm their understanding and ability to apply the CF OPP.[237] At least one of the

[237] There is one question within the exam which requires the application of systems thinking tools like the JIPB.

exam questions requires that students apply elements of mission analysis and JIPB. Using a subjective calculation of the course modules in DS 544, a student could conceivably spend 16 to 20 hours of the 48 hours learning about methods and or tools based on systems thinking.[238]

Leadership and Ethics (DS 541)

In addition to lectures and courses directly related to systems thinking and the course modules in DS 544 on CF OPP, there are a number of modules within Leadership and Ethics (DS 541) which touch on aspects of systems thinking as outlined in table 6.

| Course Code | Course Title | Time Allocation | Remarks |
|---|---|---|---|
| DS541/LDR/LD-3 | Leadership and the Dynamics of the Human Environment | Programme Time: 3.0 hours<br>Preparation Time: 1.5 hours | To develop an understanding of the relationships between leadership and social or cultural settings and the impact of group dynamics. |
| DS541/LDR/LD-4 | Cultural Complexity | Programme Time: 3.0 hours<br>Preparation Time: 1.5 hours | To familiarize the students with the conceptual models for understanding cultural complexity in international contexts. |
| DS 541/EFF/TU-1 | Critical and Creative Thinking | Programme Time: 3.0 hours<br>Preparation Time: 1.5 hours | To develop and practice the fundamentals of critical thinking, creative thinking and problem solving and to provide them with useable tools and techniques to generate better ideas. |
| DS541/EFF/TU-2 | Discourse Analysis | Programme Time: 4.5 hours<br>Preparation Time: 1.5 hours | To develop the student's understanding of discourse analysis as a powerful tool to understand the perspectives of others. |
| DS541/LDR/SM-1 | Leading in Culturally-Complex Environments | Programme Time: 3.0 hours<br>Preparation Time: 1.5 hours | To reinforce and assess the students' understanding of the dynamics of exerting leader influence in culturally-complex settings. |
| DS541/EFF/SM-1 | External Adaptability | Programme Time: 3.0 hours<br>Preparation Time: 3.0 hours | To reinforce and assess the students' understanding of leadership approaches to influence external constituents. |
| DS 542/ENV/SM-1 | Command in Complex Settings | Programme Time: 3.0 hours<br>Preparation Time: 1.5 hours | To reinforce and assess students understanding of the complexities of command in multinational and interagency contexts. |

**Table 6: A summary of DS 541 course modules related to learning Systems Thinking.**
Source: Canadian Forces College, "JCSP 38 Syllabus Joint Command and Staff Programme Residential," http://www.cfc.forces.gc.ca/118/231/cfc300-38_e.pdf; Internet; accessed 16 December 2011.

[238] The allocation of 16-20 hours is based on a student spending approximately 4-5 hours per course in Table 5. Furthermore, this time allocation includes both student preparation time and the practical application of the systemic tools such as mission analysis and JIPB.

A close examination of DS 541 reveals how its course modules are related to the promotion of systems thinking. For example, the tutorials on "Creative and Critical Thinking" and "Discourse Analysis" emphasize tools and techniques to understand the perspective of others and to generate better ideas to tackle problems. The lecture-discussions "Leadership and Dynamics of the Human Environment", "Cultural Complexity", and "Personal Resilience" all deal with understanding the challenges associated with leading in a multidimensional environment. These same themes are found in the seminar titled "Command in Complex Settings" which emphasizes the importance of understanding multiple perspectives in the context of multinational and interagency contexts and the complex demands that this places on a commander under these circumstances.

Building on these modules are the seminars titled "Leading in Culturally-Complex Environments" and "External Adaptability." These seminars reinforce the requirement for understanding and utilizing different leadership approaches to ensure a leader possesses the intellectual agility to effectively influence and lead within complex environments. Interestingly, these two seminars stress the importance of adopting a holistic view of the environment. Specifically, both seminars aim to increase students' ability to view culturally complex environments as a "system of inter-related component parts."[239] This reference to the environment as a "system" infers that it can also be perceived as a CAS. It also suggests that it can be best examined through a systems thinking approach. Based on this linkage, one can argue that systems thinking is therefore an important cognitive competency for understanding conflict

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[239] Canadian Forces College, JCSP 38 Course Schedule, http://barker/CFCScheds/JCSP38/ Term2/ term2schede.html#w17; Internet; accessed 29 April 2012.

as a CAS. This is not to say that systems thinking is deemed as the only tool necessary for problem solving. Rather, it suggests that it is a cognitive competency that assists leaders in dealing with the complexity of the COE and the complex problems generated therein.

