THE ROYAL CANADIAN NAVY AS A COMPLEX ADAPTIVE SYSTEM: LEADING IN A COMPLEX ENVIRONMENT

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By Lieutenant-Commander Phillip Durand
Par le capitaine de corvette Phillip Durand

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Abstract

The operating environment that the Royal Canadian Navy now finds itself in has become more complex, volatile, and unpredictable, and new methods of leadership are required. The examples of the American fight against Al Qaida in Iraq in 2004 and the recent collision of the USS Fitzgerald of the coast of Japan are examples of this increased complexity. This essay will argue that in order to be ready to fight, the RCN needs to approach the maritime domain with the understanding that it is a Complex Adaptable System, and use tools that are best suited for that kind of environment. The Cynefin framework allows leaders to understand the difference between ordered and predictable environments and unordered and unpredictable ones, and how to best act in each one. Complex Adaptive Systems theory, which is based on the interactions of agents, artifacts and strategies giving rise to emergent behaviors, suggest new tools that leaders can use to harness this complexity. These tools include attribution of credit, attractors, boundaries, direction and safe-to-fail experiments. Leaders in the RCN can use these tools suited for complex adaptive systems to create adaptive, innovative and creative sub-teams, departments, ships and fleets. They can understand when to be efficient and when to be resilient, and how to train teams for both situations. By applying complexity theory, the RCN can harness the complexity of the maritime operating environment in order to be ready to fight.

CHAPTER 1: DEFINING THE COMPLEX ADAPTIVE ENVIRONMENT

Once upon a time there was a rug merchant who saw that his most beautiful carpet had a large bump in the center. He stepped on the bump to flatten it out – and succeeded. But the bump reappeared in a new spot not far away. He jumped on the bump again, and it disappeared – for a moment, until it emerged once more in a new place. Again and again he jumped, scuffing and mangling the rug in his frustration; until finally he lifted one corner of the carpet and an angry snake slithered out.

– From Peter Senge's The 5th Discipline[1]

This is an essay on Complexity Theory and Complex Adaptive Systems theory, and how it can be applied to the operations of the Royal Canadian Navy (RCN). It will argue that in order to be ready to fight, the RCN needs to approach the maritime domain with the understanding that it is a Complex Adaptable System, and that its leaders must use tools that are best suited for that kind of environment. To operate in a complex environment, the RCN needs leaders and teams that are adaptable to dynamic conditions, are resilient to setbacks and casualties, have a shared consciousness and vision, and are creative, innovative and empowered. In complexity theory, these are called self-organized emergent behaviors, to which they are not divisible; if one were to consider each sailor in isolation, they would not necessarily display these traits individually. It is through their interactions that these characteristics emerge. This chapter will outline the current complex adaptive environment that the RCN operates in, using stories from Iraq, Trafalgar, and off the coast of Japan to demonstrate various complex systems at play, and how leaders can better influence them to a more desired state. Chapter 2 will introduce the Cynefin Framework, and how it allows leaders to distinguish between ordered and unordered environments, and how to operate in both. Chapter 3 will outline the mechanics of a complex adaptive system, and suggest tools that leaders can use to influence them. Finally, in Chapter 4, this essay will apply chapter 2 and 3 to the

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[1] Peter M. Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization*, 1st ed. (New York; Toronto; Currency/Doubleday, 1994), EPUB e-book, ch 4, 10.1177/0258042X1203700207.

RCN, and suggest preliminary methods to which leaders can start using these tools to create innovative, creative and effective teams, ships and fleets.

The Rise of Complexity in Iraq

In 2006, after the American military ousted Saddam Hussein from Iraq, a Jordanian by the name of Ahmad Fadil al-Khalayleh, or better known as Abu Musab al-Zarqawi, began an insurgency of terror in the vacuum left behind. Zarqawi's insurgency was unlike the Revolutionary forces that the Americans had just defeated. It was a force not based on the traditional hierarchy of a standard military force, but one based on a network. This terrorist network was initially known as Al Qaida in Iraq, which in time would evolve to the Islamic State in Iraq and Syria (ISIS).[2]

The American Special Forces (SOF) regiment, under General Stanley McChrystal, was perplexed. They were efficient in rounding up the remaining loyalist to Saddam Hussein, and they could quickly mount and hit multiple ISIS cells each night. But due to the restrictive regimented hierarchal procedures of the American Military, the American SOF units couldn't move fast enough, nor could they figure out where to consolidate their force in order to bring ISIS to its knees.[3] Intelligence that would have been useful to McChrystal was not being processed, or if it was processed, it was not done so in a timely fashion or in a way that was useful to the operators. When an Al Qaida unit was hit, all traces of that unit quickly were disbanded and hidden within 24 hours, making any intelligence that would have been useful to the Americans to expire promptly.[4]

Al Qaida did not operate in a traditional military fashion that the American SOF teams were used to fighting. For example, they did not have any apparent rank and structure. McChrystal

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[2] Joby Warrick, *Black flags: The rise of ISIS*. (New York, NY: Anchor, 2015), EPUB e-book, 10.1080/09546553.2016.1277665.
[3] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams: New Rules of Engagement for a Complex World*, (New York, NY: Portfolio/Penguin, 2015).
[4] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…*, 137.

continued to take out what they considered "high level" operatives, but due to their ability to adapt any high-level operative eliminated did little damage to the Al Qaida command and control structure. When interrogated, Al Qaida operatives would laugh at McChrystal's team, realizing how shallow their knowledge of the environment was.[5] Any traces that the operatives knew of were quickly disbanded by Al Qaida, rendering their knowledge, if they provided it, useless. The Americans were forever on the defensive, and rapidly losing the war.

McChrystal and his SOF team were operating in a complex environment; one recently termed as VUCA – volatile, uncertain, complex and ambiguous. It is an environment that is fundamentally unpredictable. However, McChrystal and his team assumed that the battlefield *was* predictable. He assumed that the battlefield was only *complicated,[6]* and that with enough data and analysis it could be predicted, or at least in a way that would allow them to know how to influence it in a way to meet the American's end state.

This problem is not unique to the American's story in Iraq. Over time, McChrystal was able to understand the difference between a complicated, predictable environment, and a *complex*, unpredictable environment, and adapted his team to defeat Zarqawi. But it took a fundamental paradigm shift, from the traditional military methods of concise planning and discrete operating procedures to one that mimicked the Al Qaida network. It was an approach that was no longer efficient but very adaptable.[7]

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[5] Ibid.

[6] As defined by Cynthia F. Kurtz and David J. Snowden, "The new dynamics of strategy: Sense-making in a complex and complicated world," *IBM systems journal* 42, no. 3 (2003), https://ieeexplore.ieee.org/abstract/document/5386804.

[7] The significance between efficiency and adaptability will be expanded upon in Chapter 2.

A complex environment is one that is unpredictable, volatile, and continually changes and adapts to the influences and activities of the agents within and without.[8] Complex environments are at play all around us, from small teams and office organizations to neighbourhoods and biological systems. A weather pattern, to which some of the initial research on complex systems stems, is a classic example of a complex system. The smallest variation within the system, such as the flap of a butterfly's wings, could theoretically cause (or prevent, because it isn't predictable) a tornado in Texas.[9]

The Butterfly Effect, as the phenomenon is now called, was first observed by Edward Lorenzo. While conducting computer simulations on weather patterns, he decided to rerun a simulation from the halfway point. He inputted the various values and then ran the simulation. To his surprise, the simulation resulted in a pattern so different from the previous one that it might as well had been a new simulation. It took him weeks to find his mistake, but when he did, it turned out to be the difference of a rounding error. While inputting the data for the simulation, he had rounded to the nearest 0.001, a rounding that in a complicated system would not have made any difference, but in a complex system resulted in massive changes.[10]

The world in which the Royal Canadian Navy operates is also becoming more complex. In the past, the RCN operated in an environment that was mostly complicated – networks were small and concentrated, interactions were few, information was limited, and the environment was mostly predictable. Although complexity was still inherent within these systems, large allied militaries like the USA were able to use superior force to artificially control the environment sufficiently

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[8] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times: Powerful practices for leaders*, (Stanford: Stanford University Press, 2015), ch 1.

[9] Edward N. Lorenz, "Predictability: Does the Flap of a Butterfly's Wings in Brazil Set Off a Tornado in Texas?" *American Association for the Advancement of Sciences*; 139th meeting. Sheraton Park Hotel, Wilmington Room, 29 Dec 1972, http://eaps4.mit.edu/research/Lorenz/Butterfly_1972.pdf.

[10] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…,* 55-56.

enough for to allow planners to treat it as predictable. Organizations that were the most efficient (and therefore the fastest) were the strongest.[11] However, the rapid rise of information technology has increased interactions between players to unprecedented levels. This results in an environment that is unpredictable, rapidly changing and adapting in response to all the other players. Old planning and operating models, which rely on the predictability of the environment, are no longer effective.

Complexity at Trafalgar in 1805

Gen McChyrstal's experience in Iraq against Al Qaida is a clear example of a complex environment at play. In the absence of a recent naval combat operation, Iraq provides an analogy to what a modern-day naval battle may experience. However, the past also provides examples to model new approaches to complexity at sea. Horatio Nelson's Victory at Trafalgar in 1805 provides not only an example of the complexity of the maritime environment but how a leader can manage and even influence that complexity as well.

Anyone who has served in any Commonwealth Navy knows well the story of Nelson at Trafalgar; Trafalgar is often considered the pinnacle of naval leadership and operations in both the Royal Navy and the RCN. However, although Nelson is celebrated as a heroic leader that brings great credit to Britain through his gallant charge and witty banter as he engages the French and Spanish, most miss the subtle complexity influences that he exhibited. Indeed, the story of Nelson is not one of the Great Man Theory, but instead one of an agile leader in complexity.

The night before Nelson and his fleet were to meet the French and Spanish fleets of the coast of Spain in the vicinity of Trafalgar, Nelson had a final meeting with his captains onboard his flagship, HMS Victory. After going over the plan of the initial formation and charge on what they

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[11] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…,* ch 2.

expected the enemy to do, Nelson gave a simple rule for all his captains to follow: "No Captain can do very wrong if he places his ship alongside that of an Enemy."[12] Nelson understood well the complexity of battle, especially once the enemy adapted to his plan. As such, at the battle the next day, instead of issuing controlling orders to the other ships by way of flag hoist (as is standard practice in any naval operation), Nelson "wasted" his flag signal on the witty saying that he is praised for to this day: "England expects every man will do his duty."[13]

This was not the confident exposition of a man who was more concerned with looking gallant instead of controlling his fleet. He was instead giving one last boundary and direction to which his captains were to operate in. The captains of his fleet, to which he spent years training to operate and think in a way that was innovative, creative and in line with his direction, understood the boundaries to which decisions were to remain in and where credit was attributed – put your ship alongside the enemy, and do your duty for England. Everything else was left up to them, for them to make a decision in the face of an adapting enemy. The French and Spanish fleets were decimated at Trafalgar, not because of Nelson's unorthodox method of approach to the battle. The approach itself was actually fairly common, and many captains – Nelson himself even – had used that approach before.[14] What set him apart at Trafalgar was that Nelson used boundaries, attractors and attribution of credit, while his enemy used top-down orders and controls. This essay will consider how leaders and teams in the RCN can operate in complexity today, much like Nelson was able to do 220 years ago.

