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Digital Warriors: A Galbraith Star Analysis of Upskilling in the CAF's Digital Transformation

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DIGITAL WARRIORS: A GALBRAITH STAR ANALYSIS OF UPSKILLING IN THE CAF'S DIGITAL TRANSFORMATION

ABSTRACT

Re-emergence of great power competition and rapid technological change associated with the Fourth Industrial Revolution have challenged government and military traditions, processes, and culture developed from industrial age thinking. Recent strategies released by the Department of National Defence and the Canadian Armed Forces (CAF) to adapt to this changing world risk failure unless current tasks and operations are re-focused to enable implementation planning and execution. If digital transformation fails, Canada's relevancy as a global security partner is in jeopardy.

Informed by academic and business literature, this research paper examines the global, operational, and policy context to develop a model of change management based on the Galbraith Star for organizational design. The model is used to assess case studies from industry and allied militaries to seek best practices for implementation of digital transformation with emphasis on experimentation. Integrated change management focused on continuous learning suggests the importance of user-centric digital upskilling enabled by industry and supported internally beyond the scope of single services. Central to the analysis is attention to digital literacy and skill frameworks, such as the Skills Framework for the Information age, to enable sense-making in an increasingly uncertain world.

The primary observation from the analysis suggests the need for greater involvement with industry and other partners throughout the organization to leverage the ingenuity of all soldiers, sailors, and aviators, regardless of rank or occupation to drive innovation via experimentation. However, using a broad view of change management identifies risks from obsolete risk-adverse

policies, structures, and incentives. The future of the CAF depends on recognition of a fundamental truth in this new era: digital skills *are* soldier skills.

CHAPTER 1: INTRODUCTION

Rapid technology developments are changing the world in unanticipated ways, often faster than organizations can adapt. Using a systematic analysis of patent data across more than 1700 possible domains, MIT research has shown slow to moderate growth in most fields with the exception of computers, communications, electrical, and electronics, which are developing orders of magnitude faster[1]. Despite this analysis, others argue that transformational technological innovation is not new, but that an overwhelming sense of disruption and anxiety is due to the way these technologies are pervasively integrated into the daily lives of the population[2]. Such broad adoption of digital technology has raised questions on the ability to form attention and the deeper impacts for society, such as capacity for critical thinking[3]. These trends and their implications paint an unclear picture for the global security environment.

Canada is reliant on coalitions and alliances to influence the global security environment[4]. In response to threats posed by adversaries capable of systems interference and building on a previous 'Revolution in Military Affairs'[5], massive disruption due to digital transformation and related domains such as artificial intelligence or quantum computing has captured the attention of many western militaries. The Department of National Defence (DND)

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[1] Anuraag Singh, Giorgio Triulzi, and Christopher L. Magee, "Technological Improvement Rate Predictions for All Technologies: Use of Patent Data and an Extended Domain Description," *Research Policy* 50, no. 9 (November 1, 2021): 7–9, https://doi.org/10.1016/j.respol.2021.104294.

[2] Todd Hirsch, "The Pace of Technological Change Is Faster Than Ever Before. Or Is It?," Entrepreneur, September 30, 2021, https://www.entrepreneur.com/leadership/the-pace-of-technological-change-is-faster-than-ever/386410.

[3] Jason M. Lodge and William J. Harrison, "The Role of Attention in Learning in the Digital Age," *The Yale Journal of Biology & Medicine* 92, no. 1 (2019): 27; Helena De Preester, "Life Is What You Fill Your Attention with – the War for Attention and the Role of Digital Technology in the Work of Bernard Stiegler," *Phenomenology and Mind*, no. 20 (2021): 109–11, https://doi.org/10.17454/PAM-2009.

[4] Stéfanie von Hlatky and Justin Massie, "Ideology, Ballots, and Alliances: Canadian Participation in Multinational Military Operations," *Contemporary Security Policy* 40, no. 1 (2019): 102–3, https://doi.org/10.1080/13523260.2018.1508265.

[5] Christian Brose, *The Kill Chain: Defending America in the Future of High-Tech Warfare*, First edition (New York: Hachette Books, 2020), chap. 1.

and the Canadian Armed Forces (CAF) as Canada's Defence Team are no exception to this trend, having recently published several strategies to adapt to the changing world.

However, the global pace of change has accelerated beyond a culturally constrained Defence Team's ability to adapt with traditional approaches. Developing personnel through digital upskilling is the unstated vital ground of the *CAF Digital Campaign Plan* yet due to complexities with organizational design this is only possible when continuous learning is pursued as a component of integrated change management. Without user-centric adoption of digital upskilling enabled by industry and supported by central services, Canada risks future relevancy as a global security partner.

This research paper will examine the centrality of digital upskilling to future operational effectiveness through a lens of change management occurring within a holistic organizational design framework. Digital upskilling will be considered as the intersection of digital literacy requirements and workforce management implications. To frame the problem space, Chapter 2 will examine the global and policy developments. Focus areas from Chapter 2 will direct analysis in Chapter 3 to prominent theories and models in literature to isolate relevant variables to populate a model as part of an analysis framework. The framework will be applied to case studies in Chapter 4 to examine best practices which may guide implementation efforts in the Defence Team. Finally, Chapter 5 will summarize the results of these findings to inform planning teams of risk and areas for development.

CHAPTER 2: GLOBAL, STRATEGIC, AND POLICY CONTEXT

Introduction

This chapter provides an overview of the challenges and pressures driving the need to change from the status quo. Divided across three sections, the global context begins by examining future requirements for the global security environment informed by technology and population implications. Strategic translation to operational context, later expanded on by an overview of policy context, further assess the changing perspectives in the operational space and isolates variables and topics requiring further analysis in the next chapter.

Global Context

Broad technological, political, and demographic trends form the environment in which organizations operate. These trends partially define the context to which organizations must adapt. Although continuously evolving, the aim point for organizational output can be viewed as the 'ends', the methods to reach those goals as the 'ways', and the resources available as the 'means'. In the case of the Defence Team, using the Clausewitzian perspective of war as an extension of politics then frames the political context as the 'ends', with technological and demographic trends as 'means'. The option space to define the 'ways' begins in this review but requires further examination in the next section.

Great Power Competition

The shifting global geo-political context has changed. The US Congressional Research Service identifies the re-emergence of great power competition as a shift from the unipolar moment at the end of the Cold War into renewed geo-strategic competition beginning in 2006,

with 2014 acknowledged as the start of the new global context[6]. Great power competition can be conceived of as strategic competition across the diplomatic, information, military, and economic (DIME) instruments of national power[7]. Retired Australian Major-General Mick Ryan has explored the intersection of the information and military dimensions at length in *War Transformed* by examining the impact of rapidly changing technology on future military requirements. Ryan has placed emphasis on the "consequences for military institutions and their ideas", as well as how the Fourth Industrial Revolution will influence people across activities ranging from leadership, recruiting, retention, and development throughout their careers[8]. Further themes noted by Ryan are the acceptance by military institutions that "future warfare will be different", and that there will be a need for adapted concepts to enable warfighting when military activities are more tightly integrated into approaches to national power[9]. This integrated competition below the threshold of major war is sometimes referred to as 'grey zone conflict', or 'irregular warfare'. While there are minor differences in the scope and scale of activities in these forms of competition[10], a common theme in both is vastly increased use of global information and communication ecosystems to integrate elements of national power. One implication of these changes is an increased need for partner integration in the future global security environment, with an ability to pivot in step with digital trends.

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[6] Congressional Research Service, "Renewed Great Power Competition: Implications for Defense—Issues for Congress. CRS Report," 2022, 1.
[7] Congressional Research Service, 2–3.
[8] Mick Ryan, *War Transformed: The Future of Twenty-First-Century Great Power Competition and Conflict*, Book, Whole (La Vergne: Naval Institute Press, 2022), 20.
[9] Ryan, chap. 3.
[10] Barak Salmoni, "The Fallacy of 'Irregular' Warfare," *RUSI Journal* 152, no. 4 (2007): 22–23, https://doi.org/10.1080/03071840701574631; Matt Petersen, "Competition and Decision in the Gray Zone: A New National Security Strategy," The Strategy Bridge, April 20, 2021, https://thestrategybridge.org/the-bridge/2021/4/20/competition-and-decision-in-the-gray-zone-a-new-national-security-strategy.

Fourth Industrial Revolution

The Fourth Industrial Revolution, also called the digital revolution, has been suggested by the World Economic Forum (WEF) as the global era beginning in 2016, directly building on the Third Industrial Revolution which was characterized by automation through electronics and information technology (IT)[11]. The WEF defines the Fourth Industrial Revolution as "a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres". This definition has been contested on the grounds that while exponential growth has been realized in areas impacted by digitalization, the underlying systems of management, power, and transportation are still being transformed by emerging technologies of the Third Industrial Revolution[12]. These views converge when considering disruptive future trends of economic, social, and political spheres based on increased distribution of sensors, networks, and predictive capability. It has been suggested that successful organizations will "manage the transition by adopting the new distributed and collaborative business models of the Third Industrial Revolution while continuing their traditional Second Industrial Revolution business practices"[13]. This concept translates from the business context to militaries as demonstrated by the United States (US) military in activities such as Exercise SCARLET DRAGON OASIS where "training operations … continue to focus on traditional warfighting skills and scenarios while incorporating digital tool training as much as possible"[14]. Two key observations can be drawn

[11] Klaus Schwab, "The Fourth Industrial Revolution: What It Means and How to Respond," World Economic Forum, January 14, 2016, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/.
[12] Jeremy Rifkin, "The 2016 World Economic Forum Misfires with Its Fourth Industrial Revolution Theme," IndustryWeek, January 15, 2016, https://www.industryweek.com/technology-and-iiot/information-technology/article/21967057/the-2016-world-economic-forum-misfires-with-its-fourth-industrial-revolution-theme.
[13] Rifkin.
[14] Aaron Mehta, "To Prepare for Digital Warfare, the Military Must Run More Digital Exercises," *Breaking Defense* (blog), February 8, 2023, https://breakingdefense.sites.breakingmedia.com/2023/02/to-prepare-for-digital-warfare-the-military-must-run-more-digital-exercises/.

from such developments. The first is that digital transformation is not an isolated trend for technical support personnel, rather, it is a critical enabler for war fighters in all domains. Second, integrated experimentation is necessary to adapt and iteratively test methods and mindsets to be prepared for an uncertain future.

The War for Talent

The 'War for Talent' can be expressed as an undersupply of (technology) workers as an international competition throughout public and private sectors. In 1998, the consulting firm McKinsey coined the term 'War for Talent' as a combination of difficulties in recruiting, retention, and talent management based on large-scale surveys of companies and case studies[15]. While the McKinsey study lacked industry-specific numbers, a recent report by the Canadian Information and Communications Technology Council (ICTC) forecasts that by 2025 there will be an increase of 250,000 jobs in the Canadian digital economy, raising the total pool to an estimated 2.26 million[16]. This gap expands on a current vacancy of approximately 200,000 positions[17]. The ICTC defines roles within the digital economy as a combination of technical and business-oriented work[18]. Mapping these roles to the CAF would be equivalent to the Communication and Electronics Branch for technical and integrative work, while operational elements such as combat units would represent (business) end-users.