The eight modules included in table 6 represent almost 40 hours of study which can be associated with learning systems thinking. Once more, all of these courses some a common supported learning objective C201e –" Demonstrate the ability for creative thinking and problem solving techniques."[240]

Taken together, these three elements of JCSP represent a time allocation of approximately 60 to 65 hours associated with learning systems thinking within the formal curriculum.[241]

**Qualitative Analysis**

Whilst the time allocated to systems thinking within the formal curriculum seems adequate why does there appear to be an imbalance between learning this method in comparison to linear thinking? Although it is difficult to discern all the factors that may contribute to this imbalance, one of the primary reasons can be linked to the actual delivery of the formal curriculum itself. This delivery of the formal curriculum itself can be influenced by a number of factors which include, but are not limited to the following: instructor competence and knowledge of systems thinking; students' experiential foundation and interest in the subject

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[240] Canadian Forces College, JCSP 38 Course Schedule, http://barker/CFCScheds/JCSP38/Term2/term2sched_e.html#w17; Internet; accessed 29 April 2012.

[241] The number is calculated as follows: 6 hours from curriculum directly related to systems thinking; 20 hours from DS 544; and 40 hours from DS 541 and 542.

itself; and the time available to instruct and apply the formal curriculum related to this method of thinking.

A directing staff (DS) that is not comfortable with a subject like systems is likely to revert back old patterns and tendencies in thinking. Given that aspects of systems thinking have only recently been included into the CF officer QS which was published in 2011, it is not surprising then that the majority of DS and students alike who are either currently instructing on or attending JCSP 38 would be more apt to using more traditional, linear methods of thinking. Robert Jervis, a highly regarded professor in international affairs, ties this reflexive tendency to the fact that "Intuitively we often think of linear systems."[242] This tendency to think linearly can be further entrenched by time. Under a compressed time schedule it is more likely that an individual will employ habitual ways of thinking in order to complete the tasks and meet the learning objectives of the activity. This may cause an individual to rush into planning for a problem at the expense of actually thinking about it.[243]

Any one of these factors can drive the delivery of formal curriculum on systems thinking in a linear way. As a consequence, this risks reinforcing linear thinking. This situation may also be exacerbated through the pedantic focus placed on learning processes like the CF OPP. This assertion is reinforced by Shruti Sardeshhmukh and Ronda Smith-Nelson, academics who have written extensively on entrepreneurship education. Sardeshmukh et al., contend that "the current emphasis on such linear process (…) is incongruent with the complex and non-linear thinking patterns that entrepreneurs need to use."[244] Thus, it appears that the delivery of the

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[242] Jervis, *"Complex Systems: The Role of Interactions*…, 2.

[243] T.C. Greenwood and T.X. Hammes, "War Planning for Wicked Problems," *Armed Forces Journal* (December 2009): 1.

formal curriculum on systems thinking risks being subordinated to linear thinking if it is done using a linear approach. For example, one of the slides in the presentation delivered to students on JCSP 38 entitled, "The CF OPP Planning Process," indicates that "CF OPP is a tool (or framework) to help commanders and staff to solve complex problems."[245] While the presentation adequately described the stages of the CF OPP it made no real distinction between the process itself and those systemic tools nested within it, like mission analysis, which can be used to make sense of complex problems. As a result, these systemic tools were reflected as just another part of the linear process rather than methodology within a process. This exclusion diminishes the importance of these systemic tools and methods of thinking. Although CF OPP is a process which can use a combination of linear and systems thinking, the focus on process seems to emphasize more linear constructs.

**Informal Learning Activities**

There are a number of informal activities that occur throughout JCSP which contribute to the development of systems thinking. As stated above, informal learning entails those activities which are not written in the formal curriculum. Field Study Exercises (FSEs), and Fire Side Chats and individual research papers represent some of the more prominent examples of informal learning activities that occur throughout the programme. Each of these activities is discussed below.

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[244] Shruti R. Sardeshmukh and Ronda M. Smith-Nelson, "Educating for an Entrepreneurial Career: Developing Opportunity –Recognition Ability," *Australian Journal of Career Development* 20, no. 3 (Spring 2011): 48.

[245] Powerpoint Presentation titled "The CF OPP Planning Process," delivered 6 February 2012.