Complexity at in the USA 7th Fleet in 2017

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[12]Adam Nicolson, *Seize the Fire: Heroism, Duty, and Nelson's Battle of Trafalgar*, (New York, NY: Harper Perennial, 2006), 45.
[13] Ibid, 128.
[14] Ibid, 216-17.

Although not an example of complexity of combat, a more recent example of the increased complexity of the maritime environment can be found in the recent collision of the *USS Fitzgerald* off the coast of Japan. The following story is taken from the ProPublica Feature titled "Fight the Ship: Death and Valor on a Warship Doomed by its Own Navy."[15]

On the evening of 16 Jun 2017, the American 7th Fleet ship *USS Fitzgerald* was finishing up exercises and was transiting at high speeds to its next mission. It's Captain Commander Bryce Benson, newly established as the commanding officer (CO), had retired to his quarters and left instructions to his night watch for the high-speed transit through busy waters. The watch on the bridge was reduced, was inexperienced, and was tired from the day's training activities.

The *Fitzgerald's* ability to remain safe at sea and to accomplish her missions was questionable from the start. The ship had only 7 of 22 certifications completed. The ship's email system was unreliable, and the officers used Gmail instead. The crew barely knew how to operate the questionable radar suite on board, and one of the radars required an operator to constantly push a button to ensure it remained accurate. The ship's navigation software was 17 years old and out of date. Over 40% of the crew at been replaced over the last year and the crew that remained had been serving under a previous CO that created a culture of complacency within the ship. Yet there was little time and money in the *Fitzgerald's* schedule and budget for repairs, upgrades and training, and the 7th Fleet was inundated with an increasing number of missions in the Pacific in response to a resurgent China and defiant North Korea.

Commander Benson was fully aware of the significant shortfalls of his ship and crew. He sailed early from the harbor and trained his crew hard all day. Yet as he retired to his cabin late that

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[15] T. Christian Miller, Megan Rose and Robert Faturechi. "Fight the Ship: Death and Valor on a Warship Doomed by its own Navy." ProPublica, 6 Feb 2019. Last accessed 24 Apr 2019, https://features.propublica.org/navy-accidents/uss-fitzgerald-destroyer-crash-crystal/.

night, he himself exhausted, he left control of the ship with a junior watch on the bridge. Usually a CO would remain on the bridge as they transited through a busy area of the ocean such as the one he was transiting through now; instead, he gave his junior bridge team more room to maneuver so that he would not be woken as much throughout the night.

As the ship transited the ocean off the coast of Japan, it had only one lookout on the bridge. The lookout was training with a supervisor on the port side of the ship, and nobody was monitoring the starboard side. This is significant because the rules of ship interactions at sea stipulate that ships approaching from the starboard (right) side have the right of way, much like two cars approaching a 4-way stop.[16] The *Fitzgerald* would have to yield right of way to any ship approaching from that direction.

At 0125 on 17 Jun, the Officer of the Watch (OOW) discovered *MV ACX Crystal* 3 nautical miles (nm) of her starboard quarter and realized that they were on a collision course. Although the Captain's orders and Standard Operating Procedures for the ship clearly state that the CO should be woken and informed of the approaching ship, the OOW chose to handle the situation herself. Inexplicitly, she chose not to act, even though rules of the sea dictate that the *Fitzgerald* must turn right or slow down to pass astern of the *Crystal*. It wasn't until the collision was imminent at 0129 did the OOW realize the predicament she was in and ordered evasive action that was contrary to how she should have reacted. Instead of quickly slowing the *Fitzgerald* with reverse thrust and/or turning right to try and pass astern of the *Crystal*, she did the opposite – she sped up and turned left, putting the *Fitzgerald* directly in the path of the *Crystal* moving at 22 knots (~50 km/hr). The resulting collision killed 9 sailors asleep in the lower levels of the *Fitzgerald* and incapacitated the

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[16] Government of Canada, *Collision Regulations (C.R.C., c. 1416)*, Justice Law Website, 29 Jan 2014, Last accessed 24 Apr 2019, https://laws-lois.justice.gc.ca/eng/regulations/c.r.c.,_c._1416/FullText.html.

captain. It would take 15 hours for the Fitzgerald to gain control of the resulting flooding and make its way back to port for repairs and recovery of the bodies still trapped in the mess.

Although investigative reports point to what seems to be a definite cause of the disaster at sea, and subsequent officers were charged and fired as a result of it, complexity theory cautions against the assumptions that there are singular cause and effect relationships at play in such a complex system. Complexity theory suggests that the collisions of the *USS Fitzgerald* and of the *USS McCain* later on that same year are not singular events with direct causes, but the emergent events of the interactions of the overall system at play. If this is so, then addressing the collisions with firings and Court Martials of senior officers does little to address the problems of the system from which the collisions emerged because it only addresses what emerges from the system as oppose to the mechanics of the system itself. This is much akin to stomping on the bump in the rug instead of letting the snake go free. This essay will suggest tools to address the fundamentals of the system beyond the emergent problems that are visible.

In times of peace, there is little political support to keep Navies relevant and operational. A Navy is a costly thing, and when there is little understanding on the importance that a Navy plays, it needs to understand that it must find a way to operate with little funding and relevant equipment. The RCN needs to stop anticipating that all its problems will be solved by the acquisition of the latest technologies or newest ships, and instead focus on how it can achieve its missions with the funding and equipment that it does have. The RCN's leaders and sailors need to be creative, innovative and ready to fight in the conditions they find themselves in now, instead of the conditions they anticipate to be in someday.

The Royal Canadian Navy in a Complex Environment

The RCN operates in an environment very similar to one the McChrystal operated in 2006. In fact, the defining characteristic of modern-day battlefields is one of VUCA and unpredictability. The rapid increase in information technology has created an environment that is densely interconnected,[17] in which information can travel almost instantaneously, stress can propagate through systems rapidly and in ways that are inexplicable,[18] and interactions are so varied that systems quickly respond and adapt in ways that allows for phenomena such as the Butterfly Effect to be commonplace.

The old environment that the RCN operated in was slow - limited interconnectivity, communication had significant barriers over a long distance, and events could not propagate through the system instantly. In this environment, efficiency was key because whoever could operate the fastest won. Now the environment is subject to unpredictable change and stability. A single action can create a viral effect, such as the self-immolation of the Tunisian shopkeeper that resulted in the Arab Spring. Yet at the same time a massive campaign designed to create drastic change can have little effect overall.[19] In a world that can change rapidly and unexpectedly, the RCN needs to be resilient and adaptable instead of efficient and streamlined.

The Naval environment is made of complex systems. These complex systems are not just found in the weather systems at sea, but include systems that range from the smallest teams within the ship to the complex joint operations against a near-peer enemy. HMC ships are crewed by around 220 personnel, with each person providing a unique role in the overall operations of the ship. This includes logistics personnel, food services, engineering (both mechanical and weapons), operators and medical staff. The ship is divided into various teams that are led by a senior officer

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[17] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier*, (New York: Basic Books, 2000), 25.

[18] Charles Perrow, *Normal Accidents: Living with High-Risk Technologies*, (New York: Basic Books, 1984).

[19] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 4.

and/or a senior Non-Commissioned Member (NCM) who act as the team leader. During specific operations, such as replenishments at sea (RAS) and coming alongside or departing harbor, sailors break and recombine into different sub-teams that are responsible for a certain part of the operations of the ship, depending on the operation to be conducted. The same happens during emergencies (such as a fire or flood onboard) or during combat operations.

Each ship is usually part of a fleet of ships, taking on various functions such as air defense, submarine hunting or air operations. Each ship takes on leadership duties for the fleet, such as coordinating the fleet's air defense, its boarding operations or its information management. A fleet, in addition, is part of a multi-domain environment, acting in space, in cyber, and in cooperation with air and land units as well. As such, there are multiple complex systems at play at any time, each influencing and adapting to the actions of the other complex systems that range from the lowest level of an attack team putting out a fire to the whole of the operation overall.

Today, as the pace of operations increases for the RCN, there are weak signals that are similar to the ones present in the 7th Fleet in 2017. The RCN is struggling to fill ships with experienced and trained crew members. There is little time and money for needed maintenance and upgrades. Shortcuts are being taken with regards to manning and supplies. Ships are proceeding on complicated missions with crews that are junior, overworked, undertrained and missing key specialty components. In short, the RCN is operating in an environment similar to the one the 7th Fleet found itself in at the time of the two collisions. This is not to suggest that a disastrous collision of an RCN ship is imminent, because a complex system is not predictable and what occurred in the 7th Fleet is not necessarily what will emerge in the RCN. It does, however, serve as a warning that the complexity of the environment that the RCN operates in has increased, and that new tools are needed to influence the system so that the RCN can avoid costly mistakes.

By addressing the complexity of the environment, and using new tools that help harness it, the RCN will instead be able to influence the situation so that it gives rise to preferable emergent behaviors such as innovation, creativity and an ability to fight. As both the story of Nelson at Trafalgar and of Gen McChrystal in Iraq serve to demonstrate, leaders can influence and even harness the complexity of the new operating environment, providing they use the proper tools. The tools used in the past may have served us, but as this essay will show that they are no longer effective because the environment has changed.

The RCN continues to approach these complex environments as if the environment was predictable. But much like the battle space at Trafalgar, in Iraq against Al Qaida or even off the coast of Japan at night, the situation has drastically changed. Much like Gen McChrystal's team, the RCN needs new strategies to be able to adapt to a rapidly changing environment. This essay will evaluate the research in complexity theory and complex adaptive systems theory, and apply it to RCN operations at the ship level and multi-domain fleet level to give suggestions to how the RCN can train its leaders and teams to better operate in this new, complex arena.

CHAPTER 2: ORDERED AND UNORDERED - UNDERSTANDING THE ENVIRONMENT

Before leaders can use tools to operate in complex adaptive environments, they need to understand when they are and are not in one. Understanding what environment a leader is operating in is a prerequisite to which tools and methods are best to approach the problem. The Cynefin Framework is a typology that allows such differentiation.