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[15] E.G. Chambers et al., "The War for Talent," *The McKinsey Quarterly* 3 (January 1, 1998): 45–46.
[16] Maryna Ivus and Akshay Kotak, "Onwards and Upwards - Digital Talent Outlook 2025" (Ottawa, Canada: Information and Communications Technology Council (ICTC), August 2021), 9, https://www.ictc-ctic.ca/wp-content/uploads/2021/08/digital-talent-outlook-for-2025.pdf.
[17] Parisa Mahboubi, "The Knowledge Gap: Canada Faces a Shortage in Digital and STEM Skills," Commentary (Toronto: C.D. Howe Institute, 2022), 7, https://www.cdhowe.org/sites/default/files/2022-08/Commentary_626_0.pdf.
[18] Ivus and Kotak, "Onwards and Upwards - Digital Talent Outlook 2025," 48–51.

Some companies have suggested that the 'War for Talent' is shifting to a 'War for Skills'[19]. The 'War for Skills' places greater emphasis on skill development internally to dynamically generate cross-functional teams, augmented by variable staffing models to address specific skill gaps. A common theme in this regard has also been called the "War to *Develop* Talent", highly focused on upskilling or re-skilling as part of a continuous learning function backed by motivational science[20]. Continuous learning in the form of training budgets and primary role vacancies can be an expensive prospect for organizations, suggesting that investing in personnel to retain them is preferable to continuous recruiting to address skill gaps. Regardless of the terminology used, talent management is an enduring problem. While there has recently been downsizing in the technology sector, which some attribute to pandemic over-hiring[21], the US continues to attract Canadian technology talent largely based on higher pay and better brand recognition[22]. The consequence is that the CAF needs to balance continuous learning with operational employment in order to recruit and retain personnel in a highly competitive market.

Strategic and Operational Context

Given CAF focus on mission success, developing the 'ways' first requires a review of the operational context. National direction is analyzed to determine the relationship with digital transformation and the influence on implementation efforts which will impact the option space.

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[19] Sheryl Estrada, "The War for Talent Has Turned into a 'War for Skills,'" Fortune, January 17, 2023, https://fortune.com/2023/01/17/war-for-talent-turned-into-war-for-skills/.
[20] Bill Pelster et al., "The War to Develop Talent," Deloitte, 2013, https://www2.deloitte.com/br/en/pages/human-capital/articles/war-develop-talent.html; Shaara Roman, "Winning the War for Talent In The Public Sector," Government Executive, February 16, 2018, https://www.govexec.com/management/2018/02/winning-war-talent-public-sector/146078/.
[21] Susan Caminiti, "Tech Companies Shed Workers Even as the Talent Shortage Rages On," CNBC, August 13, 2022, https://www.cnbc.com/2022/08/13/tech-companies-shed-workers-even-as-the-talent-shortage-rages-on.html.
[22] Randstad Canada, "The Tech Brain Drain and Talent Shortage in Canada," Randstad, February 9, 2023, https://www.randstad.ca/employers/workplace-insights/job-market-in-canada/a-primer-on-the-canada-tech-brain-drain-and-how-to-solve-it/.

International relevancy of CAF contributions occurs in the operational space, which requires a review of emerging operational-level thought. Additional development of the option space and constraints require additional examination in the next section on policy.

Strong, Secure, Engaged

Strong, Secure, Engaged: Canada's Defence Policy (SSE) provides the Canadian strategic context for digital transformation. SSE highlights key trends and expands on the global context discussed in the previous section, with emphasis on the rapid evolution of technology for both cyber and space domains[23]. Organized across 111 initiatives, SSE recognizes that technological advances "ha[ve] the potential to change the fundamental nature of military operations"[24]. Using Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) as an assessment tool, 29 of the 111 SSE initiatives are related to digital transformation in some form, with a further six being related to relevant recruiting, retention, and development requirements. Many of these 'C4ISR initiatives' are platform-specific or high-level but have an implied networking component needed to link sensors with weapon platforms, such as initiative 34 to acquire ground-based air defence systems. The threat to these systems is that "potential adversaries, including state proxies and non-state actors, are rapidly developing cyber means to exploit the vulnerabilities inherent in the C4ISR systems on which militaries depend"[25]. While these vulnerabilities create risk, security experts have stressed the need to transition from complicated high-cost systems to dispersed

[23] Canada, "Strong, Secure, Engaged: Defence Policy" (Ottawa: Department of National Defence, 2017), 49–57, https://www.canada.ca/content/dam/dnd-mdn/documents/reports/2018/strong-secure-engaged/canada-defence-policy-report.pdf.
[24] Canada, 55.
[25] Canada, 55.

network platforms to enable kill chains with increased operational survivability[26]. These observations are reinforced in the Russia-Ukraine conflict, which emphasize dispersion and speed[27]. The high rate of development and changes in global competition implies a need for Canada to overhaul obsolete doctrine and projects conceived in the context of counter-insurgency operations. Significant revision of operational doctrine and subsequent realignment of service doctrine has several second-order effects on professional development, which requires further discussion in the next chapter.

Pan Domain Force Employment Concept

Driven by the demand signal in SSE, CAF doctrine is evolving to adapt to renewed great power competition with the draft *Pan-Domain Force Employment Concept* (PFEC) by the Canadian Joint Operations Command. PFEC recognizes the increasingly integrated DIME environment and requirement to synchronize effects across multiple domains[28]. Organized across 14 elements, three are particularly relevant for digital transformation: artificial intelligence enhancement, operationalized culture, and comprehensive resilience[29]. PFEC envisions AI enhancement as a range of capabilities such as machine learning, human-machine teaming, and analytics applied broadly throughout force employment activities. Operationalized culture emphasizes the need for the CAF to be a learning organization with investments in innovation for education and continuous improvement. Comprehensive resilience recognizes the complex interdependencies inherent in CAF systems and processes, and the need to operate within a

[26] Brose, *The Kill Chain*, chap. 1,5.
[27] Mykhaylo Zabrodskyi et al., "Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022" (Royal United Services Institute, November 30, 2022), 62–63, https://static.rusi.org/359-SR-Ukraine-Preliminary-Lessons-Feb-July-2022-web-final.pdf.
[28] Canada, "Pan-Domain Force Employment Concept: Prevailing in an Uncertain World" (Ottawa: Department of National Defence, n.d.), 4, https://mars.cfc.forces.gc.ca/CFCLearn/mod/folder/view.php?id=7378.
[29] Canada, 23–30.

contested environment, whether through command and control, logistics, or otherwise. Despite the draft status, the activity and thought processes behind development of the PFEC are necessary enablers for CAF 'force employment', the operational output against which CAF effectiveness is self-assessed[30]. The dependencies with these three elements require further examination to derive salient factors affecting CAF digital transformation.

While important, force employment is only a small component of a military's ability to provide options to government. As such, assessing operationalized culture requires a broader view of the system in which force employment rests. Most military institutions, including the CAF, organize according to strategic, operational, and tactical levels[31]. Translating strategic requirements and goals to tactical activities requires organizing principles nested within an institutional element. The CAF has attempted this using a '5F' model consisting of force development (FD), force generation (FG), force employment (FE), force management (FM), and force sustainment (FS)[32]. The 5F model was proposed in 2011 to augment the operational functions of 'Command', 'Sense', 'Act', 'Shield', and 'Sustain', which are doctrinally "functional capabilities required by a [Joint Task Force] in order to effectively employ forces"[33]. While criticized as failing to provide clarity or add value[34], the purpose of the 5F model was to align all institutional and operational activities across DND and the CAF and as such the model

[30] Louise Arbour, "Report of the Independent External Comprehensive Review of the Department of National Defence and the Canadian Armed Forces," May 20, 2022, 30–31, https://www.canada.ca/en/department-national-defence/corporate/reports-publications/report-of-the-independent-external-comprehensive-review.html.
[31] Ryan, *War Transformed: The Future of Twenty-First-Century Great Power Competition and Conflict*, 124; National Defence, *Canadian Military Doctrine*, CFJP 01, 2011, 1-2-1–3.
[32] National Defence, "Report on Transformation 2011," July 6, 2011, https://www.canada.ca/en/department-national-defence/corporate/reports-publications/report-on-transformation-2011.html.
[33] National Defence, *Operations*, n.d., 1–5.
[34] John A. Steele, "Capability-Based Planning and the Royal Canadian Air Force," in *RCAF Defence Economics* (Canadian Forces Aerospace Warfare Centre Production Section, 2019), 80–81, https://publications.gc.ca/collections/collection_2019/mdn-dnd/D2-409-2019-eng.pdf.

offers an alternate lens to holistically assess concepts. Operational primacy[35] uses the 5F model to set FE as the organizing principle against which doctrine and internal strategy are developed to employ deployed forces. However, the other components of the 5F model define the inputs and capabilities available for FE. To assess digital transformation, FD can be considered as forecasting equipment and personnel capabilities against a threat model while FG and FM control the training pipeline and institutional aspects respectively. With focus on protection and sustainment activities, FS is linked to procurement and development of tactics. Since FD is where new capabilities are conceived and resourced, there exists a natural link between strategy and new technology, which suggests that any implementation of digital transformation must consider how to more rapidly field traditionally slow FD activities. More consequentially, FD must be executed while being mindful of integration requirements with allies and partners, which suggests a tension between the centralized synchronization of FD and decentralized innovation as part of FG.

The PFEC element of comprehensive resilience is a similar concept to 'operational resiliency'. In a military sense, 'operational resiliency' is effectively managing risk to train or operate within a 'denied, degraded, intermittent, or limited impact' (DDIL) environment[36], or a 'command-and-control degraded or denied environment' (C2D2E)[37]. Reliance on links within a network, such as satellites, or through services such as the Global Positioning System (GPS) for position, navigation, and timing is a risk due to threats such as GPS jamming or anti-satellite

[35] National Defence, *Canadian Armed Forces Ethos: Trusted to Serve*, A-PA-005-000/AP-138 (Canadian Defence Academy – Professional Concepts and Leader Development, 2022), 33, https://www.canada.ca/en/department-national-defence/corporate/reports-publications/canadian-armed-forces-ethos-trusted-to-serve.html.
[36] Maj Spencer S Waters, "Training in the DDIL Environment," 2022, https://mca-marines.org/wp-content/uploads/Training-in-the-DDIL-Environment.pdf.
[37] John Minor, "The Navy Must Decentralize Information Warfare," U.S. Naval Institute, January 20, 2022, https://www.usni.org/magazines/proceedings/2022/january/navy-must-decentralize-information-warfare.

warfare[38]. Training for DDIL operations can be complicated due to legal constraints such as prohibition on jamming in domestic environments[39], or difficulty introducing progressive or intermittent faults in equipment.