Field Study Exercises

There were a total of three FSEs conducted during JCSP 38. These off-site visits provide an opportunity to discuss relevant policy, defense and security issues and engage in informal learning activities outside the classroom. For instance, the FSE on domestic operations included a formal panel discussion with staff officers from strategic and operational headquarters on the application of OPP within a "real world" context. The venue provided a privileged platform for the sharing of candid opinions and perspectives by panel members, most of whom were graduates of previous JCSP courses. This exchange and interaction helped students grasp some of the realities and limitations associated with the practical application of OPP. It also helped students understand the importance of analysis and critical thinking as part of this process.[246] What was equally valuable was the informal exchange that occurred after the panel discussion between students and panel members. It gave students the chance to engage one-on-one with panel members to follow up on and gain further insights on issues that were raised during the formal panel discussion.

The above example represents but one informal learning opportunity provided to students during the Domestic Operations FSE. In fact, these informal exchanges are a regular occurrence during the FSEs and afford students the time to engage speakers and subject matter experts in the areas of personal interest that they may not otherwise receive through formal academic study.

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[246] Canadian Forces College, Field Study Exercise (FSE), 21 March 2012.

Fire Side Chats

Another dimension of informal learning occurs through student interactions outside of the course curriculum. These interactions can be encouraged through numerous mediums, one of which is termed Fire Side Chats. A Fire Side Chat represents an informal learning opportunity for JCSP students as well as CFC staff to discuss with more senior students attending the National Studies Programme (NSP) at the CFC a topic of mutual professional interest.[247] These chats occur roughly once a month and their format is intended to be less formal than a stand-up presentation in the main lecture theatre. They provide NSP students "the opportunity to share their individual experience(s) in a specific topic area and lead a professional discourse in a more interactive format with a group of interested students and staff."[248] This informal learning activity exposes students to topics and experiences that are outside their experiential realms. During JCSP 38 the topics ranged from CIDA and the CF's experience in Kandahar PRT, to Pakistan's Geo-Political Realities, and to Personal Insights on our Capital Acquisition Process. The diverse scope of these interrelated defence and security issues exposed JCSP students to a host of conflict trends within the COE that they would not normally receive during the formal course programme. They also permitted students to engage in informal yet thought provoking discussions that enabled them to gain an appreciation of the divergent perspectives and opinions concerning approaches to the resolution of these conflict trends.

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[247] Brian Moseley, E-mail titled Fireside Chat, sent 28 Sep 2011. Moseley, the Program Officer for JCSP 38, uses this e-mail to describe the scope and intent of the fire side chats and promote the benefits of these venues for JCSP students.

[248] *Ibid*.

Individual Research Project

Another informal learning activity involves an individual research project, in particular the MDS. Former Director of CFC, Randall Wakelam, points out that the aim of the MDS is not the attainment of the graduate degree per se.[249] Rather the target is "a mature intellect, capable of dealing with the professional challenges of the post-Cold War world."[250] Coombs suggests that the MDS "exists as an extension of the RMC academic programs, and provide[s] a depth and academic rigour to what otherwise might be a narrowly focussed professional program."[251] In essence, the MDS affords students an opportunity and latitude to expand their knowledge on pertinent professional matters that are outside their "comfort zone" and that are not necessarily found within the formal curriculum much like the fire side chats. This author's MDS is a case in point.

There are two other aspects of the programme that contribute to informal learning that deserve mention: the heterogeneity of the student population; and the inclusion of Individual Preparation Time (IPT).

The course load for JCSP 38 is 128 students from the CF's four services; Army, Air, Navy and SOF.[252] Included in this total is a mix of international students. For JCSP 38 there were 21 international students representing 17 different nationalities. The mix of all four services, coupled with the inclusion of the international students provides a unique learning

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[249] Robert Wakelam, "Dealing With Complexity and Ambiguity." Strathrobyn Papers, no. 4 (2010),14 ; http://www.cfc.forces.gc.ca/237/280-eng.pdf; Internet; accessed 13 March 2012.

[250] *Ibid*., 14.

[251] Coombs, *"The Evolution of Canadian Forces Staff Education* …55.