The Cynefin Framework

The Five Domains of the Cynefin Framework

Figure 1: The Cynefin Framework

The Cynefin Framework, developed by David Snowden and his team at the Cynefin Institute, is a framework that explains four different environments or systems based on their

orderedness.[20] These four categories are Simple/Obvious (Snowden changed the term to Obvious in 2014, but some models still use Simple),[21] Complicated, Complex and Chaotic environments. A fifth category is in the middle, labeled Disorder, signifying when a leader does not know which environment they are in.

Obvious and Complicated environments are considered predictable and ordered, whereas Complex and Chaotic environments are considered unpredictable and un-ordered. The ordered domains are governed by the familiar linear cause and effect that leaders and pundits so often search for. Effects that emerge can be traced back to distinct causes, although in Complicated environments finding the cause is often more difficult.

The un-ordered domains are governed by non-linear feedback loops, and therefore no distinct linear cause and effect exist, though often people try to argue the existence of such links due to their cognitive distortions. However, patterns do emerge from the interactions, to which leaders can identify and respond to. The Chaos environment is the extreme of un-orderedness, where there are no discernible patterns.

The divide between Obvious and Chaos is often depicted as a cliff, at it represents what occurs when teams become complacent in a complex environment. Often, teams will apply SOPs and routine procedures that have worked predictably in the past to situations that have evolved to which the SOPs and procedures are no longer valid. This complacency tips the team into a chaotic environment, often very suddenly.

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[20] The following description of the Cynefin Framework is a summary of David Snowden's work taken from the following publications: David F Snowden and Mary E. Boone, "A Leader's Framework for Decision Making," Harvard Business Review 85, no. 11 (2007), http://www.academia.edu/download/3459515/A_Leader_s_Framework_for_Decision_Making_-_HBR.pdf.; David Snowden, "The Cynefin Framework." YouTube video, 8:37. Posted by "CognitiveEdge," 11 Jul 2010. https://www.youtube.com/watch?v=N7oz366X0-8 and Cynthia F. Kurtz and David J. Snowden, "The new dynamics of strategy: Sense-making in a complex and complicated world," IBM systems journal 42, no. 3 (2003), https://ieeexplore.ieee.org/abstract/document/5386804.

[21] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 40.

The best actions to take are dependent on which environment the leader is acting in. In Obvious environments, leaders Sense – Categorize – Respond. As an example, a leader can sense and categorize the familiar situation, such as landing a helicopter on deck. The leader can apply the correct SOP and respond with confidence that applying the correct SOP to the categorize situation will result in a predictable outcome. This is the realm of Best Practices.

The Complicated environment is similar, but instead of categorizing the situation, leaders must Sense – *Analyze* – Respond. Analysis requires deep expertise to consider the appropriate action in this particular situation, and the leader often defers to the relevant expert. In this environment, there are only Good Practices, because often there are no right answers, only better ones. A classic example is a mechanical problem with a car, in which multiple experts (mechanics) may have different opinions to the necessary repairs, none which are wrong but some which might be better.

The Complex environment transitions to the unordered environment, and requires a much different approach than the ordered domain. Here the leader must Probe – Sense – Respond. As will be discussed in the next section, Complex environments respond and adapt to the leader's actions, making it unpredictable to how it responds. In order to learn the tendencies[22] of the environment, the leader must interact with it. The leader then senses how the environment reacts to its probe, and responds appropriately, continuing to sense and respond as the environment adapts and evolves. Through this interaction, Emergent Practice arises. It is this environment that Part III

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[22] Jennifer Berger and Keith Johnston introduce the term *tendency* to depict what is classically considered emergent behaviors. Although the literature favors emergence, the term tendency does well to depict the subtleness of these patterns. Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times: Powerful practices for leaders*, (Stanford: Stanford University Press, 2015), 39.

will consider in much more detail, including why complex systems are different from complicated ones, and tools leaders can use to probe and respond to the adaptive environment effectively.

Finally, because the Chaotic Environment contains no discernible patterns, the leader is required to Act – Sense – Respond. The leader must act on the environment immediately in order to try and influence the environment to stabilize to a point where patterns can start to emerge. Here, Action-on drills are most useful, and it gives leaders and teams a repertoire of responses to try and stabilize or contain the environment quickly.

Normally leaders, especially military ones, act in Simple and Complicated environments, and which the majority of our productivity and business procedures are based on. However, the procedures for Complex and Chaotic environments are significantly different because the Complicated procedures assume that the system is predictable, providing you have enough data. Leaders and teams struggle in Complex environments because they faithfully apply the procedures that have worked in Complicated environments, but it ends up doing more damage than good (except in rare cases). It is only when those leaders allow their teams to act with techniques that are unique to the Complex realm that leaders and teams find success. This is part of the reason why the concept that "no plan survives first contact the enemy" is so prevalent.

The Cynefin Framework therefore allows leaders to quickly distinguish what environment they are operating in, and therefore know what approach to use. Many management or leadership strategies do not consider which type of environment the leader is working in. Yet there is a great difference between a predictable environment and an unpredictable one, and what works in one environment doesn't necessarily work in the other. Knowing the environment allows leaders to be flexible but confident in which strategies and tools to use.

Ordered vs Un-ordered Environments

Snowden's definitions between ordered and unordered are especially relevant when leaders are determining what tools or managerial processes they should apply. Snowden uses the term "unordered" as a play-on of the word "undead" to describe its nature – there is still order to the system, but not in the traditional sense.[23] Ordered environments (Obvious and Complicated) have cause and effect, in which the degree of how obvious the cause and effect determines whether it is Obvious (such as administrative tasks) or Complicated (such as the inner workings of a car engine). Ordered environments allow envisioned outcomes to be achieved through planning and execution, such as blueprints, campaign designs or work orders. The system will respond to any stimuli in a predictable way, and through analysis and enough data, a good or better solution can be found. In these types of environments, such as car or plane repairs, budgeting procedures, or landing or launching a helicopter at sea, the methods of Powerpoint briefings, specific procedures and safety briefs make sense. Each time they are executed, we can expect the results to turn out pretty much the same way. In the case of Complicated systems, there may be disagreements between experts, so there may be multiple "right" ways of completing the task, but each are predictable and do not vary much between them. This is the realm of efficiency and stability,[24] which will prove important when considering systems in a military environment.

Unordered systems (Complex and Chaotic) do not have cause and effect, but instead the interactions of the system give rise to emergent patterns or behaviours. Any interaction with the system will rarely have the same effect twice; the system is therefore unpredictable. This is the environment that Lorenz discovered when trying to predict the weather. The slightest variable may have an unpredictable effect that will differ each time it occurs in the environment. Other

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[23] David Snowden, "Multi-ontology sensemaking: a new simplicity in decision making," *Journal of Innovation in Health Informatics* 13, no. 1 (2005): 47-48, http://hijournal.bcs.org/index.php/jhi/article/viewFile/578/590.
[24] Ibid, 48.

massive interruptions in the environment, which would be predicted to be major influencers, could have none. These domains are resilient and adaptive[25].

David Snowden uses the example of a birthday party to emphasize how leaders must understand what happens when they apply managerial systems best suited for ordered environments in unordered ones:

> *Imagine organising a birthday party for a group of young children. Would you agree on a set of learning objectives with their parents in advance of the party? Would those objectives be aligned with the mission statement for education in the society to which you belong? Would you create a project plan for the party with clear milestones associated with empirical measures of achievement? Would you start the party with a motivational video so that the children did not waste time in play not aligned with the learning objectives? Would you use PowerPoint to demonstrate to the children that their pocket money is linked to the achievement of the empirical measures at each milestone? Would you conduct an after-action review at the end of the party, update your best practice database and revise standard operating procedures for party management? No! Instead, like most parents, you would create barriers to prevent certain types of behaviour, you would use attractors (party games, a football, a videotape) to encourage the formation of beneficial largely self-organising identities; you would disrupt negative patterns early, to prevent the party from becoming chaotic, or necessitating the draconian imposition of authority. At the end of the party, you would know whether it had been a success, but you could not have defined (in other than the most general terms) what that success would look like in advance.[26]*

By distinguishing between ordered and unordered environments, leaders can match the right tools to capitalize on the strengths of the environment they are operating in and avoid applying tools best suited for one environment erroneously to another. As Snowden's birthday party example shows, the use of tools developed and suited for the ordered domains are much different from the strategies used in the unordered ones. Part III will delve into some of the strategies available to leaders acting in unordered domains.

Efficiency vs Resiliency

The border between ordered and unordered domains is significant because it highlights the inverse relationship between efficiency and resiliency.[27] McChrystal provides two definitions that

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[25] David Snowden, "Multi-ontology sensemaking: a new simplicity in decision making…,47-48.
[26] Ibid, 45.
[27] Ibid, 48.

are worth using for this purpose. He defines efficiency as getting the most from the least amount of time, effort and resources,[28] and he defines resiliency as linking elements that allow them to reconfigure or adapt in response to change or damage.[29] As mentioned earlier, ordered domains are efficient and stable, while unordered domains are resilient and adaptable. Snowden points out that they are inversely proportional to each other – as the system increases in efficiency and stability, it becomes less resilient and adaptable. The same is true in reverse.[30]

This inverse relationship between resiliency and efficiency was a key discovery in McChrystal's fight against Al Qaida in Iraq; in order to counter Al Qaida's adaptability, McChrystal had to reduce some of the efficiencies of his command and control model so as to increase the adaptability of his organization, which allowed him to better operate in the complex environment that Al Qaida had created.[31]

McChrystal uses a soccer analogy to exaggerate what happens when teams that are efficiency-focused try to operate in unordered environments.[32] He describes a soccer team in which each player has a specific patch of the field to remain in, executing their specific drills in a specific sequence for each play. The coach directs the play from the sidelines, and each player executes it in sequence in practice. Each player has a set of blinders on so that they can only see their specific patch of the soccer field, and they instead closely watch the coach and not the other players or the ball for directions. They require written permission from the coach each time they want to execute their kick of the ball.

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[28] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…*, 20.
[29] Ibid, 80.
[30] David Snowden, "Multi-ontology sensemaking: a new simplicity in decision making, 48.
[31] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…*, 79.
[32] Ibid,141-42.

The soccer fable highlights the fallacies that occur when leaders use ordered methodologies in unordered environments. Players who are inhibited by procedures and rules that restrict their ability to respond to the changing environment on the ground become useless to the team. Instead, by defining boundaries and direction (such as the rules, boundaries of the field, and the other team's goal line), players can react quickly and effectively to the rapidly changing environment without requiring the coach's explicit permission or direction. Additionally, it allows members to contribute to the overall goal as a team than just execute "just their job."[33]

In the Naval environment, these are the environments that teams, both small and as fleets, respond to. This is also that realm of combat operations. Therefore, you cannot have a system or organization that is both resilient and efficient at the same time. Note that neither is wrong nor better than the other. However, each thrives in its own environment - efficiency is best suited for ordered domains, while resiliency is required to survive in unordered ones. An organization that prides itself on its efficiency within an unordered environment will not survive very long; the same can be said for a team that is resilient but operating in an ordered one.