Although not a part of established Canadian doctrine[40], the US method of using primary, alternate, contingency, and emergency (PACE) planning for communication capabilities is heavily leveraged by the Canadian Army and has been taught at the Canadian Forces School of Communication and Electronics for decades. While the US implementation of PACE planning is developed and exercised across multiple echelons[41], the Canadian approach is typically focused on reaction to denial of a service and a resulting order to switch to a lower system, which is rarely exercised due the disruptive effect on a compressed tempo in which units struggle to achieve their battle task standards. A consequence of this rarely exercised transition is the reduction in information management capacity as lower systems in a PACE plan tend to have less reach or integration with information repositories. A relatively simple tactical scenario is the use of combat net radio (CNR) using very-high frequency radios as a primary system, with high-frequency radios as an alternate, and satellite phones eventually as an emergency system. Equipment distribution and training restrictions limit the dispersion of nodes for lower means to essential services, with reduced network participation. While CNR provides an all-informed network, satellite phones are point-to-point transmissions, which introduces delays in the decision-action cycles in operations. In a networked environment this challenge becomes more

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[38] Waters, "Training in the DDIL Environment," WE26.
[39] Innovation Government of Canada, "Jamming Devices Are Prohibited in Canada:That's The Law," Backgrounders (Innovation, Science and Economic Development Canada, July 22, 2011), https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/spectrum-allocation/cellular-services/jamming-devices-are-prohibited-canadathats-law.
[40] National Defence, *No Man's Land: Tech Considerations for Canada's Future Army* (Kingston: Army Publishing Office, 2014), 4–18.
[41] Michael S. Ryan, "A Short Note on PACE Plans," *Infantry* 102, no. 3 (September 2013): 13, https://www.benning.army.mil/infantry/magazine/issues/2013/jul-sep/pdfs/JUL-SEP13web.pdf.

complex as services are more likely to have single points of failure such as individual servers or databases.

Translating 'operational resiliency' to an industry context is when companies identify risk and develop approaches to manage it while maintaining operations. An ideal example in a network-reliant case is Netflix, which purposefully injects routine failure as part of their 'Simian Army' program[42]. The purpose of such stress testing is to continually reinforce organizational learning to adapt to degraded environments, recognizing that "in complex systems, failure is inevitable"[43]. Returning to the military context, this is a critical warfighting skill recognized by military organizations such as the US Marine Corps (USMC) which routinely conduct exercises in DDIL environments[44]. These approaches highlight that continuous learning and continuous improvement are necessary in both individual and collective senses to enable long-term performance. Further, in the case of the USMC it is the warfighting element that advocates the need for operational resiliency, not the technical community.

In an organization with low technical maturity, appetite for operational resiliency is balanced against increased capability. Development of enhanced networking is seen in the CAF as a two-edged sword because "[f]ailure to exploit these networks or, conversely, become entirely dependent on them, has potential risks that may negate an advantage or even leave the Canadian Army at a significant disadvantage."[45] Developing personnel to have comprehensive resilience implies a necessity for strong baseline skills augmented by continuous and rigorous training environments where system failures are exercised by design. Due to the emphasis on

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[42] Gene Kim et al., *The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations*, First edition (Portland, OR: IT Revolution Press, LLC, 2016), 364–65.
[43] "What Are Blameless Postmortems? (Do They Work? How?)," accessed May 3, 2023, https://www.blameless.com/blog/what-are-blameless-postmortems-do-they-work-how.
[44] Waters, "Training in the DDIL Environment," WE27.
[45] Jean-Marc Lanthier, "Close Engagement-Land Power in an Age of Uncertainty," n.d., 7.

warfighting, these DDIL exercises should become as important as attacking an objective with kinetic means. Digital skills *are* soldier skills.

Policy Context

The operational context highlighted planned investments, but also covered risks in professional development and the need for preparedness in the threat environment, enabled by continuous learning with realistic conditions. Further development of the 'ways' to achieve a 'digitally transformed' force examines relevant policies in the form of published strategies. These policies are then assessed to isolate variables which impact the ability to implement continuous learning and change management initiatives.

CAF Digital Campaign Plan

The *CAF Digital Campaign Plan* presents a vision where the "CAF will become digitally transformed by 2030"[46]. Key elements of this vision include a broadly distributed data mesh and a focus on better informing decision-makers in operational and institutional environments. The vision builds on a Digital Maturity Model (DMM) which crosses a spectrum from 'digitally aware', to 'digitally enabled', 'digitally transformed', and finally 'continuous digital innovation'[47]. The DMM is the framework upon which the objectives within the lines of effort (LoEs) are described, with most objectives currently resting at the 'digitally aware' state. Elements of the *Digital Campaign Plan* include people, data, processes, technology, and culture. The LoE themselves are spread across governance and the 5F model discussed earlier, nested within the requirement for interoperability with allies in pan-domain operations. Focusing on

[46] Canadian Armed Forces, *Canadian Armed Forces: Digital Campaign Plan*, n.d., 10.
[47] Canadian Armed Forces, 6–7.

developing personnel draws direct links to the objectives of designing the digital workforce as well as investing heavily in digital literacy and associated skills. The critical requirement for broad digital literacy, especially at senior leadership levels, is echoed by industry professionals[48]. 'Digital literacy' has been defined as an "essential set of skills needed to find information and communicate in today's world"[49]. In this sense, digital literacy is relevant at the institutional level to support FD and FM activities, while the tactical level requires digital literacy skills for both FE and FG. FS requires digital literacy through all levels owing to heavy reliance on information systems to support materiel management requirements. The relationship between designing the digital workforce and dependency on skills within a digital literacy framework requires greater clarity as both are significant elements of organizational design. While a short overview is given below, this topic requires much deeper examination in the next chapter.

The concept of a 'data mesh' from the *Digital Campaign Plan* vision provides useful context to examine knowledge and skills needed by a digital workforce. A 'data mesh' is similar to a 'data fabric', which has been described as management and accessibility of a "platform that supports all the data in the company"[50]. Data fabrics are associated with knowledge graphs, which can be derived from graph databases as a more flexible alternative to traditional relational databases and facilitate machine learning techniques[51]. While both graph and relational databases encode relational information in the data, graph databases store this information as data itself while relational databases store this information as part of the inherent structure, which makes

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[48] Tony Saldanha, *Why Digital Transformations Fail: The Surprising Disciplines of How to Take off and Stay Ahead*, First edition (Oakland, CA: Berrett-Koehler Publishers, a BK Business Book, 2019), 43–45.
[49] Nicole Johnston, "The Shift towards Digital Literacy in Australian University Libraries: Developing a Digital Literacy Framework," *Journal of the Australian Library and Information Association* 69, no. 1 (2020): 93, https://doi.org/10.1080/24750158.2020.1712638.
[50] Favio Vázquez, "Ontology, Graphs and Data Science," *International Journal of Business Analytics and Intelligence* 7, no. 1 (2019): 6.
[51] Vázquez, 7.

support for big data and unstructured information more challenging in relational databases[52]. It has been suggested that part of the motivation to move to graphs over relational representations is the ability of graph representations to facilitate improved "interaction between human and data"[53], which in turn may help improve knowledge and understanding. While migration of relational databases to a graph representation are challenging in of itself[54], the magnitude of this problem is even larger for the CAF, which tends to rely on email or spreadsheet files to capture and transmit information. These poor information management capabilities have been suggested as a result of exceptionally low digital literacy and a symptom of the CAF's limited ability to manage information[55]. This observation suggests an inherent relationship between digital literacy and information literacy, both with related skills which require development beyond the current ability of the CAF to self-deliver, suggesting a need to develop relationships with external providers. Reinforced by the operational shift in thinking to focus on information operations[56], increased digital literacy across the force will be crucial to operating with allies, understanding risks, and navigating the cognitive hierarchy. The cognitive hierarchy is a model describing how data can become understanding, which will need further examination in the next chapter.

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[52] Zhihong Nan and Xue Bai, "The Study on Data Migration from Relational Database to Graph Database," *Journal of Physics. Conference Series* 1345, no. 2 (2019): 1–2, https://doi.org/10.1088/1742-6596/1345/2/022061.
[53] Marcelo Arenas, Claudio Gutierrez, and Juan F. Sequeda, "Querying in the Age of Graph Databases and Knowledge Graphs," *ArXiv.Org* (Ithaca: Cornell University Library, arXiv.org, 2021), 9.
[54] Nan and Bai, "The Study on Data Migration from Relational Database to Graph Database," 1.
[55] Robert C Engen, "When the Teeth Eat the Tail," n.d., 13–14.
[56] Chris Thatcher, "Manoeuvre in the Information Domain," *Canadian Army Today*, May 4, 2020, 37–40, https://s3.amazonaws.com/canadianarmytoday/downloads/CanadianArmyToday-v4i1-Spring2020.pdf.

Canadian Army Digital Strategy

The *Canadian Army Digital Strategy* calls itself the "Vital Ground to CA Modernization"[57] which draws on Canadian Army (CA) culture to appreciate 'vital ground', defined within NATO and CA doctrine as "ground of such importance that it must be retained or controlled for the success of the mission"[58]. Released in parallel with and informed by the *Digital Campaign Plan*, the *Digital Strategy* emphasizes the importance of digital transformation to the CA Modernization Strategy, which underpins all other aspects of the current modernization cycle. Organized along four LoE, the *Digital Strategy* seeks to achieve five 'aim points' designed to develop a regenerative culture to ensure future relevance and interoperability with allies. Three of the LoE build on FG to "invest in people", FM to "optimize CA structures and transform our processes", and FD to "modernize our technology"[59]. A fourth LoE to "strengthen our relationship with data" crosses all components of the 5F model and signals the importance of data and information management to decision-making and the ability to achieve operational effectiveness. The Canadian Forces Effectiveness Framework is presented in Figure 2.1, defining operational effectiveness as being comprised of mission success, internal integration, member well-being and commitment, external adaptability, and military ethos[60]. Although the CAF has been accused of being too focused on operational effectiveness as an organizational existential threat, the implied priority is on the 'mission success' component[61].

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[57] *Modernization Vital Ground: Digital Strategy*, A-PP-007-00/AF-001 (Ottawa, Ontario: HQ, Canadian Army, 2022), 1–2.
[58] NATO Standardization Agency, "AAP-06" (North Atlantic Treaty Organization, 2013), 2-V–2, https://www.jcs.mil/Portals/36/Documents/Doctrine/Other_Pubs/aap6.pdf; National Defence, "Land Operations," January 1, 2008, 7–48.
[59] *Modernization Vital Ground: Digital Strategy*, 17–19.
[60] National Defence, "Leadership in the Canadian Forces: Leading People," vol. 3 (Ottawa: Published under the auspices of the Chief of the Defence Staff by the Canadian Defence Academy, Canadian Forces Leadership Institute, 2007), 3–5, https://publications.gc.ca/collections/collection_2013/dn-nd/D2-313-3-2007-eng.pdf.
[61] Engen, "When the Teeth Eat the Tail," 66.

The *Digital Strategy* re-orients this view by shifting focus to *enable* mission success through development of internal integration and external adaptability. While CAF integration mindful of external pressures may be perceived as both reactive and requiring high effort, the *Digital Strategy* hints at ways to achieve this through revised governance models, experimentation, and innovation. To achieve these aims, the *Digital Strategy* is seeking to enable 'loose coupling' within a traditionally risk-adverse and controlling 'tightly coupled' system, evident through both recognition of the "changing nature of conflict" and need to "overcome our tendency toward process-based initiatives – we must remain mission-focused"[62]. This has implications for training and education models as well as organizational structure.

Figure 2.1 – Canadian Forces Effectiveness Framework
Source: National Defence, *Leadership in the Canadian Forces: Leading People*, 3

[62] *Modernization Vital Ground: Digital Strategy*, 7,18.