[252] Joint Command and Staff Programme 38 Homepage; http://barker/Admin/JCSP38/Admin/profile-jcsp38.pdf; Internet; accessed 1 April 2012. The course profile for JCSP 38 indicates a total of 107 Canadian students in attendance. The breakdown by service is follows: Army 46, Air 36, Navy 24, and SOF 1.

environment for CF officers. It is an environment that encourages a cross-pollination between students of different environments and exposes CF officers to different cultures and divergent perspectives. This includes how people think as well as how they perceive conflict and other related issues. Paul Iles, a clinical psychologist who is widely published in the field of organizational development and learning, remarks that "heterogeneous teams with diverse perspectives and resources are more likely to be creative and innovative, and therefore diversity is likely to give rise to greater organizational flexibility and adaptability."[253]

Another area where informal activities can occur is during programme preparation time. There are two types of preparation time incorporated into the JCSP timetable to prepare for and to complete preparations for formal activities: Assignment Preparation Time (APT) and Individual Preparation Time (IPT).[254] Preparation time includes reading, researching, and reflecting on programme activities.[255] For JCSP the schedule builds in three hours per evening and six hours per weekend for IPT. However, when there is a deficit in IPT it is compensated for in the scheduled under the label of APT. Although preparation time is "built-in" into the schedule it still represents an opportunity where informal learning can occur. In a sense, it permits students personal study time to contemplate and reflect on learning activities in an unstructured format. As mentioned above, informal learning can even occur during formal activities such as during syndicate discussions and exercises.

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[253] Paul Iles, "Learning to Work with Difference," *Personnel Review* 24, no. 6 (1995), 47.

[254] Canadian Forces College, *Syllabus JCSP*…, 1-8.

[255] *Ibid*., 1-8

**Qualitative Analysis**

All of these informal activities provide opportunities for students to be exposed to and learn different perspectives on how conflict is viewed and how complex problems are solved. These perspectives may encourage the examination of conflict as a CAS, as well as the use of methods like systems thinking to assist in this endeavour. However, informal learning depends heavily on the individual and their motivation to learn. They can also be constrained by the time each individual dedicates to the preparing for formal learning activities. Some of these activities demand significant preparation time, which may detract from informal learning. This demand will vary between individual students depending on their familiarity and interest in the subject material. As such, it is difficult to measure activities associated with informal learning. That said, it can be argued that JCSP does offer students opportunities outside of the formal curriculum that exposes them to unique views of conflict, as well as alternative methods of thinking like system thinking. Although the content of these activities may not be directly related to systems thinking, it can be argued that anything that exposes a student to holistic thinking supports the development of systems thinking. Ultimately, however, the extent to which these opportunities are leveraged depends greatly on an individual student's propensity and motivation to pursue and or seize learning opportunities outside the formal course curriculum that promote systems thinking.

**Observations on the Analysis**

The examination of JCSP 38 offers a number of observations regarding formal and informal learning activities associated with the development of the cognitive competency of systems thinking. Three key observations are offered, the first two concerning the design of

formal and informal learning activities and the third being tied to the actual execution or delivery of the course curriculum. Together, these three observations can aid in determining if the PME that the CF's future senior leaders receive during their DP 3 affords them the opportunity to develop the cognitive competencies that are required for understanding conflict as a CAS in the COE.

Observation 1

Expressed quantitatively, the JCSP core curriculum allocates roughly 60 hours to learning methodologies like systems thinking. Despite this allocation of time dedicated to system thinking there still appears to be an imbalance for learning systems thinking in comparison to linear thinking. This imbalance appears to be heavily influenced by the manner in which the formal curriculum is delivered, which tends to be predominantly linear. This supports King's contention that PME tends to be "overly focused on the linear application of planning processes."[256]

One possible reason for this apparent deficiency in the delivery of the formal JCSP curriculum regarding methodologies like systems thinking can be linked to CF joint doctrine, specifically, the CF Joint Publication (CFJP) 5.0 on the CF OPP. The CFJP 5.0 is a manual which is intended to guide operational planning in the CF. Although the manual's preface makes reference to "new planning concepts" such as SOD, it indicates that these concepts are "not yet mature enough to be written into doctrine."[257] SOD is an application of systems thinking which

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[256] Richard King, Thoughts on the Operational Art (Quantico, Virginia: United States Marine Corps, 2006): 2, quoted in Murray Simons, *"Holistic Professional Military Development: Growing Strategic Artists"* (doctoral thesis, Massey University, 2009), 19.

[257] Department of National Defence, B-GJ-005-500/FP-000 *The Canadian Forces Operational Planning Process (OPP)* (Ottawa: DND Canada, 2008), i.

can assist commanders in operational planning. The fact that a systems methodology like SOD is still not part of our doctrine suggests that systems thinking itself is limited in making the contribution that it could with the CF OPP as compared to linear methods even though systemic tools like mission analysis and JIPB are already used within this process.