Multi-ordered Systems

In Complex Adaptable Systems, unordered systems contain ordered sub-systems, which they in themselves can contain more ordered and unordered systems. It becomes the task of the leader to distinguish at what level of the system they are operating in, and if that particular system is ordered or unordered. Seeing the system, and distinguishing what type of system it is allows leaders to approach the problem intentionally, without applying their default patterns of thinking automatically.[34]

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[33] Peter M. Senge, The Fifth Discipline…, ch 2.
[34] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 39.

In their book *Systems Thinking Made Simple*, David and Laura Cabrera argues that all systems are governed by four simple traits – Distinct, Systemic, Relationships and Perspectives. Each system can be considered distinct from other systems. However, systems remain part of greater systems and are potentially made up of smaller systems. Within systems, and systems themselves can relate with other elements and systems in their environment through interactions. Finally, every system and part of the system can be the point or in the view of a perspective.[35]

A boundary is essential to how we understand objects and systems - what an object or system is not is just as important as what it is. It simplifies thinking, but it also allows bias to be introduced.[36] Nothing exists in isolation, and changing the way the system is organized or viewed changes the meaning itself. When considering systems, the leader needs to distinguish where to stop zooming in or out. The leader also needs to consider at which point it views the system from, and consider switching the perspective so that which is viewed is now viewing. By doing so, leaders find different meanings underlying the systems being observed.[37] Drills are ordered systems, and therefore leaders can expect the execution of drills to be efficient. SOPs and administrative instructions are also ordered. Engine repair, helicopter launches and landings, and navigation in pilotage waters all benefit from efficient methods and Good/Best practices. However, how the outcome of the ordered system interacts with the complex environment is unpredictable, and therefore the interaction is unordered.

Combat operations, on the other hand, are not predictable, nor are emergencies or team dynamics. To approach these systems from an efficiency perspective, as many leaders do, results in causing more damage than good. A leader has to continuously evaluate what type of system they

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[35] David Cabrera and Laura Cabrera, *Systems Thinking Made Simple: New Hope for Solving Wicked Problems*, Ithaca, (NY: Odyssean, 2015), EPUB Kindle e-book, ch 2, https://doi.org/10.1002/inst.12062.
[36] Ibid.
[37] Ibid.

are influencing, interacting in or using themselves. They can do this by framing the system (distinct), zooming in and out of the systems (System), understanding the interactions of the systems (relationship) and looking at the system from multiple points of view (perspective).[38] Once the leader has identified the types of systems and environments at play, they can better address the situation with the right set of tools.

Now that the different environments have been defined, the next part of this essay will focus on unordered systems – specifically a type of unordered system called a Complex Adaptive System. It will define the elements of a complex adaptive system, and show that through the elements' interactions emergent, self-organized behaviours arise. It will then consider tools that leaders can use to influence complex adaptive environments so that it evolves towards their desired end states.

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[38] David Cabrera and Laura Cabrera, *Systems Thinking Made Simple…*, ch 2.

CHAPTER 3: COMPLEX ADAPTIVE SYSTEMS - FROM AGENTS TO EMERGENCE

Now that the unordered environment has been defined and differentiated from the ordered one and why that is significant, this essay now considers the unordered, and specifically the Complex domain in more detail. Complexity theory suggests tools to influence the elements of complex systems to achieve desired emergent behaviours and characteristics. Once leaders understand the elements and interactions of the system and environment they are in, they are better positioned to then probe and learn from the environment to influence it to a more desired state.

Baseline of Complex Systems

Complex systems are made up of multiple different agents, artifacts and strategies, which form populations. The following will explain each in detail. Note that these descriptions are based on Axelrod and Cohen's Framework for Harnessing Complexity.[39]

Agents

Agents are any member or node of a system.[40] Along with artifacts, they are the basic elements of a complex system. They have a position in space and movement and can interact with other agents and artifacts purposefully. An agent is defined by its location, capability (how it can affect the world around it) and memory (what impressions it carries forward from the past). Each agent contains a strategy or strategies that it uses to interact with its environment. Therefore, when determining how to interact or influence systems, it is important to understand the variety of agents at play both within the system, and the forces influencing the agents from outside of it.

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[39] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*
[40] Ibid, 4.

Artifacts

Artifacts are objects that agents can use to interact with the environment. Artifacts normally elicit a specific response by the agent using it.[41] Artifacts do not have their own purpose, nor do they have the ability to reproduce on their own. A car, a pen and a house are all examples of artifacts, and agents respond to them and use them in ways unique to the artifact. Sometimes when leaders consider the elements of a system at play, they forget to consider the impact of artifacts on that system. Understanding the behaviours that artifacts can evoke in the agents is important when considering how to influence them.

Populations

Populations are groups of agents or strategies.[42] Agents can belong to a variety of different populations all at the same time. Populations are normally defined by a tag or characteristic that links them. These tags can be obvious or implicit. Populations are important because they are both sources and recipients of knowledge and improvements. Additionally, although subtle, populations have structures or interaction patterns that can determine which agents are likely or not likely to interact with other agents. Examples of populations in RCN ships include officers, NCMs, engineers, HQ 1 teams, and agents that like to work-out or play video games. An agent's connection to a population influences the strategies that they use. Understanding the obvious and not so obvious populations that agents belong to, as well as the characteristics that links them is important when considering how to disrupt undesirable self-organizing behaviors by those agents, or when trying to create new ones.

Types

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[41] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 6.
[42] Ibid, 4.

Types allow leaders to create sub-populations within the populations present in the ship or their teams, which can create different interactions and emergent behaviours, depending on the types defined. Types are used to distinguish agents of a population based on common observable traits.[43] The use of types is most useful in populations that contain a high level of variety. Using types allows leaders to group agents for a variety of purposes related to a leader's goals and intent without having to account for the variety of other differences that exist with each agent. It also allows leaders to influence the level of variety within their teams and systems.[44]

Types can be either endogenous or exogenous. Endogenous types are those created and used by the agents in the system, and exogenous are types used by outside observers.[45] An example of an endogenous type in a ship would be the department an agent belongs to. An example of an exogenous type would be a leader's label of certain members of his or her team.

Types have the power to cause agents to act in certain ways when in the vicinity of an agent that displays the relevant trait.[46] For example, how a junior NCM acts in the vicinity of a senior officer on the ship will be much different how they act when amongst their peers. A leader can define types to influence how agents act or interact, or to increase or decrease variety within their team. If a leader does this purposefully, they can create such emergent behaviours such as esprit-de-corps or teamwork. However, if a leader unconsciously labels team members in such a way that causes divisions within the team, or creates conditions of action in the vicinity of certain types of the population that are detrimental to the desired emergent traits, then a leader's actions can have the opposite effect.

Feedback Loops

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[43] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 35.
[44] Ibid.
[45] Ibid, 35-36.
[46] Ibid, 36.

Feedback loops are found in the interactions between agents and their artifacts. They are one element that causes the non-linear activity that is characteristic of complex adaptive systems. There are two main types of feedback loops, and in combination, they can create the conditions for complex phenomenon to appear, such as the Butterfly Effect and Tipping Points. The first is the positive feedback loop. This feedback loop is responsible for creating the conditions for continuous, exponential growth or decline within a system.[47] Note that although the feedback loop is called positive, the positive refers only to the fact that the system continues to build on itself until slowed or stopped by a different feedback loop or boundary; it could create a massive exponential growth (such as in a market spike) or a massive collapse (such as in the market collapse of 2008).

The second type of feedback loop is called a negative feedback loop. This loop is a stabilizing loop; it counteracts the system's movement in either direction.[48] This feedback loop is most commonly used in the field of cybernetics – the balancing of systems using this loop. A common example of a negative feedback loop is a thermostat. As the temperature falls, the feedback loop will turn on the furnace to raise temperatures. Once the temperature is raised to a certain level, the thermostat turns the furnace off, thereby regulating the heat at a set level. These loops are found throughout the system, often working with and against each other. It is often hard to determine where these loops reside, but where there is great growth, decline or stability, often a feedback loop, or multiple feedback loops, are at play.

Strategies

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[47] Peter M. Senge, *The Fifth Discipline…*, ch 5.
[48] Ibid.

Strategies are rules and responses that agents use to interact with their surroundings or in pursuit of their goals.[49] Strategies are also procedures, processes, actions-on drills and a variety of set actions that agents can utilize when they respond to the environment. Strategies change over time, based on how well the strategy is doing against a measure of success, from trial and error, by imitating another agent, or due to a change in the environment. They can spread through populations, and change while they spread, creating variation within the system.

Early complexity theorists considered strategies to be simple rules,[50] such as those used by a bird in a flock (stay close to your neighbour, avoid predators). However, humans as agents do not use simple rules to interact with their environment; these strategies are much more complicated. Cabrera calls strategies in human agents "mental modes," and defines them as structure applied to information, where information is matter, information and data, and structure is how the information is ordered to provide meaning.[51] Visualizing the structure of the mental model allows the leader to manipulate the mental model to view it in different ways. To demonstrate how changing the structure can change the meaning, consider the following two sentences: *I want to eat, Grandma*, and *I want to eat Grandma.* The change in structure gives a much different meaning to the information.

Knowledge becomes a collection of mental models in which agents use to interact with their surroundings.[52] However, these mental models are not accurate, and feedback with the environment allows agents to update their mental models based on the feedback received. Learning becomes a process of updating mental models or strategies. Strategies are what drives agents to interact with their environment, so therefore it is the engine of interactions. The

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[49] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 4.
[50] David Cabrera and Laura Cabrera, *Systems Thinking Made Simple…*, ch 2.
[51] Ibid.
[52] Ibid.

continuous change of strategies is a major change driver for interactions that in turn makes systems complex.

Complex Adaptive Systems

Levels of Complex Adaptive Systems

To understand how emergent behaviours and problems arise, first it is important to understand the properties of complex systems that exist between the agents at the lowest level and the behaviours that eventually emerge.