Conceptualizing elements of the CA as a 'loosely coupled system' enables closer examination of the contrast between standardization required by bureaucratic processes and flexibility needed for innovation. The flexibility offered by a 'loosely coupled system' is in both the organizational sense as well as information-handling. 'Loosely coupled systems' are a term attributed to Karl Weick to convey an image of "physical or logical separateness … between two systems on the basis of the activity of the variables which the two systems share"[63]. Weick stresses that coupling extends beyond mere connection or interdependency, and notes in later work that systems may simultaneously exhibit tightly or loosely connected elements[64]. Such concurrent existence suggests that bureaucratic hierarchical organizations such as the CA can leverage 'loosely coupled systems' as innovation centres, if supported by policies and resources.

This spectrum of interconnection dependent on the elements examined offers flexibility at the cost of vagueness, as Weick notes in their early work 15 different views of what 'loosely coupled' might mean dependent on context[65]. To examine the challenge facing the CA, the areas where Weick identifies challenges include coordination, responsiveness, ability to inspect, decentralization, delegation, and the ability to prepare with limited information. The differentiation between 'loosely coupled' or 'tightly coupled' depends on the respective element, with an example that high decentralization would correspond to 'loose coupling' whereas high centralization would permit greater local control and 'tight coupling'. It is probable that change associated with digital transformation will generate tension within areas of the organization,

[63] Karl E. Weick, "Educational Organizations as Loosely Coupled Systems," *Administrative Science Quarterly* 21, no. 1 (1976): 3, https://doi.org/10.2307/2391875.
[64] J. Douglas Orton and Karl E. Weick, "Loosely Coupled Systems: A Reconceptualization," *The Academy of Management Review* 15, no. 2 (1990): 204, https://doi.org/10.2307/258154.
[65] Weick, "Educational Organizations as Loosely Coupled Systems," 5.

especially those elements moving towards loose coupling in the sense of decentralization or informal networks, as will be examined later in the section on change management.

Resolving friction associated with change has been called by some observers as challenges to the 'immune system', a term used to capture actions based on mis-aligned policies or individual motivations to slow down or block change[66]. Due to the leadership and coordination required, movement towards loosely coupled systems will likely be at higher risk of such 'immune system' responses based on real or perceived risk to individual portfolios where loose coupling represents a loss of control. However, as a partial mitigation to this risk, a recent meta-study of organizational couplings suggests that 'loosely coupled systems' offer better resiliency[67]. From an analytics or business intelligence perspective, there may be some concern that 'loose coupling' will generate data with a high degree of variance, degrading the capability of the nascent analytics function[68]. Industry expert John Doerr warns against tightly coupled (vertical) cascading 'objectives and key results'[69]. Doerr suggests potential for emergent horizontal or diagonal alignment is desirable to reduce the overall coordination effort which detracts from functional work and degrades overall alignment. A similar analysis is offered by the vendor community on the basis that 'loose coupling' for data requirements increases flexibility in adapting to change and makes a case for improved data management practices[70]. These industry management perspectives suggest that use of 'loosely coupled systems' is

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[66] Saldanha, *Why Digital Transformations Fail*, 99–102.
[67] Leonel Arango-Vasquez and Mariano Gentilin, "Organizational Couplings: A Literature Review," *Innovar : Revista de Ciencias Administrativas y Sociales* 31, no. 79 (2021): 169–70, https://doi.org/10.15446/innovar.v31n79.91898.
[68] National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy* (Ottawa: National Defence, 2019), 2.
[69] John Doerr, *Measure What Matters: How Google, Bono, and the Gates Foundation Rock the World with OKRs* (New York: Portfolio/Penguin, 2018), 81–89.
[70] Jared Hillam, "Loose Coupling – Data Architecture from the 1700's?," Intrincity, 2020, https://www.intricity.com/learningcenter/intricity-loose-coupling.

essential to enabling internal integration and external adaptability, or as the CAF describes it, operational effectiveness. However, moving to an organizational reality where both hierarchical and 'loosely coupled systems' coexist will challenge the thinking and structures of the existing CAF professional development system.

Professional development in the CAF has a basis in skill competencies but is not structured to adapt to rapid skill change. The need for modernization is driven by a suggestion that emerging skills have a half-life as low as 2.5 years[71]. The Canadian Forces Professional Development Framework (CFPDS) is described in the Defense Administrative Orders and Directive (DAOD) 5031 series (especially DAOD 5031-8) as a combination of policies, military employment structures, establishments, and authorities for the purpose of developing personnel and employing them in a variety of roles[72]. The Canadian Forces Individual Training and Education System (CFITES) is a multi-volume policy based on industrial age training and education research from 1972-78 which links the CFPDS to FE and FD[73]. In theory, this model adjusts professional development requirements based on operational or procurement pressures using the PRICIE model[74]. In practice, staffing shortages often preclude deep analysis, which is exacerbated by a high management cost to adjust sub-systems within the CFITES model. The result is a focus on training and education linked purely to immediate operational requirements, a

[71] "Skills Transformation For The 2021 Workplace," IBM Training and Skills Blog, December 7, 2020, https://www.ibm.com/blogs/ibm-training/skills-transformation-2021-workplace/.
[72] National Defence, "DAOD 5031-8, Canadian Forces Professional Development," policies, November 13, 2013, https://www.canada.ca/en/department-national-defence/corporate/policies-standards/defence-administrative-orders-directives/5000-series/5031/5031-8-canadian-forces-professional-development.html.
[73] Blake C.W. Martin et al., "The Implementation of Canadian Forces Individual Training and Education System and Mission Essential Competency Training Analysis Methods: A Case Study," Scientific Report (Defence Research and Development Canada, December 2016), 3–8, https://cradpdf.drdc-rddc.gc.ca/PDFS/unc265/p805133_A1b.pdf.
[74] National Defence, *Manual of Individual Training and Education, Volume 1: Interim Guidance-Introduction/Description*, vol. 1, A-P9-050-000/PT001 (Ottawa, Canada: National Defence, 1998), 9; Canada, "Personnel, Research & Development, Infrastructure and Organization, Concepts, Doctrine and Collective Training, Information Management, and Equipment Supplies and Services," DTB Record 42611, n.d.

danger which management guru Peter Drucker explicitly warns against when considering the future of knowledge workers and the information age[75]. However, while the emphasis of CFITES tends to be placed on training and education, self-development and work experience are other recognized forms of continuous professional development[76]. Although difficult to standardize, further developing delivery of these forms of learning may facilitate the 'loose coupling' and external engagement suggested by experts which the CA needs to lead digital transformation[77]. The requirement to continuously renew digital skills suggests a need for a more agile system. To explore this further, research on continuous learning and learning organizations will be examined in the next chapter.

DND/CAF Data Strategy

The *DND/CAF Data Strategy* envisions data management as an enabler for other digital approaches within new Government of Canada direction and policies[78]. The need for the *Data Strategy* was derived from the *CDS/DM Joint Directive to Develop and Operationalize a Defence Program Analytics Capability*, which identified required changes in practices and culture[79]. This assessment is reinforced by a recent Defense Artificial Intelligence Observatory (DAIO) review of Canada's ability to implement artificial intelligence, and digital transformation more broadly, which it summarized as "badly positioned to embrace digital transformation … [as

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[75] Peter F. Drucker, "The Age of Social Transformation," *The Atlantic Monthly (1993)* 274, no. 5 (1994): 67.
[76] National Defence, *Manual of Individual Training and Education, Volume 1: Interim Guidance-Introduction/Description*, 1:5.
[77] Saldanha, *Why Digital Transformations Fail*, 130; Sari Wilde, Alison Smith, and Sara Clark, "Organizations Need a Dynamic Approach to Teaching People New Skills," *Harvard Business Review*, November 26, 2021, https://hbr.org/2021/11/organizations-need-a-dynamic-approach-to-teaching-people-new-skills.
[78] National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy*, 2.
[79] Jonathan Vance and John Foster, "CDS/DM Joint Directive to Develop and Operationalize a Defence Program Analytics Capability," July 28, 2017, para. 5e, http://intranet.mil.ca/assets/DefenceTeam/docs/en/adm-pa/organization/10-02-dsi-defence-program-analytics-initiating-directive-2017.pdf (DWAN).

a] consequence of the organization's structure, its history, and its culture"[80]. The DAIO report attributed extremely poor data management to organizational balkanization because of unification in the 1960s and the Forces Reduction Program of the 1990s, which led to a loss of trust and data management expertise respectively[81]. In attempting to rebuild these capabilities for the CAF, the *Data Strategy* draws heavily on industry perspectives by using the Data Management Association Data Management Body of Knowledge for definitions of data and data management, which is organized over 11 knowledge areas. The provided definition of 'data' is "the representation of facts as text, numbers, graphics, images, sound or video", while data management describes required activities over the data lifecycle[82]. The data vision is that "data are leveraged in all aspects of Defence programs, enhancing our defence capabilities and decision-making, and providing an information advantage during military operations"[83]. Composed of four pillars, equivalent to LoE described in previous policies, the two key pillars for this paper are the need for data literacy and skills, and data culture.

Data literacy in policy is foundational, but currently ill-defined. The *Data Strategy* provides a short definition for data literacy in one of the annexes despite the need to 'define data literacy' as a high priority item in the high-level roadmap. Statistics Canada provides a more complete definition of data literacy as: "[T]he ability to derive meaningful information from data. It focuses on the competencies involved in working with data including the knowledge and skills to read, analyze, interpret, visualize and communicate data as well as understand the use of data in decision-making."[84] The provided definition for data literacy fails to capture the other

[80] Engen, "When the Teeth Eat the Tail," 6.
[81] Engen, 9–11.
[82] National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy*, 3.
[83] National Defence, 9.
[84] Statistics Canada, "Data Literacy Training," December 11, 2020, https://www.statcan.gc.ca/en/wtc/data-literacy.

activities within the data lifecycle such as collection, storage, and integrity, which are crucial tasks to enable the desired literacy skills[85]. The concept of a data lifecycle itself is contentious, with various models proposed dependent on the purpose for which the data is intended to be used, such as the "Research data lifecycle" as opposed to the "Abstract Personal Data Lifecycle"[86]. Variable definitions of data lifecycles and the impact on information management policies create confusion, especially when aspects of data management have low perceived value due to operational primacy. This research suggests a link between data literacy and digital literacy, which is reinforced in later DND/CAF data strategy implementation which aims to build education based on "the criticality and centrality of data to digital literacy in operations"[87]. Given that data is also the foundation of the cognitive hierarchy, this link will be examined further in the next chapter.