Perhaps systems thinking methodologies like SOD need to be validated through further experimentation before it can be accepted into CF doctrine and fully appreciated as a valid method that can be integrated into a planning process like CF OPP. In 2009, the Director Land Concept Designs (DLCD) initiated a study into the need for a shared interagency planning process to address complex problems within the COE.[258] The study also called for the consideration of an approach which entailed the integration of methodologies like SSM into a known process like OPP to address the complexities of both today's and tomorrow's security problems."[259] The study was to culminate with an experiment, as part of Army Experiment 10 (AE 10), to investigate the viability of such an integrated approach to improve interagency planning capability.[260] Unfortunately, the experiment never materialized.[261]

Whilst JCSP focuses on both process and methodologies there appears to be an emphasis on linear thinking. This seems to stem primarily from the linear approach to deliver the curriculum related to systems thinking. This approach reinforces linear thinking and, in so doing, subordinates systems thinking methods and tools to more linear methods and processes.

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[258] LCol Bill Cummings "Thoughts on a Complex Problem Solving Approach to form the basis of a Whole of Government Planning Approach to Fragile States" (Kingston: Directorate Land Concepts and Designs AoT Design (Structure), 6 December 2009).

[259] *Ibid*., 19.

[260] *Ibid*., 39.

[261] LCol Bill Cummings, telephone conversation, 15 May 2011. LCol Cummings indicated that the lack of funding was one of the primary reasons for cancelling the inclusion of the validation of the interagency planning process during AE 10.

Granted, systems thinking methodologies like SOD for example are still a somewhat novel idea, requiring further maturation, in comparison to proven, traditional linear methods of thinking as well as processes like CF OPP. Notwithstanding the fact that systems thinking is included as an elective within the JCSP, it would seem that until validation of the relevancy of this methodology within the context of CF OPP occurs, systems thinking will remain on the periphery of the core curriculum even though the realities of complexity within the COE might warrant otherwise. However, the fact that JCSP has included systems thinking as an elective into JCSP curriculum demonstrates an interest on the part of CFC faculty to provide students with opportunities to develop this cognitive competency.

Observation 2

Without a doubt the formal and informal learning activities mentioned above provide some valuable opportunities for students to gain different perspectives on conflict and for examining complex problems. However, there appears to be a lack of focus with respect to the practical application of alternative thinking methods during certain formal activities, such as exercises. Because the delivery of the formal curriculum places emphasis on linear thinking and process it detracts from learning how to think through the problems using systemic methods like mission analysis and JIPB. The frequent calls made by the directing staff to "follow the process" during exercises seems to reinforce this claim.[262] This is in line with issues raised by a CFLI technical report published in 2008 which sited that "OPP was applied too mechanistically."[263]

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[262] This is based on the author's experience during on two CFOPP exercises while attending JCSP 38; Exercise VIKING REVENGE and Exercise JARDINS ENTREMERS. The intent of these exercises was to practice campaign design at the operational level using the CFOPP up to and including stage three – COA Development. On numerous occasions during both exercises it was constantly reiterated to students to "stick with the process." Ex VIKING REVENGE aims to familiarize students on elements of operational design while Ex JARDINS ENTREMERS aims to develop the students' ability to think and plan at the operational level using the CFOPP as a

It seems that the application of these systems thinking methods are either not performed at all or if they are, they are performed "implicitly within the mind of individuals."[264] As a result, students are inclined to default to old habits for examining problems. This may include the way in which they attempt to formulate solutions in the "face of complexity", which is often achieved through analytic and linear constructs.[265]

Observation 3

It can be argued that the observations raised above concerning course design can be attributed to the actual execution and/or the delivery of the course curriculum itself. This appears to stem from the difficulty associated with understanding a methodology like systems thinking. Ryan, drawing on conclusions made by U.S. historian Matt Mathews, cited the following regarding the application of a systems thinking methodology like Shimon Naveh's SOD:

> Shimon Naveh's SOD has come under much criticism for being nearly incomprehensible to those who were charged with its implementation. The core of SOD may not be without merit, but it is useless if it cannot be understood by officers attempting to carry out operation orders using SOD terminology and methodology.[266]

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planning tool. Notwithstanding these aims, both exercises include learning objective C201e — Demonstrate the ability for creative thinking and problem solving techniques. This seems to place some importance on the application of systemic tools and methods as part of the CF OPP.

[263] Bentley, *"Broadsword or Rapier?...*, 13.

[264] Schmitt, *"A Systemic Concept for Operational Design…*, 8. Schmitt notes that quite often the application of Design, which is a methodology rooted in systemic thinking, is largely absent during planning processes.

[265] *Ibid*., 8.

[266] Alex J. Ryan, "Applications of Complex Systems to Operational Design": 1258; http://necsi.edu/events /iccs2011/papers/40.pdf; Internet; accessed 13 March 2012.