Figure 2: David and Laura Cabrera's levels of complex adaptive systems[53]

Cabrera's table in Figure 2 summarizes the different levels of a complex adaptive system and clearly indicates at which level leaders should focus on when influencing the complex systems they are either in or near. As mentioned before, the concept of Simple Rules when dealing with social structures is not relevant, so it may be more prudent to replace "Simple Rules" in the table with "Interactions and Strategies" instead. What this table then indicates is that leaders need to understand and focus on the agents, artifacts, strategies and their interactions to best influence the

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[53] David Cabrera and Laura Cabrera, *Systems Thinking Made Simple…*, ch 2.

system. Trying to address the self-organization of agents or the emergent behaviours or problems becomes futile because the system has too many variables that adapt and interact in unpredictable ways.[54] By focusing on the agents, strategies and interactions the leader can effect lasting change and influence the system so that the system is inclined to produce what the leader wants instead of trying to predict how the system will react as if the system was ordered.

Change

Axelrod and Cohen define complex adaptive systems as systems that contain agents and artifacts that seek to adapt to their environment.[55] Cabrera further argues that complex adaptive systems stem from autonomous individuals following simple rules based on what they observe in their surroundings. Although the idea of humans using simple rules is contested,[56] it is agreed that this combined, dynamic behaviour gives rise to observed emergent behaviours.[57]

Complex adaptive systems are constantly changing. As agents interact with the system, they update their strategies from the feedback they receive, which changes the system for both the agent and all other agents. Since all other agents are changing their strategies to adjust to the new system, the system continues to change as a result. When multiple populations are changing their strategies to adapt to each other, this is called a *co-evolutionary process*.[58] As a result, although a leader or team may update their strategy to fit the feedback received from their actions, the rapid pace of change in the system may make their new strategy obsolete within a short timeframe.

There are two important subtleties in regards to complex adaptive systems. First of all, the changes to strategies may or may not be beneficial for all agents. Second, even if some of the

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[54] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 39.
[55] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 8.
[56] David Snowden, "Multi-ontology sensemaking: a new simplicity in decision making," , 50.
[57] David Cabrera and Laura Cabrera, *Systems Thinking Made Simple…*, ch 2.
[58] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 8.

agents gain in their change of strategy, the total system may not improve.[59] Therefore, it is important for leaders to continue to evaluate their actions from multiple perspectives. From the leader's perspective, any change in their strategy may at first appear beneficial to them, but it may adversely impact other agents such as other team members or other teams within the organization. It may even be detrimental to the entire system. A classic example of this subtlety would be the extraction and sale of fossil fuels for the benefit of a multinational company and its shareholders, since the consumption of the fuel is causing detrimental climate change to the world.

Variety

In any complex adaptive system, a leader needs to strike a balance between variety and uniformity. Variety is a key variable in complex environments. Too little variety and systems risk failure and exploitation of their weaknesses by outside agents and populations. Too much variety and there may be a state of eternal boil, where the system becomes chaotic and no discernible patterns can be detected.[60]

A leader must consider variety when building teams at the small team level, the ship level and the fleet. Variety of experience is an easy trait to measure and explore, providing the leader allows and encourages that variety of experience become relevant during interactions between members. Team members and leaders can quickly quash variety of opinion through groupthink and bullying, but they also can become paralyzed in the decision making if there is too much variety of ideas and no convergence on a direction forward. A leader and team must find the balance of variety in experience, in opinion, in membership, and in an assortment of other ways.

Variety within systems is increased and decreased by the choices made in regards to the selection of agents and strategies. There are two methods of selection that leaders can choose from.

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[59] Robert M. Axelrod and Michael D. Cohen, Harnessing Complexity…, 8.
[60] Ibid, 43-44.

Leaders can select and copy agents, in which the entire agent is chosen, created, replaced or removed (or destroyed). Leaders can also select and copy strategies. This requires only the desired methods, processes and actions of the agents be either copied or destroyed instead of the entire agent that is using it.[61]

Selecting agents allows leaders to preserve the context to which made the agent successful without understanding it.[62] If it is known that agents that come from Waterloo University are proficient in fixing ship engines, then the RCN can purposefully select agents that are graduates of that university and program to fix engines on the ship. However, selection of agents is expensive and takes time to produce.

Selecting strategies allow leaders to choose the methods that make agents successful. The method is quick and usually does not cost as much as selection at the agent level. However, before they can select the strategy to copy, leaders must understand which strategies made the agent successful, and what context the successful strategy was used in.[63] For example, if the leader determines that the specific strategy that graduates of Waterloo use with fixing a diesel engine follow certain, repeatable steps, then leaders can teach all team members that in the case of this situation, this strategy will be the most successful. Leaders often encounter difficulty when they tried to copy strategies that were successful in one context and apply them to another. For example, Snowden argues that management fads are a result of taking strategies that are successful in Complicated situations and trying to apply them to Complex or Chaotic ones.[64]

Additionally, choosing to copy a certain strategy can minimize variety by choosing strategies or agents that are strong in the moment, and insisting on adherence to only that strategy

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[61] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 118.
[62] Ibid, 128.
[63] Ibid, 131.
[64] David Snowden, "Multi-ontology sensemaking: a new simplicity in decision making,", 46-47.

and discouraging other strategies that are weaker now, but may prove essential when the system evolves. Leaders can instead enhance variety by using copying strategies that recombine strategies to form new strategies or recombine teams to form new teams. Understanding variety allows leaders to consciously choose how to manipulate it through copying strategies at either the agent or strategy level.

Interactions

Interactions are what make complex adaptive system unordered and unpredictable. It is through the interactions of agents, artifacts and their strategies that emergent behaviours arise.[65] There are two main forms of interactions to consider: Proximity and Activation. Proximity between agents and artifacts governs how likely agents will interact with each other. Activation factors are processes that affect the timing of events or agent activities.[66]

Proximity is self-explanatory, but an example of activation factors could be externally clocked activation, such as meal times, or internally active processes, such as Action-on drills in the event of the discovery of a fire. Internally activation processes are important because it allows for flexibility at the agent level, but if not monitored or controlled properly, it could let undesirable events propagate uncontrollably as well.[67]

Most complex adaptive systems have distinct interaction patterns that fall between the random and the fully structured.[68] These patterns can be subtle, and leaders must closely observe the system to spot them. Structures control interactions both subtly and overtly. Structures will influence interaction behaviours of the agents,[69] even of those in close physical proximity.[70] For

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[65] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 63.
[66] Ibid, 68-69.
[67] Ibid, 71.
[68] Robert M. Axelrod and Michael D. Cohen, Harnessing Complexity…, 63.
[69] Peter M. Senge, *The Fifth Discipline…*, ch 3.

example, although the Ordinary Seaman NavCom is right behind the Captain on the bridge, the structure of the military hierarchy limits his or her ability to approach and interact with the Captain directly. In some cases, these structures can change over time - the structure influences the interactions, which in turn can influence the structure. This can be obvious when it occurs, such as when the Canadian Joint Operations Center (CJOC) was formed by collapsing Canada Command, Canadian Expeditionary Force Command, and Canadian Operational Support Command in order to match the drawdown of the Afghanistan mission.[71] However it usually occurs subtly, such as how a neighbourhood will shape a potential buyer, but those buyers will over time shape the environment.[72] This is another example of co-evolutionary change.

The rise in complexity in the world is due in large part to the increase in interactions through the advent of information technology. This technology has removed barriers in space, time, energy and capacity, and now allows instant interactions with a multitude of agents across the globe.[73] If a leader wants to influence the complex adaptive system they are in, then interactions are a powerful level to probe. Barriers, activation timings, signals and attractors are tools leaders can use to influence complex adaptive systems at the level of the interactions. By observing both the subtle and obvious structures, barriers, attractors and activation timings that govern the local interactions, the leaders can find a wealth of areas to influence.

Emergence

When influencing complex adaptive systems, leaders move from focusing on incidents and problems and looking for patterns of behaviours instead. These patterns of behaviours are called

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[70] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity...*, 74.
[71] National Defence. "Canadian Joint Operations Command Stood-up in Ottawa." News Release, 6 July 2018. www.forces.gc.ca/en/news/article.page?doc=canadian-joint-operations-command-stood-up-in-ottawa/hgq87xia.
[72] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity...*, 69.
[73] Ibid, 26.

emergent behaviours or properties, and they are one of the main distinguishing features of complex adaptive systems. Emergent behaviours arise from agents interacting and self-organizing themselves. Sometimes this is caused by boundaries, other times by attractors or attribution of credit.[74] However, none of the agents themselves will contain the pattern or trait seen as a whole. Therefore emergent behaviours and properties are indivisible – if you break the system down to the agents and artifacts, none will exhibit the behavior that has emerged. Instead, it is the constant interactions of the agents and artifacts in the system in which this pattern has emerged.

An example of emergent traits is the concept of wetness. Water is the combination of two hydrogen atoms with an oxygen atom. Neither hydrogen nor oxygen are considered wet. Nor is any one water molecule considered "wet." However, when combined together into puddles, lakes and ocean, the emergent trait of wetness is felt.

Another example of emergent behavior is a flock of birds. A flock of birds in flight allows the emergent behaviour of safety in numbers, as well as the impressive display of clouds of birds in flight, cannot be reduced to any one bird. However, through the use of simple rules (stay close to your neighbour, avoid predators, find food) and their interactions with their neighbours, these emergent behaviours arise.[75] To that effect, in a complex adaptive system, a problem is therefore no longer the effect of a singular cause, but instead the emergent property of the interactions of the agents within the system. Therefore, leaders must resist reducing the emergent behavior or problem down to the elements that make it up. They need to understand how the interactions of those elements self-organized to allow the behavior to emerge. Finding and fixating on a singular cause (i.e. scapegoat) often does not solve the underlying system that gave rise to the problem in

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[74] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 62.
[75] David Cabrera and Laura Cabrera, *Systems Thinking Made Simple…*, ch 2.

the first place; in fact, it often makes it worst. This is what happened in the American 7th Fleet after the *USS Fitzgerald's* collision. Leaders need to instead uncover the system that, through its interactions, has created the emergent problem and/or behaviour and address the system using complexity tools instead of the classic complicated ones.

Tools to Influence Complex Environments

Once leaders understand the mechanics of complex adaptive systems, they can start purposefully interacting with them in order to create desired emergent characteristics and behaviours. The following section suggests a few tools from the theory that leaders can use to influence the systems they are operating in. These tools include issuing direction instead of targets, setting and eliminating boundaries, using and dampening attractors and applying attribution of credit. It also introduces the safe-to-fail experiment, which is a powerful way of probing a complex adaptive environment in order to learn how it responds and adapt to it as it evolves.

Direction

In complex adaptive environments, leaders need to set a direction instead of a target or SMART goal, much like a hiker will use a compass instead of a photograph of the future.[76] Direction is different from goals and targets in that they are not SMART (Specific, Measurable, Achievable, Relevant, Time-bound). SMART goals or outcomes work well for Complicated environments. However, targets, SMART goals and other specific outcomes and end states often hinder the mission then help it.