Data culture seeks to develop and leverage increased use of data management, with trust as a central component. Derived from the current state, trust has suffered from fear of consequences of presenting accurate data as well as an expectation that data has been entered incorrectly[88]. The ethics behind this lost trust have been examined thoroughly in the context of the US Army, where pressure to meet unachievable performance targets due to limited resources resulted in falsification of data[89]. Another theme in this ethics study was low perceived value of data collection efforts which is addressed in the *Data Strategy* through a communications plan. CAF personnel shortages are likely to stymie efforts to address perception of data collection

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[85] Syed Iftikhar Hussain Shah, Vassilios Peristeras, and Ioannis Magnisalis, "DaLiF: A Data Lifecycle Framework for Data-Driven Governments," *Journal of Big Data* 8, no. 1 (2021): 2, https://doi.org/10.1186/s40537-021-00481-3.
[86] Shah, Peristeras, and Magnisalis, 3.
[87] National Defence, *Data Strategy Implementation Plan 2022-2025* (ADM(DIA), 2022), 17, http://intranet.mil.ca/en/organizations/adm-dia/dia-newsroom/article-release-data-strategy-implementation-plan.page.
[88] National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy*, 15.
[89] Leonard Wong and Stephen J. Gerras, *Lying to Ourselves: Dishonesty in the Army Profession* (Carlisle, PA: Strategic Studies Institute and U.S. Army War College Press, 2015), 7–9.

efforts, with institutional attention on addressing larger cultural and readiness questions[90]. Given the foundational nature of data to develop understanding, this risk suggests a need to show relevancy, supported by leadership engagement in the form of sufficient resources.

Despite the importance of the *Data Strategy* to enable future capabilities, the internal contradictions and lack of implementation-level detail were not integrated within the CAF. The *Data Strategy Implementation Plan* was released three years after the *Data Strategy* in 2022, with supporting DAODs soon afterward to reinforce the authority framework. The emphasis of the implementation plan is on data sharing within a more permissive risk management environment focused on data-centric as opposed to network-centric security models[91]. The purpose of the transition from data management by ownership in silos to an enterprise-wide ownership model is to enable departmental analytics[92]. While the authority frameworks and detailed mechanisms now exist to enable integration through data-sharing and analytics, it is too early to tell if they will be effective. Trust and data falsification are likely to be enduring problems unless value can be demonstrated, evident in the ethics study where individuals "have … so many information demands that … if I'm not asked specifics, they [higher command] don't care"[93]. Possible representations of value may be in the form of incentive structures and processes, whose links are represented in organizational design models which will be presented in the next chapter.

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[90] David McDonough, "People Are the Canadian Military's Most Important Capability: Christian Leuprecht," *Macdonald-Laurier Institute* (blog), April 6, 2022, https://macdonaldlaurier.ca/people-are-the-canadian-militarys-most-important-capability-christian-leuprecht/; Wayne Eyre and Bill Matthews, "CDS/DM Directive for CAF Reconstitution," October 6, 2022, para. 6, https://www.canada.ca/en/department-national-defence/corporate/policies-standards/dm-cds-directives/cds-dm-directive-caf-reconstitution.html.
[91] National Defence, *Data Strategy Implementation Plan 2022-2025*, 6.
[92] National Defence, "Vision for Analytics in the DND/CAF," June 16, 2021, https://www.canada.ca/en/department-national-defence/corporate/reports-publications/analytics-dnd-caf-vision-guiding-principles/vision-analytics-dnd-caf.html.
[93] Wong and Gerras, *Lying to Ourselves*, 10.

DND/CAF AI Strategy

Artificial intelligence is a central feature of the Fourth Industrial Revolution, crucial to handle the "5Vs" (volume, velocity, variety, veracity, and value) [94] generated within big data and the proliferation of sensors through both industrial and consumer applications. The *DND/CAF AI Strategy* highlights these societal and higher government trends by offering a vision with outcomes in both the battle space and the corporate space, recognizing that abilities of AI systems are constrained by their intended application[95]. The five LoE of the *AI Strategy* are designed to build internal capacity while informed by both external engagement and risk mitigation. The LoE which intersect the most with factors discussed so far include culture, talent and training, and partnerships[96]. Culture improvements are sought in synchronization with other Defence Team initiatives and seek to address the risk adverse nature of leadership by adjusting incentives and promoting cross-functional teams. Talent and training are predominantly focused on establishing data and digital literacy but recognize challenges in recruiting and retention for talent potential where technical skillsets are undervalued in current structures. Building partnerships suggests a need to develop an 'AI ecosystem' where industry, academia, and non-traditional relationships are nurtured with defence and security interests prioritized. The goals and suggested actions within the *AI Strategy* appear aspirational and well beyond the scope of authorities of DND/CAF organizations, which is a significant reason why an independent review has suggested the organizational structure and lack of coherent data policies as "major limiting

[94] Bernard Marr, "Big Data: The 5 Vs Everyone Must Know," LinkedIn, March 6, 2014, https://www.linkedin.com/pulse/20140306073407-64875646-big-data-the-5-vs-everyone-must-know/.
[95] National Defence, *Department of National Defence and Canadian Armed Forces Artificial Intelligence Strategy* (Ottawa, Ontario: National Defence, 2022), 1.
[96] National Defence, 1, 17–18, 22–23, 26–27.

factors for the implementation of AI systems at scale in Canada's defence establishment"[97]. Some military experts have suggested that a method to begin developing this capability is to have a range of skillsets developed via pervasive integration throughout professional military education, which could help build awareness and accelerate motivation to address long-standing foundational data problems[98]. Despite these criticisms, from an organizational design perspective the *AI Strategy* is the most holistic of the reviewed strategies by addressing people, policy, rewards, and culture. Further, identification of the importance of non-DND/CAF organizations in furthering defence objectives, backed by internal investment in data and digital literacy, provides a starting point when developing case studies to search for implementation best practices.

Chapter Summary

Several of the recent policies and strategies from DND and the CAF address elements of the complexity associated with the Fourth Industrial Revolution and the re-emergence of great power competition. This context keeps the institution focused on operational effectiveness, but re-orients the emphasis on isolated mission success to the broader components of the CAF effectiveness framework to include internal integration and external adaptability. From the contextual analysis three broad themes emerge which are interwoven throughout the doctrine, policies, and strategies: continuous learning with implications on individual professional development and collective exercises, continuous improvement in support of operational resiliency enabled by experimentation, and elements of change management needed to guide transformation efforts. The requirement for improved collaboration with partners drives a need to

[97] Engen, "When the Teeth Eat the Tail," 14.
[98] Ryan, "Intellectual Preparation for Future War: How Artificial Intelligence Will Change Professional Military Education," War on the Rocks, July 3, 2018, https://warontherocks.com/2018/07/intellectual-preparation-for-future-war-how-artificial-intelligence-will-change-professional-military-education/.

adapt structures to enable integration and innovation with allied militaries, industry, and academia. Linked to each of these factors is an assumption of improved data and digital skills, guided by literacy frameworks, and nested within the cognitive hierarchy to enable improved understanding to make sense of an increasingly uncertain world.

CHAPTER 3: MODELS AND THEORIES

Introduction

The analysis of the global, operational, and policy context for the CAF highlighted the need to invest in continuous learning, continuous improvement, and change management to enable the digital transformation necessary to operate in the future security environment. This chapter will examine relevant major models from literature to investigate defined variables of interest. Given the importance of addressing change holistically, the variables will be collected in a proposed DND/CAF-specific implementation of the Galbraith Star. The purpose of the custom model is to assess case studies in the following chapter, to further examine implementation options which the CAF can leverage in support of digital transformation.

Continuous Learning

This section will examine the bridge between individual learning and the relationship with the wider institution both from a learning perspective and from the lens of motivation and commitment. The cognitive hierarchy provides a model to conduct a deeper examination of 'digital literacy' and skill frameworks to guide development requirements and potential impacts on employment structures. A review of organizational learning and learning organizations will highlight deficiencies in the CFPDS where opportunities can be leveraged to rapidly deliver and integrate training into daily work. Finally, a brief review of motivation and commitment theory will address risks with the 'War for Talent' and will suggest factors which may influence perception of relevancy of digital transformation for all CAF members.

Cognitive Hierarchy

The 'Revolution in Military Affairs' first described in the 1990s suggested that increased networking, surveillance, and intelligence functions would decrease the Clausewitzian fog and friction of warfare, yet history has proven that this is at best a partial view[99]. Vastly increased sensor distribution has resulted in what some have suggested as "the end of secrets", such as 'live-tweeting' of the Osama Bin Laden assassination in Operation NEPTUNE SPEAR, yet the sheer volume and intersecting factors of information obscures the importance of individual events[100]. The Observe-Orient-Decide-Act (OODA) loop is a decision-making model developed by John Boyd to cut through the fog of war, where the 'orient' component has been suggested as the most important due to the influence on the other factors[101]. Increased complexity drives a need for improved orientation, or 'sense-making', in both the institutional and tactical senses; from a tactical perspective this is essential for survivability and mission success, while force development and external adaptability are examples from an institutional perspective. Sense-making has been described as a critical skill in understanding of an environment[102], which is in turn the pinnacle of the cognitive hierarchy in CAF doctrine as presented in Figure 3.1[103].

[99] Brose, *The Kill Chain*, 29, 32.
[100] P. W. Singer and Emerson T. Brooking, *Likewar: The Weaponization of Social Media* (Boston: Eamon Dolan/Houghton Mifflin Harcourt, 2018), 58.
[101] Gregory M. Schechtman, *Manipulating the Ooda Loop: The Overlooked Role of Information Resource Management in Information Warfare*, Book, Whole (Chicago: Barakaldo Books, 2020), 47.
[102] Deborah Ancona, "Sensemaking: Framing and Acting in the Unknown," in *The Handbook for Teaching Leadership: Knowing, Doing, and Being*, n.d., 3.
[103] *Command Support in Land Operations*, B-GL-331-001/FP-001 (Kingston, Ontario: Army Publishing Office, 2008), 4–1.

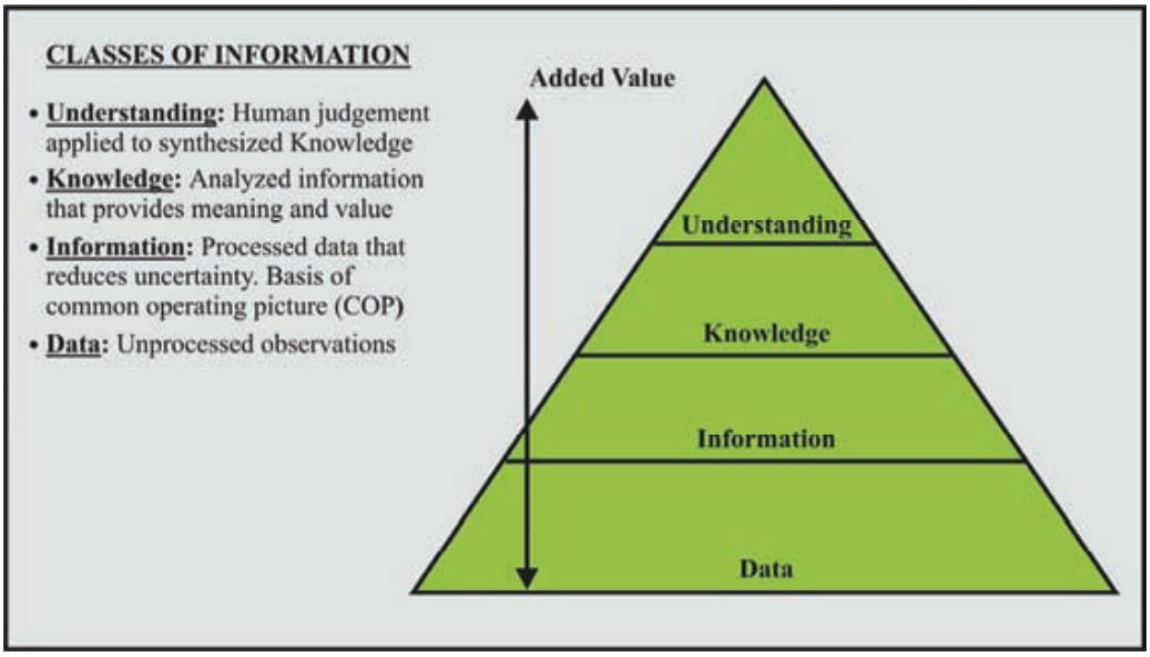

Figure 3.1 – Cognitive Hierarchy Pyramid
Source: National Defence, *Command Support in Land Operations*, 4-1