Ryan points out that even Naveh acknowledges the difficulty in understanding a systems thinking method like SOD.[267] Naveh's acknowledgement is telling and certainly does not lend confidence in the utility of this method for dealing with conflict as a CAS. If Naveh, the pioneer of SOD, concedes to a difficulty of understanding SOD, one can only imagine the trials and tribulations that DS might have trying to grasp the essence of systems thinking well enough to instruct and coach students through methods like SOD with a respectable degree of competence.

Still, others like Milan Vego, a Professor of Operations in the Joint Military Department at the Naval War College, state that systems thinking provides nothing more than a reductionist and simplistic perspective for examining problems.[268] Vego contends that proponents of systems thinking attempt to discern complexity through "scientific certainties" in order to reduce and separate "tangible and intangible elements" of problems into "nodes and links."[269] He also claims that this approach that does not account for the "friction and fog" in war which makes it impracticable to separate tangible and intangible elements.[270] Vego concludes that "the traditional way of military thinking is more comprehensive" than viewing conflict through a "systems of systems prism." This one perspective certainly brings into question the usefulness of systems thinking methodologies.

However, the claim that systems thinking is nothing more than analytic, linear thinking shows the schism between interpretations on what this method is actually all about. If one

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[267] *Ibid*., 1259.

[268] Milan N. Vego, "Systems Versus Classical Approach to Warfare," *Joint Force Quarterly* 52, 1st Quarter (2009), 43.

[269] *Ibid*., 43.

[270] *Ibid*., 43.

cannot agree upon a common understanding of what systems thinking actually is then how can we formulate a coherent approach to instruct it?

The difficulty in comprehending systems thinking, combined with the divergent perspectives on this method, raise questions as to its utility for understanding conflict as a CAS and examining complex problems. Moreover, these issues represent significant challenges associated with instructing and coaching students on this methodology. One can thus appreciate why there might be difficulty and, to a certain extent, resistance among by DS and students alike to understand and apply systems thinking vis-à-vis linear thinking and linear processes like CF OPP. This creates the conditions where formal learning activities related to systems thinking are subordinated and or overshadowed by linear methods.

**Assessment**

These three observations taken from the examination of JCSP 38 lead to one main conclusion. Although JCSP boasts a number of formal and informal activities which afford students the opportunities to learn systems thinking, these activities appear to fall short of their mark due to the manner in which they are delivered. The issue with delivery appears to be caused by a lack of education and understanding on systems thinking methodologies. This results in a "say-do" gap between what is written in course curriculum and how it is actually taught during the course. It also risks having learning activities related to systems thinking subordinated to linear constructs, which results in lost educational opportunities to apply systems thinking. Although informal learning can be thought to mitigate the formal activities, its unstructured and uncontrolled nature are such that it cannot be relied upon as a guaranteed supplement to formal learning. Based on this conclusion, the PME that the CF's future senior

leaders receive during their DP 3 does not adequately permit them to develop the cognitive competency of systems thinking that they require in understanding conflict as a CAS in the COE.

**Recommendations on a Way Ahead**

There are a number of recommendations to ameliorate this situation. These include: one, the need to include additional formal learning activities on systems thinking; two, the need to educate CF Officers earlier in their careers on methodologies like systems thinking; and three, the validation of systems thinking methodologies as part of the CF OPP. Each recommendation is elaborated below.

**Recommendation 1 – Improve the delivery of formal learning activities on systems thinking within formal JCSP curriculum**

CFC can improve the manner in which it delivers formal curriculum related to systems thinking. Specifically, it needs to do a better job in articulating the difference between methods and processes. This explanation needs to include the relationship that exists between methodologies like linear and systems thinking and processes like the CF OPP. The simple distinction between methodologies and processes will enable a better understanding of the methods of thinking, as well as an enhanced appreciation for the systemic tools like mission analysis and JIPB that exist within the CF OPP that can be leveraged to assist in understanding complex problems.

**Recommendation 2 – Educate CF Officers earlier in their careers on methodologies like systems thinking**

The addition and delivery of formal learning activities into PME requires educating CF officers on systems methodologies within a broader context that goes beyond the PME delivered during DP 3. Educating CF officers on systems thinking methodologies needs to start at an earlier stage in their PME than DP 3. Some sources suggest that this needs to occur during DP 2 focused at the senior captain level.[271] Introducing these methods at an earlier stage of the CF officers DP will expand their cognitive inventory in methods for examining problems so they are better equipped to understand conflict as a CAS and to deal with the complex problems that they will invariably encounter during their employment and throughout their careers as they ascend through the DPs. The inclusion of aspects of systems thinking into the CF officer QS should assist in institutionalizing these methods within the PME that is delivered within the DPs.