Berger and Johnston argue that targets and specific outcomes lock teams into a single process, and remove the ability for teams to be able to respond to the environment as it adapts. Due to the unpredictability of the environment, targets can quickly become obsolete as the team or

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[76] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 88-89.

organization interacts with the environment, or if other agents and organizations enter or leave it. Opportunities that present themselves are lost as teams focus on targets that do not fit its specific criteria.[77]

Additionally, teams and leaders will often cause more damage to the mission or goal by forcing the system to conform to the target, causing unpredictable detrimental effects to emerge instead. For example, a call center that wanted to reduce customer complaints about customer wait times set a target of a certain number of phone calls taken by each operator. Operators then reduced the time spent on phone calls, cutting customers off to reach their targets, causing customer service to go down instead of up.[78]

Although leadership books espouse a clear vision, SMART goals and specific targets, in a complex environment this rarely works. Instead, Berger and Johnston suggest that direction needs to be thought of like a compass. As you navigate the environment, there is a direction you want to move towards. There is a general destination the leader wants to reach. However, a compass allows the leader and team to adapt to the environment at hand, and address obstacles or take advantage of opportunities that the map could not have predicted. It allows freedom of movement by the team in dealing with the complexity of the environment they are navigating in.

Boundaries

The use of boundaries is a powerful tool for leaders to use in complex adaptive environments. Boundaries influence how agents can interact, which in turn governs self-organization and emergent behaviours of the system. Boundaries are physical, such as walls, lines, fences and allocations, and they exist in concept, such as organizational charts, laws, social

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[77] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 94-95.
[78] Ibid, 95.

status, caste systems and social protocol. Time is also a boundary – there are only certain ways in which to communicate with the past and the future.[79]

Boundaries are found in organizations, ecologies and life itself. Boundaries dictate who and what agents can interact with, how often and when. Many boundaries are invisible to teams and leaders and exposing and naming these invisible boundaries is an important tool for leaders to use.[80]

Leaders influence their organization through the boundaries they set and eliminate. However, most often this use of boundaries is unconscious. Leaders can influence their team in a very powerful way just by exposing the boundaries that are invisible in the organization and purposefully adding or eliminating boundaries to nudge the system dynamics to a more desirable state.

There are many different ways leaders can use boundaries to influence the interactions that they desire. In teams, leaders can change interactions and behaviours by changing boundaries. Creating new teams, disbanding old ones, and relocating members and teams are ways of changing boundaries. A leader that has a closed door policy vice a leader that is open and among the team members is setting different boundaries that changes interactions. Security clearances, Need-to-Know criteria and security caveats are all boundaries that serve to open some interactions and limit others.

The work Gen McChrystal did to transform his organization to battle Al Qaida in Iraq is an example of the power of manipulating boundaries to create different self-organizing behaviours. McChrystal eliminated boundaries between teams by swapping team members between different

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[79] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…,* 78-79.
[80] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 93.

units such as Navy SEALs and Green Berets. He sent strong Liaison Officers to embassies and civilian organizations that were involved in the fight against Al Qaida. He broke down security protocols and consolidated all headquarters operations within one room instead of being separated into individual compartments. He held a daily Operations and Intelligence briefing in which all players across the fight – from the individual units in the field to the distant civilian organizations such as the CIA and NSA – could deposit and discuss the current intelligence and operating picture on the fight against Al Qaida.[81] Through these manipulations of boundaries, McChrystal was able to create what he termed a "shared conscious," in which everyone could see the system as a whole and understood how each person fit into that system and what their role was.

Attractors

Attractors are agents, artifacts or systems that attract other agents to it. This attraction allows for self-organizing behavior to evolve around the attractor as agents remove barriers and move into proximity of one another. Attractors are neither bad nor good, and the same attractor can influence desirable, undesirable or both behaviours around it.[82] The same attractor can create a massive self-organizing emergent behavior in one instant and have no effect in another instant. Attractors can lay dormant until a certain criterion is reached, or can remain a major attractor for years and then suddenly become unattractive.[83]

Attractors can be coupled with boundaries and directions. They can be used to influence behaviours within a set boundary. Leaders have the ability to either enhance the desirable emergent behaviours that may occur around the attractor or quickly damped any negative effects

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[81] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…* ch 6, 8, 9.
[82] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 103.
[83] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 14.

instead.[84] Take the example of Snowden's birthday party. A soccer ball in the backyard can be a planned addition by the parent to create a self-organized soccer game or similar source of fun during the party. Common knowledge and past experience suggest that a soccer ball at a party will create a self-organized game or something of a similar nature – or so the parent predicts. However, the attractor may or may not work as anticipated. Instead, the soccer ball may be completely ignored, not serving as the attractor the parent hoped it would. Or it could do the opposite and attract a fight between friends or other such undesirable behavior instead.

Since attractors act in complex adaptive environments, the actions they create are unpredictable. As such, leaders need to be careful about how they are used. A real-life example of a recent attractor is the shopkeeper in Tunisia, Mohammad Bouazizi. His actions as an attractor also serve as an example to the unpredictability of the environment, as well as how tightly coupled society has become due to information technology. Bouazizi, in protest to how he was treated and humiliated by an authoritarian government, lit himself on fire.[85] His cousin shared it on social media, and overnight Bouazizi's death became an attractor for thousands of Arabs to self-organize around. His action caused multiple Arab autocracies to fall over the period over the course of a few months in what is now remembered as the Arab Spring.

Attractors are an easy tool for leaders to use or spot in complex systems because many interactions and associated emergent behaviours center on them. Often attractors act in predictable ways, but leaders must never take for granted that attractors will act in similar ways to the past in a

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[84] David Snowden, "The Cynefin Framework." YouTube video, 8:37. Posted by "CognitiveEdge," 11 Jul 2010. https://www.youtube.com/watch?v=N7oz366X0-8.

[85] Fisher, Marc. "In Tunisia, act of one fruit vendor sparks a wave of revolution through Arab world." The Washington Post, 26 Mar 2011. Last accessed 24 Apr 19, https://www.washingtonpost.com/world/in-tunisia-act-of-one-fruit-vendor-sparks-wave-of-revolution-through-arab-world/2011/03/16/AFjfsueB_story.html?utm_term=.a9ef6108274c.

complex environment. Therefore, any use or elimination of attractors still needs to be done purposefully and with caution.

Attribution of Credit

Attribution of credit is a powerful tool for leaders to influence strategies and interactions among agents. In fact, often the leader is using attribution of credit but doesn't realize it or the impact that it has. Agents choose and create strategies or mental models of reality.[86] They use measures of success to determine which to copy and which to discard.[87] Credit can be defined as something of value, such as money, praise, attention, recognition, fame or bonuses, or any other item that agents deem valuable. But it can also be defined as something negative to be avoided, such as pain, punishment, isolation, violence or other undesirable outcomes or methods, depending on how it is used.

Where we assign credit, we create conditions for selection. These measures of success are often implicit. Agents do not need to know what is considered valuable in the system in order to select or copy it. An example of this is evolution. Agents do not select for the best chances of survival of the species, but instead they are driven by what is instinctively considered attractive in a mate – traits that the agent does not understand but follows nevertheless.[88] Leaders have the power to assign credit to agents, artifacts and strategies of their choosing. Often this assignment of credit is done unconsciously in their actions, such as granting attention and affection towards strategies and agents that they enjoy vice what the organization needs. Leaders need to be conscious of what credit they assign where, and use this ability to assign credit to where it needs to affect the change they want to see in their teams and organization.

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[86] David Cabrera and Laura Cabrera, *Systems Thinking Made Simple…*, ch 2.
[87] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 118.
[88] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 120.

Attribution of credit is studied in depth in behavioural studies and is beyond the scope of this essay. But what leaders need to understand is that any attribution of credit assigned to agents or strategies within their teams or organizations will create conditions for those agents and strategies to be selected and copied.

Safe-to-Fail Experiments

A Safe-to-Fail experiment is the opposite of the more commonly known fail-safe experiments – they are safe, and often designed to fail.[89] Safe-to-Fail experiments are designed so that if they fail, they have minimal detrimental impact on the complex adaptive system. However through these experiments, the leader is able to learn how the system responds and is able to act accordingly.

As discussed earlier, boundaries are an important tool in creating innovation and creativity in a complex adaptive system. In a complicated system, creativity and innovation comes from recombination strategies.[90] Steve Jobs was famous in quipping that creativity is nothing more than connecting other people's ideas. However, in a complex adaptive system, creativity and innovation are served by recombination of strategies and ideas, but cannot be effective unless tested in the system at that time and place because they require context.[91] Since complex adaptive systems respond to the same stimuli differently over time and space, leaders need to use boundaries to create space for team members to be able to probe the system to learn about it.

In this way, boundaries allow safe-to-fail experiments to be conducted, providing that the boundaries are very clear to what is safe and what is not.[92] When a leader is able to provide team members direction in which they are to move, and clear boundaries to what is safe and allowed and

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[89] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 53-54.
[90] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 41-42.
[91] Ibid, 133-34.
[92] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 93-94.

what is not, innovation and creativity can flourish as team members are able to experiment in that space in a way that encourages them to fail. Failure, through the use of boundaries and safe-to-fail experiments, becomes a method of learning and adapting.[93]

According to the Cynefin Framework, leaders act in complex environments through Probe – Sense – Respond.[94] Safe-to-fail experiments are a practical method to do just this. To understand a complex system, or to learn more about it, leaders and teams need to interact with the system. However, leaders do not want to upset the system during their interactions in a way that is detrimental to the mission or goals of the organization. But most operational plans and strategies do just that – they seek to interact and manipulate the environment in a way that is uncontrollable.

Safe-to-fail experiments allow leaders to probe the environment and adapt to how the environment responds without putting the team or organization at risk. Unlike fail-safe experiments to which most leaders are familiar, safe-to-fail experiments are a learning tool that is designed to fail.[95]

Safe-to-fail experiments have the following criteria:

- They are safe to fail. If they fail, there is minimal damage to the organization or its missions or goals;

- They are small, replicable and can either be quickly enhanced when desirable traits emerge or quickly damped or extinguished when undesirable ones emerge;

- They are cheap and quick;

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[93] Ibid, 153-54.

[94] Cynthia F. Kurtz and David J. Snowden, "The new dynamics of strategy: Sense-making in a complex and complicated world," *IBM systems journal* 42, no. 3 (2003), 468, https://ieeexplore.ieee.org/abstract/document/5386804.

[95] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 106-107.

- Multiple experiments are conducted across the operation; and

- The team celebrates both successes and failures, as both teach the team something about the environment and how to proceed.[96]

To encourage safe-to-fail experiments, leaders use direction (instead of a target), boundaries and attractors. If direction, boundaries and attractors are tools that help leaders influence their complex adaptive systems, safe-to-fail experiments are the method to which they use them. Instead of using a singular design that assumes predictability of the environment and is more often than not obsolete within the first few moments of being enacted, safe-to-fail experiments allow the leader to try new and innovative ideas, respond to emerging opportunities, and remain relevant no matter how the complex system responds.