The cognitive hierarchy is a useful model to contrast multiple forms of literacy. A portion of the Statistics Canada definition of data literacy provided was the requirement for the knowledge and skills to read, analyze, and interpret data, augmented by the tasks within data management of collection, storage, and processing. Contextual analysis and interpretation transform data into information. Although tactical combat environments are not typically the subject of studies on big data, the 5Vs (volume, velocity, variety, veracity, and value) are applicable due to efforts to reduce the fog and friction of war. As a result, the limits in human cognitive capacity and processing implies that the importance of having people routinely execute this analysis as they traditionally would is significantly diminished. Reliance on AI has been suggested as having operational or even strategic value for this function[104]. Despite this suggestion for re-alignment, when processing data to information in a contested environment is

[104] Congressional Research Service, "Renewed Great Power Competition: Implications for Defense—Issues for Congress. CRS Report," 24.

considered, there is an imperative for soldiers to have excellent data literacy skills to mitigate risks posed by adversaries operating within doctrine where DDIL is a prominent feature. Similarly, data literacy is needed for redundancy to maintain availability of systems in case supporting AI systems are intentionally rendered ineffective or encounter novel scenarios for which they are unprepared.

While data literacy (perhaps aided by AI) is the foundation, digital literacy enables traversal of the remainder of the hierarchy. The goal is to enable decision-making, which is represented in this model as judgment applied to knowledge. Recalling the definition of digital literacy as an "essential set of skills needed to find information and communicate in today's world"[105], the link to the cognitive hierarchy is the ability to select and synthesize relevant contextual information, followed by communication to transfer the knowledge between individuals. The primacy and variety of context in this model is then a challenge for people to manage. Digital literacy can reduce the processing burden through appropriate selection of tools and methods. Many CAF members experience 'role overload', defined by occupation stress experts as "the extent to which role demands are perceived by the respondents as exceeding personal and workplace resources and their perceived inability to accomplish the expected workload"[106]. While not perfectly aligned, 'role overload' has strong similarities to 'information overload' which some researchers have defined as "a state of affairs where an individual's efficiency in using information in their work is hampered by the amount of relevant, and potentially useful, information available to them"[107]. Given the influence of big data, the impact

[105] Johnston, "The Shift towards Digital Literacy in Australian University Libraries: Developing a Digital Literacy Framework," 93.
[106] Samuel H Osipow and Anne S Davis, "The Relationship of Coping Resources to Occupational Stress and Strain," *Journal of Vocational Behavior* 32, no. 1 (February 1988): 1–15, https://doi.org/10.1016/0001-8791(88)90002-4.
[107] David Bawden and Lyn Robinson, "The Dark Side of Information: Overload, Anxiety and Other Paradoxes and Pathologies," *Journal of Information Science* 35, no. 2 (April 2009): 182,187, https://doi.org/10.1177/0165551508095781.

of increasing technology immersion is likely to increase 'information overload' and degrade operational effectiveness by reducing the ability to understand complex operational environments. Investment in digital literacy is therefore essential to enable continued operational relevance for the CAF, but to prepare personnel a deeper appreciation of digital literacy is needed.

Better understanding of the role of digital literacy in the cognitive hierarchy requires more than the surface definitions. Although the definition of digital literacy is itself contested, one perspective is a collection of frameworks to extend reading and writing as methods to encode or decode between written symbols and sound, enabling transfer of knowledge[108]. Using reading and writing as a foundation and adding new skills such as 'new media literacy' as technology invents new ways to preserve and transmit information, the digital literacy framework in Figure 3.2 has been suggested as a tool to examine "components of digital literacy at a conceptual level"[109]. The model is constructed using three dimensions; the technical dimension corresponds to operating equipment, the social dimension addresses communication between people, and the cognitive dimension focuses on problem-solving and decision-making. In using this model to assess a variety of other professional digital literacy frameworks, the author found that despite a dependency on technical skills they were "overwhelmingly partial to the cognitive and social focus of digital skills and technical proficiency tends to be glossed over compared to the other dimensions"[110]. This may exhibit bias due to the primacy of the cognitive domain over affective and psychomotor domains in the modified Bloom's taxonomy, which has

[108] Cathy Green, "Digital Literacies and the Skills of the Digital Age," in *Learning in the Digital Age*, 2020, 112–13, https://doi.org/10.22488/okstate.20.000003.
[109] Green, 116–17.
[110] Green, 120.

similarities to the digital literacy model above based on skills such as remembering, understanding, synthesizing, and creating[111].

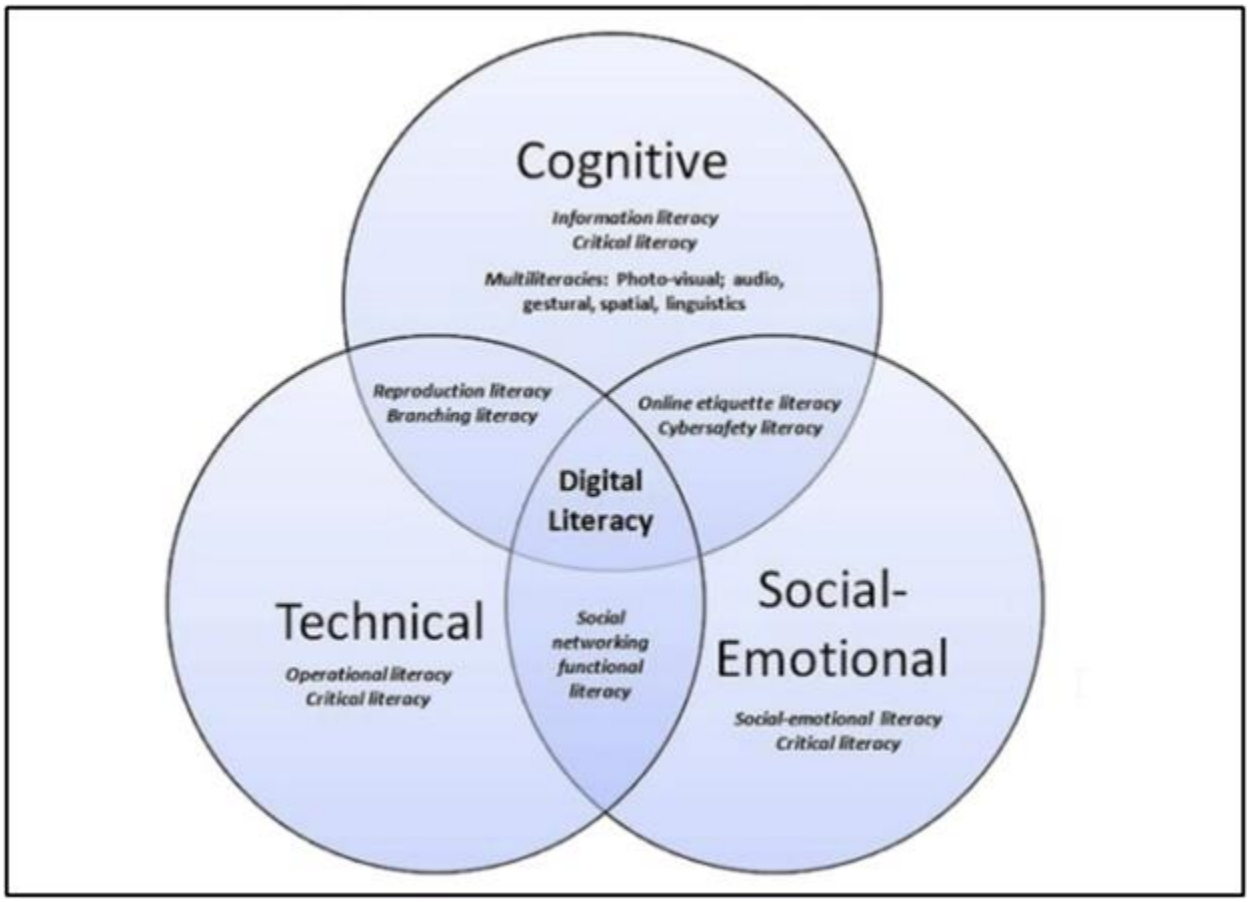

Figure 3.2 – Digital Literacy Framework
Source: Green, Digital Literacies and the Skills of the Digital Age, 116

The impact of exploration and exploitation of new technologies cannot be overstated, as maintaining digital literacy implies a need to remain current as technology evolves[112]. Further, the degree of institutional investment should vary by role, based on the skills required for immediate performance and future development[113]. This combination of appropriate skill profiles

[111] Lorin W. Anderson, David R. Krathwohl, and Benjamin Samuel Bloom, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*, Abridg, Book, Whole (New York: Longman, 2001).
[112] Saldanha, *Why Digital Transformations Fail*, 127–34.
[113] Martin Charette, "Developing Digital Literacy Across CAF Officers Through Training and Education," n.d., 6–8.

and changing technology raises a question on appropriate force structure. Technology-based occupations are far from static constructs, as the emergence of cyber operators and the merging of teletype operators with radio operators to form 'signal operators' highlights the impact of technology distribution[114]. Returning to the concept of 'role overload', a question which must be examined is the degree of specialization required by tactical soldiers. Continuous improvement literature, to be examined later in this chapter, offers a potential solution by viewing low-density specialists as 'constraints' whose employment must be optimized in their role. However, the idea of forming a cross-functional team requires all members to have a baseline understanding of the roles and capabilities of other members, which suggests that high centralization may be detrimental to establishing trust and team dynamics. This implies that entry-level digital literacy and skills will become a core standard to be maintained, similar to the ability to operate a personal weapon. Research has shown the importance of life-long learning and high levels of self-motivation as critical dependencies to enable acquisition and maintenance of digital literacy skills, which implies that employment of digital technology must enable tasks traditional users deem relevant[115]. The potential impact to occupational structures is then a function of rates of change and the difficulty of developing and maintaining skill profiles to meet these capability requirements.

A common educational design tool is the modified Bloom's taxonomy, where different levels of thinking are progressive, beginning with remembering and culminating with creating. The ability to apply concepts from the middle of the taxonomy requires the use of skills, which can be developed and assessed. By blending the technical, cognitive, and social-emotional

[114] "Branches," accessed May 7, 2023, https://www.canadiansoldiers.com/organization/branches.htm; "Communications & Electronics Professions," *CMCEN* (blog), accessed May 7, 2023, https://cmcen-rcmce.ca/communications-electronics-professions/.
[115] Green, "Digital Literacies and the Skills of the Digital Age," 115.

dimensions of the digital literacy framework and applying the levels of domains within the modified Bloom's taxonomy, a common skillset can be developed to align professional development efforts and enable communication. Multiple information and communications technology (ICT) sector frameworks exist, notably the Skills Framework for the Information Age (SFIA), the European e-Competence Framework, the Skills Framework for ICT from Singapore, and the i-Competency Dictionary from Japan[116]. Based on the prevalence and global acceptance of SFIA, this framework will be used in this paper, based on adoption by Canadian allies and partners[117].