**Recommendation 3 - The validation of systems thinking methodologies as part of the CF OPP**

More experimentation needs to be done to validate this "new" way of thinking and make it more mainstream within the CF. Recently, however, DRDC scientists have conducted a series of experiments which have shown some promise in the area of improving decision making and adaptation skills in complex situations. The experimentation has leveraged simulated complex environments (also known as interactive learning environments) with the aim of enhancing systems thinking skills and improving the "cognitive readiness" of military officers and civilian members engaged in comprehensive operations so that they are better prepared to understand and

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[271] Bentley, *"Rapier or Broadsword?"*…, 21

adapt to complex situations.[272] Further experimentation in this domain to "Canadianize" a systems thinking methodology will spark a wider awareness, interest and acceptance within the CF for the integration of systems thinking into main stream doctrine and the CF officers' PME. Either way, whatever methodology the CF adopts it will have to be "compatible with natural human cognition processes,"[273] while satisfying the intellectual needs of the CF officer corps so they are armed with the appropriate cognitive competencies to confront the realities of the COE.

## CONCLUSION

An examination of JSCP 38 has shown that the PME which the CF's future senior leaders receive during their DP 3 does not adequately permit them to develop the cognitive competency of system thinking that they require for understanding conflict as a CAS in the COE.

Systems thinking is a methodology which contrasts linear thinking. Linear thinking views conflict as an entity whose whole is equal to the sum of its parts. As such, conflict and its associated problems can be broken into its constituent parts and reassembled to provide a solution. Systems thinking views conflict as a complex phenomenon which cannot be understood in its entirety. It takes a more holistic view of conflict emphasizing relationships between agents in order to frame those aspects of the problem which can be framed for resolution. The differences between these two methods are such that they not only provide divergent views of a problem, but could conceivably result in generating different solutions to the same problem.

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[272] Ducharme, Michel et al. *Training Systems Thinking and Adaptability for Complex Making in Defence and Security* (Valcartier: DND Canada, 4 November 2011), 1.

[273] Schmitt, *"A Systemic Concept for Operational Design …*, 9.

The pertinence of systems thinking and the manner in which it views conflict becomes more readily apparent when examined in relation to the properties of a CAS: aggregation and non-linearity. Aggregation is the manner by which a CAS self-organizes through the aggregation of its agents. However, this aggregation generates emergent properties in the CAS which are difficult to predict with any great accuracy. The property of non-linearity makes the CAS sensitive to initial conditions whereby the overall inputs and outputs are not proportional. Both of these properties are inherent in all CAS and result in interactive and unpredictable behaviour that generate complex problems which defy linear, analytic and reductionist methods of thinking.

The interactive and unpredictable behaviour of a CAS is also reflected in the conflict trends of the COE, which include intra-state conflict, transnational crime, ethnic and religious strife, terrorism and globalization. These increase the level of interplay between actors within the COE which, in turn, increase its level of complexity such that it exhibits the same properties of a CAS. Ultimately they add a level of complexity to the COE, and its problems therein, that transcend traditional linear views of conflict.

These views of the COE as a CAS are reinforced through the influential writings of preeminent theorists and thinkers like Clausewitz, Boyd and Naveh. All conceive conflict as a CAS which reflects the interactive and unpredictable behavior of a CAS. This behaviour makes accurate prediction of conflict difficult for which linear thinking is not well suited while implying a need for a more holistic approach based on systems thinking.

These suggestions for a more systemic approach for understanding conflict as a CAS bring to the fore its importance as a cognitive competency for leadership development of the CF officer corps within the DP 3. This is evidenced by its inclusion as a cognitive competency in

the CF LDF and is reinforced through other frameworks, specifically, Paparone's et al., key leadership tasks and Zaccaro's executive leadership characteristics. Together, these frameworks underscore the important contributions that systems thinking can have in understanding the nature of a CAS, specifically, its interactive and unpredictable behaviour.

The examination of JCSP 38 highlights the relative importance placed on system thinking as part of the PME that CF officers receive during their DP 3. However, the examination of the formal and informal learning activities offered by the programme reveals three key deficiencies in the development of this cognitive competency. The first concerns an imbalance between learning systems thinking in comparison to linear thinking within the formal curriculum. The second is a lack of opportunities for the practical application of systems thinking during formal learning activities themselves. The third concerns the general lack of education and understanding of system thinking. Taken together these three deficiencies inhibit the delivery of formal learning activities related to systems thinking that is offered within the JCSP curriculum.