Conclusion

This section outlined complex adaptive systems in detail, as well as ways of influencing them. Complex adaptive systems are made up of agents, which form populations. These agents carry strategies to which they use to interact with their environment and each other. Agents use artifacts - tools and objects that elicit certain responses from agents. Agent interactions can be influenced by leaders through the use of attractors, boundaries, selection processes and attribution of credit. By creating safe-to-fail experiments using these levers, leaders can amplify results that give rise to the desired emergent characteristics, and dampen those that create undesirable ones.

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[96] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 107-109.

CHAPTER 4: CREATING A NAVY READY TO FIGHT

Thus far this essay has defined the complex operating environment that the RCN finds itself in today. It introduced the Cynefin Framework and the difference between ordered and unordered environments, and how efficiency and resiliency are inversely related. It then outlined the mechanics of complex adaptive systems, and suggested a few tools leaders can use to influence the mechanics of the system to bring about desirable emergent behaviours. This final chapter will use these tools to suggest a few ways leaders within the RCN can start applying this knowledge to influence the complex adaptive systems at play within their teams, on ship and within the maritime operating environment as a whole. This list is nowhere near exhaustive; it does this solely to provide a starting point for a much deeper discussion on using complex adaptive theory to operate in this new environment.

This chapter first suggests ways leaders can use the Cynefin Framework to determine what environment they are operating in so as to apply to proper tools to the situation at hand. It then suggests tools to train teams in both ordered and unordered environments. It shows how leaders can view teams and ships as complex adaptive systems and use the previously suggested tools to influence the desired emergent behaviours of that team. Finally, it suggests ways to develop the emergent behaviours of shared consciousness and empowered execution that Gen McChrystal was able to create during his time in Iraq.

The Cynefin Framework as a Tool for the RCN

If the RCN was to take anything away from this essay, the Cynefin Framework would be a good choice. Leaders can make better choices on how to operate just by distinguishing the different environments in which they are working. Leaders and teams using the Cynefin Framework will be able to see how complicated and simple systems are nested in complex

environments. Teams can understand the difference between disorder and chaos, and how to move out of both into either a complex or complicated environment. In short, the Cynefin Framework gives leaders and teams a choice in which tools to employ.

Leaders in the RCN can use the Cynefin Framework and the tools of complexity to influence the conditions to which the desired behaviours would likely emerge. Sailors can train so that Obvious and Complicated systems, such as door and hatch procedure, detect-to-engage sequences, helicopter and small boat launch and recovery, and navigation in pilotage waters are efficient and proficient. They can be trained to understand how to act to quickly to contain chaos to bring it to either a complex or a complicated system through drills and Actions-On responses. When they realize they are operating in a Complex environment, leaders can use tools such as attribution of credit, attractors and boundaries to influence the complex systems in a direction that is more desired. For example, ship culture or esprit-de-corps can be changed by identifying and disrupting attractor that are creating undesired behaviours or using boundaries to disrupt the OODA loop of an adversary during combat operations.

Training for Ordered Environments

The RCN is effective at training sailors to operate in the ordered domain, both in simple and complicated environments. Drills are practiced on a schedule to ensure currency is maintained. The Sea Training Organization is a group of experts that sail with a ship to sea and test the organization and the proficiency of their drills and procedures. Experts are trained at various schools across the fleet in their respective areas, and individuals garner experience by being posted into jobs that start as simple and work their way up to complicated as their experience at sea and on ship increases. Best Practices and Good Practices are updated by experts on shore, and these strategies are copied by sailors and ships as they become available.

Leaders need to prize efficiency and proficiency in ordered systems, but not in unordered ones.[97] Ordered systems on a ship are such things such as procedures that can be captured in Ships Standard Operations (SSOs) and other procedural manuals. They include administrative duties, basic seamanship, and anything that can be covered by a checklist. They also include anything that can be trained in a quick reaction, or actions-on drills, such as door-and-hatch procedures, joining and exiting procedures, contact block reports or Detect-to-Engage missile firing sequences. In this case, leaders and teams can quickly categorize the environment or system and apply the SOPs or Best Practices to complete the task effectively. Training in this environment is simple and straight forward and is made better through the repetition of drills.[98]

Complicated systems on ship, such as engineering and weapon maintenance, ship handling and navigation (especially in pilotage waters) and helicopter and small boat operations, are the domain of experts. Complicated problems require an approach of sense, analyze and respond.[99] Problems in weapons and engineering systems, in navigation operations and in-flight operations, are all complicated in nature. The experts in charge of these problems must sense, analyze and then act. Their actions are based on past data, and they expect the problems to act in a predictable manner. Engineers know that when they connect certain wires or remove and replace certain parts, predictable actions should result. Navigators know that ships will respond in a predictable way based on the physics of hydrodynamics, inshore traffic laws and basic seamanship methods. If the environments don't respond as expected, it isn't because they've adapted or changed, it is because the expert made the wrong assessment of the situation. More data will always help solve the problem or obstacle.

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[97] David Snowden, "Multi-ontology sensemaking: a new simplicity in decision making," 47-48.

[98] Jamie C., Gorman, Nancy J. Cooke, and Polemnia G. Amazeen. "Training adaptive teams." Human Factors 52, no. 2 (2010): 296, https://journals.sagepub.com/doi/pdf/10.1177/0018720810371689.

[99] Cynthia F. Kurtz and David J. Snowden, "The new dynamics of strategy…, 468.

Training for Unordered Environments

The RCN struggles to train leaders and teams on how to operate in unordered domains - complex and chaotic environments. Complex environments at sea are the dynamics that occur when bringing teams together, ranging from the firefighting teams at HQ1, the casualty clearing teams in the Wardroom to Bridge Teams on a watch rotation. Often ships must self-organize in a variety of teams to accomplish special tasks and missions, and the emergent behavior of the ships dictates the success or failure of the mission. Complex environments on the ship also include any mission that ship is given. Examples of these complex missions range from replenishment at sea to the action stations state of readiness.

Complexity is also present in fleet operations, ranging from ScreenExs, in which ships switch relative positions in formation of ships, to entry and exit maneuvers of a harbor. Finally, combat in a multi-domain context represents the most complex environment of all, where enemy forces adapt and influence the system in order to destroy ships or win the battle. Ships must be able to quickly sense, probe and adapt as the enemy does the same. Teams can self-organize into either motivated, creative and effective teams or unmotivated, unprofessional groups of individuals. The former team allows the desired emergent culture of ships ready to fight; the latter gives rise to ships not safe at sea instead.

Finally, chaotic environments are often seen in emergencies or during the exchange of fire in combat. Chaos environments are defined by no pattern evident. A ship with multiple fires and floods on board in the midst of an air war may be in a state of chaos. A team that is lost within a smoke-filled compartment while fighting a fire may be in a chaotic environment. In this case, Actions-on drills are the best tools for teams and leaders to use in order to move chaotic situations into either complex or complicated ones.

Within any system, there may be many simple and complicated systems interacting with the complex systems concurrently. Engineering systems, actions-on drills and SOPs are used effectively within complex environments and should be. In McChrystal's war against Al Qaida, SOF teams used their simple and complicated drills in order to prepare, deploy, engage and capture and return ISIS operatives.[100] Headquarter personnel used SOPs to communicate, document and interact. However, being able to distinguish what requires Good or Best Practices and what requires probing and Safe-to-Fail experiments is what sets good leaders and team apart from the poor ones.

An ability to utilize the right tool for the environment at hand allows teams to interact successfully with complexity. For example, in the case of a helicopter crash on deck, team members can move quickly to close up the ship and set boundaries around the fire to contain it. They use actions-on drills to which they have practiced to a high level of proficiency to contain the Chaotic environment. Once the fire is contained and the environment has shifted to a Complex one, they can probe it with safe-to-fail experiments, such as placement of foam and water, direction of approach, or even orientation of the ship to provide optimum wind and stability for fighting the fire. Once the fire is under control and the team is operating in a Complicated environment, firefighters can use good and best practices to put out the fire, overhaul it and bring the state of the ship back to normal operating procedures.

In the RCN, what may distinguish a great team or ship from a mediocre one may be the ability to assess the type of environment they are operating in, and act in a method or with tools appropriate to the situation. These teams will value efficiency in ordered domains, and adaptability

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[100] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…*, ch 2.

in unordered ones. Teams would analyze complicated situations but know to probe complex ones. Effective teams and ships who can utilize this knowledge will increase their readiness to fight.

Seeing Teams and Sub-Teams as Complex Adaptive Systems

When teams are considered complex adaptive systems, the leader's interaction with them evolves. Teams seen as complicated are treated with complicated tools – systems and procedures that were developed to work with machines and computers. This is the bases of Taylor's Scientific Management theory – people execute tasks assigned to them by higher leaders. As disciples of Scientific Management espouse – "we have men trained to think".[101]

To provide an example of how this plays out on a ship, we will use the example of a bridge team. The bridge team is responsible for the safe and timely operations of the ship on behalf of the captain. The team is led by a junior officer, called the Officer of the Watch (OOW). The Bridge Watch is comprised of a 2nd Officer of the Watch – a junior officer who is in training to one day assume the duties of the OOW. There are a helmsman and throttleman, who steers the ship on the order course and speed. There are one or two lookouts, who reports to the OOW what they visually see around the ship. The Naval Communicators man the various radio channels the ship is responsible for monitoring and responding to. A Quartermaster is responsible for internal calls and communications throughout the ship. The Petty Officer of the Watch (POOW) roams the ship to ensure internal compliance with the OOW's orders and directions. In the Operations Room two decks below, the Operation Rooms Officer (ORO) and their team support the OOW in radar monitoring and running various operations. In the Machine Control Room (MCR), the Engineering Officer of the Watch (EOOW) and their team supports the OOW by maintaining the

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[101] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…*, ch 2.

engineering systems running the ship. This team changes every 4 hours or every 8 hours, depending on what part of the team you belong to, and often becomes some form of a recombined team every 4 hours.

Leaders that consider teams as complex adaptive systems use direction, boundaries, attractors and attribution of credit to influence the team to be motivated, innovative and aligned. Each team dynamic is different, and no two methods are effective, although most leaders often try to treat them as such. A leader must constantly seek multiple perspectives from their team members in order to update their mental models of the changing reality that they are operating in.[102] Talking with team members, interacting with them continuously, and listening with the purpose to how they see the team and environment allows the leader to see beyond their own strategies and mental models. Team members who can do the same with other team members also gain a similar understanding of the dynamic on the whole.