SFIA is comprised of seven levels of responsibility based on industry practices, where skills and competencies are to be described on a per-level basis using generic attributes of autonomy, influence, complexity, business skills, and knowledge[118]. There are currently over 120 skills within the framework, organized across seven different views, including digital transformation[119]. Figure 3.3 provides the digital transformation skill view in SFIA, where the vast majority of the identified skills apply to this analysis[120]. SFIA has been criticized as lacking certification mechanisms, transferability, sufficient coverage of the sector, and risks with backwards compatibility between versions of the framework[121]. Although at various degrees of concern, these issues are common across the other frameworks mentioned earlier at various extents. The SFIA Foundation recognizes the challenges with currency and accreditation,

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[116] Jason Brown, "An Examination of the Skills Framework for the Information Age (SFIA) Version 7," *International Journal of Information Management* 51 (2020): 3.
[117] "Standard Skills Profiles," Folder, SFIA, accessed April 24, 2023, https://sfia-online.org/en/tools-and-resources/standard-industry-skills-profiles.
[118] "How SFIA Works," Page, SFIA, accessed April 24, 2023, https://sfia-online.org/en/about-sfia/how-sfia-works.
[119] "SFIA Professional Skills," Page, SFIA, accessed April 24, 2023, https://sfia-online.org/en/about-sfia/sfia-professional-skills.
[120] Peter Leather, "Digital Transformation Skills in SFIA" (SFIA Foundation, November 26, 2019), https://sfia-online.org/en/assets/documents/sfia-view-of-digital-transformation-skills.pdf.
[121] Brown, "An Examination of the Skills Framework for the Information Age (SFIA) Version 7," 4–7.

providing references to domain bodies of knowledge and recently partnering with digital certification platform Credly to provide partial mitigation[122]. These are reasonable risks from a Canadian perspective, as the Canadian Information Processing Society has selected SFIA as the skills framework for their certification program and IT skill assessment, implying a degree of transferability within Canadian society[123].

[122] "SFIA and Bodies of Knowledge," Folder, SFIA, accessed April 24, 2023, https://sfia-online.org/en/tools-and-resources/bodies-of-knowledge.
[123] "Skills Framework – CIPS," May 3, 2023, https://cips.ca/skills-framework/.

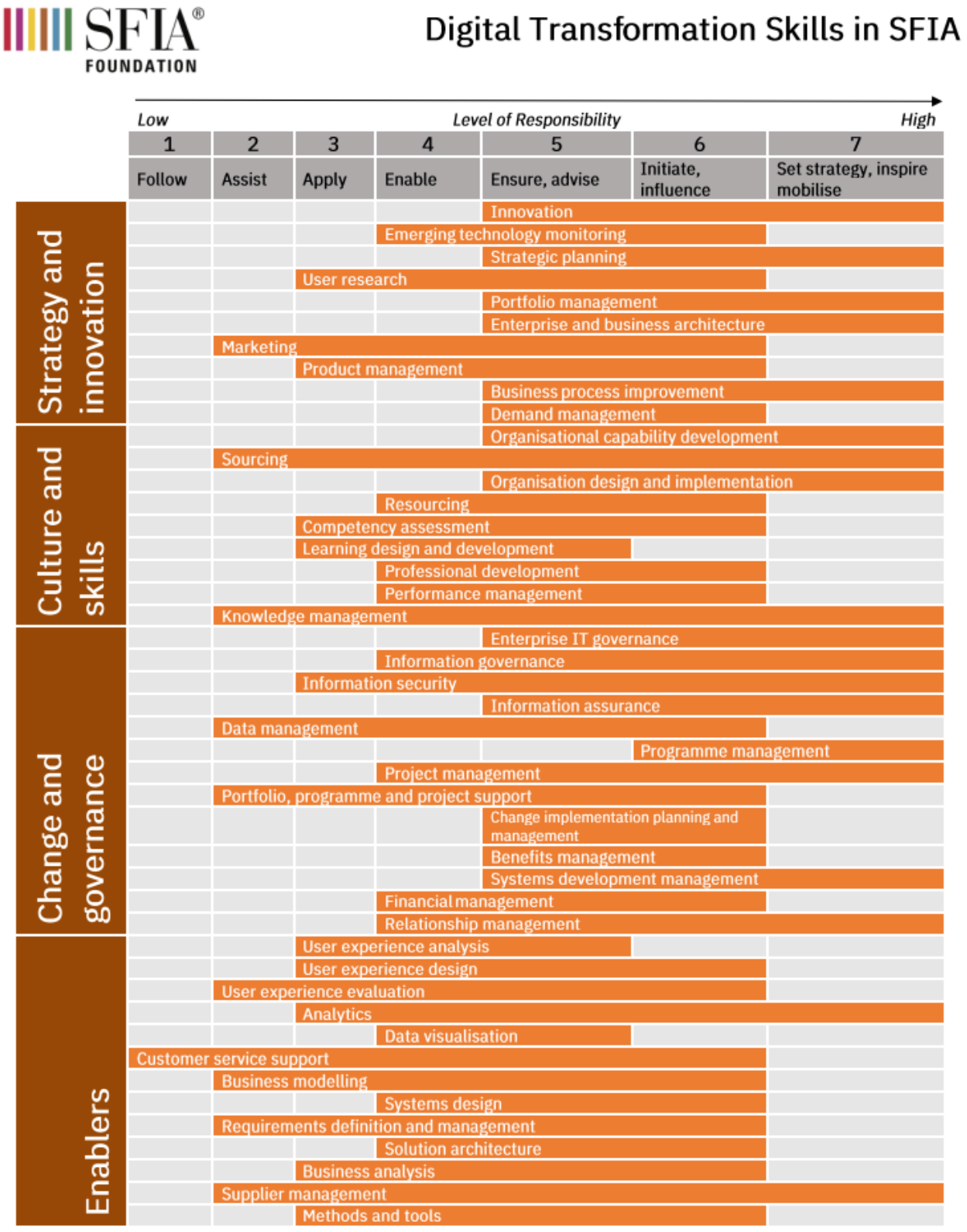

Figure 3.3 – Digital Transformation View of Skills in SFIA
Source: Leather, Digital Transformation Skills in SFIA

Learning Organizations

The terms ‘learning organization’ and ‘organizational learning’ are similar but with different emphasis. Anders Örtenblad provided a thorough analysis of this topic in the early 2000s, summarized as “while ‘organizational learning’ is regarded as processes (of learning) in the organization, the ‘learning organization’ is a form of organization itself”[124]. Örtenblad’s analysis is based on a typology where ‘old organizational learning’ and learning at work correspond to ‘organizational learning’, while learning climate and learning structure are related to learning organizations. The term ‘old organizational learning’ is an emphasis on individual cognitive learning as opposed to ‘new organizational learning’ in the literature which had a social and collective context, which further makes a case for learning within communities of practice[125]. In a CAF context, this would be the equivalent of the distinction between individual and collective training, noting that in the current form CFITES only addresses individual training[126].

Existing policy and directives are a significant challenge to enabling the CAF as a learning organization. Returning to the concepts of loose coupling and decentralization from the policy analysis, CFITES is designed to set parameters for training and education, while self-development and work experience are defined but left to management through other policies such as DAODs[127]. DAODs define authorities and structure such as ‘designated training authorities’ or ‘training establishments’ yet are focused exclusively on training and education with the exception that documented work experience may be recognized as a form of prior

[124] Anders Ortenbiad, “A Typology of the Idea of Learning Organization,” *Management Learning* 33, no. 2 (2002): 215, https://doi.org/10.1177/1350507602332004.
[125] Ortenbiad, 221.
[126] Martin et al., “The Implementation of Canadian Forces Individual Training and Education System and Mission Essential Competency Training Analysis Methods: A Case Study,” 8.
[127] National Defence, *Manual of Individual Training and Education, Volume 1: Interim Guidance-Introduction/Description*, 1:6–8.

learning. Modernization efforts have been attempted in the past, such as the development of the CAF Campus framework to improve governance and resource allocation[128]. DAOD 5031-8 does provide some policy flexibility by "allowing in-service, out-service and alternative training delivery [and using] a variety of instructional strategies, learning methodologies and technologies"[129]. Most of these CAF professional development concepts are almost entirely within the perspective of traditional organizational learning with limited application to the learning climate or learning organization practices advocated by communities of practice in sectors associated with digital transformation. For example, DevOps practitioners advocate for continuous learning practices where integration of daily learning and process improvement are a function of generative cultures but without certification or qualification[130]. This is contrasted with CFITES recognition of self-development as "self-initiated, professionally or personally oriented learning that normally takes place on personal time", which sets it apart from the learning climate typology element by being outside the workplace[131]. A probable constraint is the CFITES reliance on a lengthy 'needs assessment' process requiring in-depth subject matter expert and leadership analysis to determine if formal training or education is required. The strict adherence to process and limitations in the focus on training and education in the CFPDS suggest missed opportunities for knowledge and skill development through the learning climate and learning structure typologies. Allocating work time to bounded self-improvement, a best practice

[128] Debbie Miller, "INDIVIDUAL TRAINING AND EDUCATION (IT&E) MODERNIZATION FOR THE CANADIAN ARMED FORCES," *Canadian Military Journal (Ottawa)* 13, no. 4 (2013): 58.
[129] National Defence, "DAOD 5031-8, Canadian Forces Professional Development," para. 4.10.
[130] Kim et al., *The DevOps Handbook*, 37–46.
[131] National Defence, *Manual of Individual Training and Education, Volume 1: Interim Guidance-Introduction/Description*, 1:5.

within high-performing companies[132], is within existing DND/CAF policies and would enable professional development within the scope of digital transformation.

Tracking such learning may be enabled through micro-credentials, which are similar to digital badges where specific skills or achievements are recognized and stored, often digitally. The development, assessment, and retention of micro-credentials have several risks for validity or loss of information[133]. The development of selecting which components of knowledge or skill potentially has the same challenge as the CFITES needs assessment process where some form of management overhead is required to ensure system value. The alternative, which could take the form of crowdsourcing or other distributed model, runs the risk of irrelevancy; not everything needs to be quantized and tracked[134]. Despite these risks, adoption of appropriate micro-credentials would align with existing CAF management practices. Risk mitigation for digital skills is achievable using skill frameworks such as SFIA, and credential tracking systems such as the SFIA Foundation use of Credly, or the internal DND/CAF Defence Learning Network. Enduring challenges of assessment methodologies and framework updates remain, even if micro-credentials are pursued.