Despite these deficiencies within JCSP, CFC's efforts to date to incorporate methodologies like systems thinking into the curriculum have placed this institution ahead of current CF doctrine and shows promise for further integration of these concepts into the curriculum in the future. Ongoing research by DRDC on decision making in complex domains as well as the reference to systems thinking as part of the requisite elements in the recently published Officer QS should provide the impetus for the College to afford more opportunities for students who attend JCSP to develop systems thinking methodologies as part of their PME.

Given the complexity of the COE, preparing for operations within this environment in the future will undoubtedly be a difficult task. If the CF is to effectively prepare its future senior leaders to successfully operate in a COE where conflict is reflective of a CAS then they will

require a relevant PME that provides them with the cognitive competencies to deal with this reality. This requires a PME that transcends the traditional views of conflict which are confined to the Newtonian paradigm. Systems thinking represents a cognitive competency that provides an alternative lens through which the CF's future senior leaders can view conflict and the challenges that its complex and adaptive properties will undoubtedly pose for them in the COE and beyond.

# ANNEX A

## JCSP 38 COURSE LEARNING OUTCOMES AND OBJECTIVES

| Course | Learning Outcome | Learning Objectives |
|---|---|---|
| 541 | At the end of DS 541, participants will have demonstrated the requisite knowledge and understanding of the conceptual foundations of leadership required to be effective in the institutional, operational, and cross-cultural contexts cross national and international settings. | Analyze leadership using relevant theories, models, and cultural perspectives. |
| | | Analyze the role of the leader as a steward of the profession. |
| | | Synthesize theories, models and frameworks to make independent moral/ethical decisions |
| | | Examine capacities required to influence others in the institutional, operational and cross-cultural contexts across national and international environments |
| 542 | At the end of DS 542 participants will have demonstrated the requisite knowledge & understanding of the conceptual foundations of command required to be effective in the institutional, operational, and cross-cultural contexts across national and international settings. | Analyze command using relevant theories, models and regulatory frameworks. |
| | | Describe the perspectives that characterize the institutional, multi-agency, and cross-cultural environment in which command is exercised in domestic; and international operations. |
| | | Comprehend the linkages among national capacities, government objectives, and defence management. |
| 543 | At the end of DS 543, students will have analyzed warfare theory, examined the doctrinal concepts of CF operations in the contemporary operating environment, analyzed warfare theory, and examined emerging concepts, capabilities and threats from a CF and component perspective. | Analyze the impact of social, political and technological shifts on the theory and practice of war. |
| 544 | At the end of DS 544, students will have discussed the terminology and stages of the CF Operational Planning Process and applied the process in an operational-level exercise. | Interpret operational art, including the stages of the CFOPP, and apply the process up to and including stage III. |
| | | Apply the operational functions and demonstrate their significance in planning joint and combined operations. |
| 545 | At the end of DS 545, students will have analyzed the elements and capabilities of component power md applied the doctrinal concepts of component power in a contemporary operating environment. | Analyze the fundamentals, functions and command of components, and examine low they contribute to planning joint and combined operations. |
| 546 | DS 546, students will have designed md produced operational plans for full-spectrum joint and combined operations within a contemporary operating environment. | Interpret the doctrine, organization, plans and routine operations of domestic operations and continental defence, including the involvement of OGDs. |
| | | Interpret the doctrine, organization, plans and ongoing operations of expeditionary operations, including involvement of OGDs and NGOs. |
| | | Design CONOPS, using the CF O for full-spectrum joint and combined operations within the contemporary operating environment. |
| 547 | At the end of DS 547, students will have examined Canadian policymaking and major factors which influence it. They will have compared the instruments and sources of power md institutional processes, sociocultural determinants and strategic issues that shape Canadian policy. Students will also have examined the global environment with a focus on the United States, other international actors, and various international organization in which Canada plays a major role. | Compare and contrast the domestic and structural factors that influence Canadian governance, policymaking, and response mechanisms. |
| | | Compare and contrast Canadian national security, foreign, defence, and development policies. |
| | | Analyze the effects of emerging strategic sues, challenges and opportunities on Canadian foreign and defence policies. |
| | | Analyze the relationship between Canada and the United States, and understand the differences between their foreign and defence policies. |
| | | Analyze the international context (factors, actors, and systems) within which Canadian policies are generated and implemented. |

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