In the case of the Bridge Team, an OOW has the choice to rule the team by direction only, without feedback. They can bark orders and issue control from their perspective alone. They can make decisions based on limited input and their own, very limited experience. The OOW can also choose to engage in the different perspectives, and start to understand each member and their position to better enhance their own understanding of how the team functions and the environment they operate in. Given the constant turnover and recombination of the teams, the OOW is required to this constantly, over the 4 hours of their watch, every watch if they wish to be effective at it.

Through the use of gaining different perspectives, leaders can start identifying boundaries, attractors and attribution of credit that is already present in the team. Often many

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[102] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 21-25.

of the boundaries, attractors and credit are invisible to team members and the leader, but much like Adam Smith's invisible hand of the economy, these aspects guide team interactions. Some of them create positive self-organized emergent behaviors in the team that the leader will want to enhance. But some boundaries, attractors and credit will produce negative effects, even if in the past they have created positive ones. Understanding which ones are at play allows the leader to take the next steps of creating a team with the desired characteristics.

The leader can use the tools of boundaries and attractors to start to influence the team in the chosen direction. Boundaries are used to increase certain interactions and decrease other ones, both in between team members and between team members and the environment in which they operate. Boundaries are also used to set the safety criteria of safe-to-fail experiments. Defining these boundaries are very important when determining what behaviors you want to emerge. Attractors are the key tool of safe-to-fail experiments. Although not all safe-to-fail experiments are based on attractors, the point of the experiments is to create self-organized emergent patterns that are desirable. The easiest way to do so is to use attractors. As mentioned before, attractors can attract both desirable and undesirable patterns; therefore the leader must be able to dampen the undesirable experiments quickly.

Finally, attribution of credit also is an important tool for leaders to utilize. Credit influences actors to change their strategies and behaviors in order to increase the likelihood of them receiving credit. When a leader credits certain traits and behaviors, other members of the team will copy the strategy to try and receive credit as well. However, sometimes the leader says that they are attributing credit towards certain behavior, such as safe-to-fail experiments, but subtly they favor

success and are adverse to failure. Team members will quickly understand where credit really lies and will copy or create strategies that enhance their ability to gain it.[103]

Referring back to the example of the Bridge Team, boundaries exist physically through the separation of the bridge from the operations room or MCR. They exist by military rank structure, with NCMs being required to follow orders from officers, and limit how and when they can approach officers and voice their perspective. Boundaries exist between specialties and trades, including how and what language they use. Boundaries exist between ages, between backgrounds and between hometowns and provinces. Understanding how these boundaries create and inhibit interaction is important for the OOW to understand.

The OOW can use attractors such as information on contacts in the area from the radar set to influence lookouts to search the surrounding seas better. They can experiment with food and pop on the midnight shift, or use drills and questions to start discussions and mentoring sessions. The observant OOW will watch how the team reacts with each attractor, and what patterns emerges, and adapts their strategy to develop the desired emergent behaviors of teamwork, cohesion, innovation and motivation. Attractors exits around the technology on the bridge, or where key, interesting information resides. There are various speakers on the bridge, some broadcasting more interesting information than others. Other sailors are great storytellers and are attractors within themselves.

Finally, depending on the OOW, credit can be assigned to sailors who are effective at their job or who are the most fun to be around. Sailors often pick up what each leader desires very quickly. The OOW can give praise and credit to proper reports, actions-on drills, correct answers to skill-testing questions, or emergent patterns of innovation and teamwork. However,

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[103] Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity…*, 136-37.

they may also inadvertently undermine themselves by providing attention and praise to traits such as storytelling, humor, gossip, successes and other traits and behaviors that diminish teamwork, innovation and safe-to-fail learning that they want on their bridge team. If they ignore the lookout working hard to scan the sea, and instead enjoy the story that the other lookout tells with great gusto, the former lookout will soon copy the latter's strategy in order to receive similar credit.

Once a leader understands how the visible and invisible boundaries, attractors and credit allocation is influencing their team, they can start creating safe-to-fail experiments to start dampening emergent behaviors that are undesirable and creating ones that are desirable. This requires the mindset that failure is a good thing – it is a chance to probe the system and learn.[104] However, this is a difficult mindset for the leader to adopt, as any sort of failure is not in line with normal societal expectations of a leader. It could be seen as a sign of weakness or embarrassment of the leader. Leaders need to understand how to work past these insecurities if they wish to harness the complexity of the team dynamics. For example, junior OOW often tries to exert their leadership through direct orders and little feedback. They feel that not knowing is a weakness, and they are intimidated by the various experiences that they are given charge of. Some of the senior sailors that report to the OOW have more days at sea then they have in the military overall. The purpose of the Bridge Resource Management course, which is based on the very successful Cockpit Resource Management Course taken by all pilots, seeks to switch this mindset to one of allowing the team to come up with answers.[105]

Additionally, using the perspectives gained, the leader can set the direction the team is to follow. As discussed previously, this is different from specific targets, objectives or

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[104] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 108.
[105] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…*, 111.

SMART goals. Like an explorer following the compass, the track will adjust.[106] Again, this is contrary to the idealized leader. Society often believes implicitly that a leader is expected to have a clear vision, a specific objective and a well-defined path to realizing them. A leader that communicates uncertainty, and adjusts the path as the situation changes are not considered a charismatic and inspiring leader but will be a leader that creates a team that is adaptable and resilient to the changing environment. The leader's mindset must change from one of the valiant decision makers on top of a horse leading a charge to the explorer looking for the lost gold of El Dorado.

Developing Shared Consciousness and Empowered Execution

Gen McChrystal's example in Iraq in 2004 showed how creating a shared consciousness and empowered execution[107] allowed a traditionally top-down hierarchical organization to become adaptable and resilient as a network organization would. McChrystal created these emergent behaviors through the removal of boundaries, the creating of more interaction and information sharing, and pushing decision making power within safety boundaries to the lowest level of the organization.[108] He allowed safe-to-fail experiments to occur across the organization simultaneously and rewarded both the success and failures of these experiments by allowing agents to share what they learned at the daily O&I gathering.[109]

Likewise, a ship can develop the pattern of behaviors of shared consciousness and empowered execution in a similar manner. The first and most important part is listening to the

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[106] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 88-89.
[107] Stanley A. McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams…*, ch 10.
[108] Ibid, 209.
[109] Ibid, 164.

various perspectives across the ship.[110] The ship's company can vary between 25 to 250 members, depending on the ship and the operations it has been assigned. Constantly gathering perspectives from 250 personnel is a daunting task, and is most likely impossible. However, the more perspectives that the decision makers, normally the Command Team of the Captain, the Executive Officer and the Cox'n (ship's senior NCM), can take, the better their design decisions will be. Other allies can help the Command Team in gathering these perspectives. Leaders of the various small teams can gather and consolidate perspectives on behalf of the Command Team. The Executive Officer can bring in a Padre or outside personnel that are trained to listen to gather perspectives that respect the confidentiality of the conversations. In short, the more perspectives the Command Team, or any team leader in the ship is able to collect, the better their influence will be on their teams.

In considering the various perspectives, the Command Team should search for boundaries that are both explicit and implicit.[111] The obvious boundaries will be there, such as mess designation, sleeping quarters, rank structure, positions in the various organizations, physical and temporal working spaces and schedules. However, the Command Team needs to search for boundaries that exist on a subtle level or the absence of boundaries that will influence interactions in a potentially desirable way. For example, if within the Master Seaman & Below Mess, there were cliques formed around certain tags that were detrimental to ship overall (i.e. personnel from a certain province of origin), the Command Team could set boundaries to dispel those organizations or create attractors or attribution of credit that would dispel those boundaries naturally.

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[110] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 21-25.
[111] Ibid, 92-93.

The Command Team should also search for attractors and attribution of credit already at play in the organization. Again, there will be obvious ones that are common across the RCN, but the Command Team must search for the ones that implicit and most likely present only in their ship due to the agents and populations assigned to it. Credit might be assigned by peers to behaviours that are sexually explicit or are contrary to the rules and regulations of that ship. Attractors may center on certain TV channels or centers of gossip. Those that would follow the rules and regulations may receive some credit from the leadership, but that credit cannot compete to the credit assigned by the fellow peers within their mess.

Once the Command Team has a Map of the Present,[112] they must first set the direction they want to move in, and then the boundaries to define what is safe to experiment with and what is not. The Command Team must shift their own mindset to one that celebrates failures as learning (providing they fall within the boundary), in order to encourage them through their leadership. Then they must communicate this direction, boundaries and mindset to their senior leaders, the Heads of Department and Chiefs of Departments. By pressing the direction, safety boundaries and mindsets from the top down, the Command Team will be able to remove the boundaries that inhibit the sailors to innovate and experiment safely from the ground up to increase teamwork, adaptability and the other emergent behaviors that the command team desires.

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[112] Jennifer Garvey Berger and Keith Johnston, *Simple habits for complex times…*, 28.

CONCLUSION

This essay gave an overview of David Snowden's Cynefin Framework and Robert Axelrod and Michael Cohen's Harnessing Complexity Framework, with input from a variety of other sources to understand the basics of Complexity Theory. It applied it to the Royal Canadian Navy and its operations in a VUCA environment. It showed how the RCN needs to evolve to meet the unpredictable environment it now operates in, especially in light of the accidents that occurred in the US 7th Fleet and the reality of combat operations as demonstrated by Gen McChrystal's campaign against Al Qaida in Iraq in 2004.

There are many ways the RCN can use the tools of complexity, and this essay suggested a few of them. Leaders in the RCN can use the Cynefin Framework to determine what type of environment they are in and respond to that environment appropriately. Leaders can improve efficiency in ordered systems, such as drills, SOPs and flight operations, but needs to be resilient in unordered operations, such as combat, emergencies and team dynamics. Leaders in the RCN can use boundaries, attractors and attribution of credit to influence teams and sub-teams to a more desirable state. They can use safe-to-fail experiments within safety boundaries to do this. Finally, leaders can develop shared consciousness and empowered execution in order to develop the resiliency that Snowden advocates for complex systems.

Overall, complexity theory provides a more dynamic set of tools that leaders can use to develop the emergent behaviors that are required for the RCN to operate in the new complex environment effectively; tools that capitalize on the unpredictability of the environment, instead of fighting or ignoring it. Through the use of complexity tools, the RCN can adapt to the rapid change characteristic of the new millennium, and in the end, be ready to fight. This essay only scratches the surface of complexity theory, and complexity theory is a new and promising way thinking.

Moving forward, there is much potential for complexity theory and its suggested practical tools to greatly enhance how the RCN operates in this new VUCA environment. It is only a matter of safely experimenting and probing the system with it.

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