Motivation and Commitment

Motivation has a significant impact on learning, especially in a team context. Positive learning requires cognitive engagement for retention of information and to mitigate risks of

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[132]Dorie Clark Contributor, "Google's '20% Rule' Shows Exactly How Much Time You Should Spend Learning New Skills—and Why It Works," CNBC, December 16, 2021, https://www.cnbc.com/2021/12/16/google-20-percent-rule-shows-exactly-how-much-time-you-should-spend-learning-new-skills.html; Nicole Forsgren, Jez Humble, and Gene Kim, *Accelerate: The Science behind DevOps: Building and Scaling High Performing Technology Organizations*, First edition (Portland, Oregon: IT Revolution, 2018), 94–99.,

[133] Peter Greene, "Education Micro-Credentials 101: Why Do We Need Badges?," Forbes, accessed April 25, 2023, https://www.forbes.com/sites/petergreene/2019/02/16/education-micro-credentials-101-why-do-we-need-badges/.

[134] Jerry Z. Muller, *The Tyranny of Metrics* (Princeton: Princeton University Press, 2018), 59–64.

burnout and dissatisfaction[135]. This is further reinforced in literature on 'role overload' and 'information overload' as previously discussed, as related to the wide variety of tasks and skills which CAF members are expected to execute. Research which has shown that social support through families or operating as part of a team can aid motivation and decrease the effects of burnout leading to improved psychological well-being[136]. Given the need to maintain member psychological well-being as part of the CAF effectiveness framework, motivation is effectively a significant contributor to operational effectiveness. Ethics studies discussed earlier suggest that placing additional (learning) burdens on members with low perceived value may increase 'role overload' and have a negative impact on motivation[137]. Combining these factors suggest that adding digital literacy or professional development of related skills should consider motivation as a critical enabler, which may be achieved through a degree of agency in selection of tasks or learning. The positive influence of collective training as a social support mechanism cannot be discounted in this regard, suggesting the need for progressive individual skill development as an input to collective tasks.

Motivation affects the way people perceive the world and react to stressors such as change. Two main models for motivation and commitment are the Herzberg and Meyer-Allen models[138]. The Herzberg model examines motivation through a focus on personal growth and extrinsic conditions such as pay and working conditions. The Meyer-Allen model is an investigation of organizational commitment, with key factors as the emotional bond (affective commitment), feeling of duty and loyalty (normative commitment), and a lack of alternatives

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[135] Abaid Ur Rehman, Tariq Mehmood Bhuttah, and Xuqun You, "Linking Burnout to Psychological Well-Being: The Mediating Role of Social Support and Learning Motivation," *Psychology Research and Behavior Management* 13, no. Journal Article (2020): 547, https://doi.org/10.2147/PRBM.S250961.
[136] Rehman, Bhuttah, and You, 552.
[137] Wong and Gerras, *Lying to Ourselves*, 4–6.
[138] Nancy Otis, Irina Goldenberg, and Joelle Laplante, "Basic Training Satisfaction and Early Retention in the Canadian Armed Forces," External Literature (P) (Defence Research and Development Canada, May 2021), 1

(continuance commitment). The 'War for Talent' has shown the continuance commitment not to be a factor for technology workers, which suggests increased importance in developing affective and normative commitment for these individuals. Daniel Pink further develops these concepts by suggesting a three-factor model around autonomy, mastery, and purpose[139]. An area in this model where the CAF excels is purpose with the concept of 'service before self' when acting in the national interest. Autonomy as one of the generic attributes of SFIA suggests this concept resonates with industry. Pink decomposes autonomy to elements of task, time, technique, and team. While the CAF context offers little flexibility in task requirements or scheduling due to priorities, the concept of 'mission command' promotes variance in technique to achieve a mission. Pink's component of mastery explores the concepts of fixed versus growth mindsets and their respective relation to performance goals or learning goals[140]. A key suggestion is that a growth mindset leads to improved resiliency and can motivate individuals by moving from a perspective of compliance to engagement. However, task selection is a challenge as 'Goldilocks tasks' are needed to promote growth and lead to 'flow', which builds internal motivation where the challenge of the task is its own reward[141]. Encouraging innovation by providing resources and authority to improve local conditions through a 'digital mindset' is an example of where digital transformation can blend with motivation theory and promote learning.

Continuous Improvement

This section provides a short summary of methods behind continuous improvement methods, from the perspective of organizational culture. Investment in these methods requires

[139] Pink, *Drive*, 78
[140] Daniel H. Pink, *DRiVE: The Surprising Truth about What Motivates Us* (New York, NY: Riverhead Books, 2009), chap. 5.
[141] Pink, 111–17.

both strategic leadership commitment and internalized commitment throughout a workforce to be successful. The topics are only covered at an introductory level for later discussion, as a full examination is beyond the scope of this paper. Of note, while these methods are generally accepted in academic literature and practitioner guides, they have been criticized of being management fads building on previous iterations[142]. Their inclusion is based on current practice in industry to link with elements of the *Digital Campaign Plan*.

Lean

Lean management originated in the 1990s as part of the Toyota Production System (TPS), which is also credited with the origin of Just-In-Time production methods[143]. The TPS was derived from a long history of continuous improvement, based on a perspective of adaptation to external pressures through investment in personnel and learning[144]. The focus of lean management is the reduction of waste across all value streams, which can be thought of as limiting work in progress to reduce transfer times based on its origin in manufacturing, where the ultimate goal is 'single piece flow'[145]. A value stream has been defined as "the sequence of activities required to design, produce, and deliver on a customer request"[146]. The concept of value streams is what enabled lean manufacturing to expand across the organization into management functions and beyond. Cross-functional teams blended with centres of excellence enabled improved organizational throughput, recognizing the relationship between physical and

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[142] Dag Naslund, "Lean, Six Sigma and Lean Sigma: Fads or Real Process Improvement Methods?," *Business Process Management Journal* 14, no. 3 (2008): 269–71, https://doi.org/10.1108/14637150810876634.
[143] Edward D. Arnheiter and John Maleyeff, "The Integration of Lean Management and Six Sigma," *TQM Magazine* 17, no. 1 (2005): 9, https://doi.org/10.1108/09544780510573020.
[144] Mike Rother, *Toyota Kata: Managing People for Improvement, Adaptiveness, and Superior Results* (New York: McGraw Hill, 2010), 3–18.
[145] Arnheiter and Maleyeff, "The Integration of Lean Management and Six Sigma," 9.
[146] Karen Martin and Mike Osterling, *Value Stream Mapping: How to Visualize Work and Align Leadership for Organizational Transformation* (New York: McGraw-Hill, 2014), 7.

administrative processes[147]. Tools for lean management are based on value stream mapping to gather a holistic perspective of the organization, workflow management techniques such as kanban boards, and kaizen to isolate target processes for improvement[148]. Additional practitioner references are available which expand on the implementation of these tools, but a deeper review is beyond the scope of this paper[149].

Theory of Constraints

The Theory of Constraints (TOC) was developed and popularized in the 1980s by Eli Goldratt with the release of business novel *The Goal: A Process of Ongoing Improvement*[150]. The philosophy behind TOC is continuous improvement of the weakest links in a system by viewing the system as a series of links as opposed to a chain as in the Total Quality Management (TQM) model, which has the dual goal of system improvement and demonstrating results in overall system metrics. TOC emphasizes beginning with total system understanding to enable practitioners to appropriately identify the constraint, and then work to solve or mitigate the constraint by focusing resources to prioritize optimal performance at the constraint as improvements elsewhere are at best inefficient. This is best summarized as: "[I]f the performance of each part of a system is individually maximized, the system as a whole will not behave as well as it could. Conversely, if a system is performing as well as it can, not more than one of its parts will be"[151]. TOC uses a series of sub-models to align perspectives and guide improvements: the five focusing steps, the thinking process, and throughput accounting (as opposed to cost

[147] James P. Womack and Daniel T. Jones, "From Lean Production to the Lean Enterprise," *Harvard Business Review* 72, no. 2 (1994): 93–96, 99–101.
[148] Naslund, "Lean, Six Sigma and Lean Sigma: Fads or Real Process Improvement Methods?," 275.
[149] Martin and Osterling, *Value Stream Mapping*; David J. Anderson, *Kanban: Successful Evolutionary Change for Your Technology Business* (Sequim, Washington: Blue Hole Press, 2010).
[150] H. William Dettmer, "Quality and the Theory of Constraints," *Quality Progress* 28, no. 4 (1995): 2.
[151] Dettmer, 3.

accounting)[152]. With several concepts in TOC being very similar to Lean production and TQM, many of the same tools can be employed (as captured in Figure 3.4), albeit with different focus. Tool selection is heavily dependent on the application domain, as some analysis has shown the TOC-specific concept of drum-buffer-rope for queue management to significantly out-perform kanban, whereas other domains have found the inverse[153].

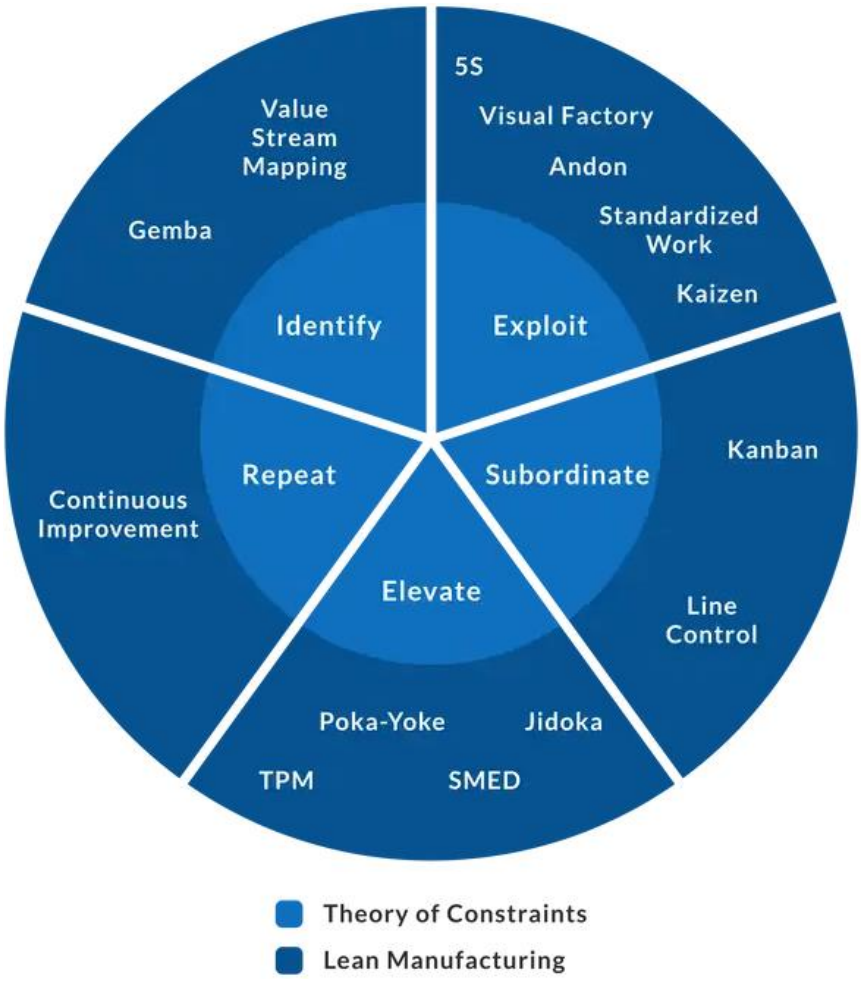

Figure 3.4 – The Five Focusing Steps and Associated Tools
Source: Lean Production, Theory of Constraints

[152] Lean Production, "Theory of Constraints (TOC)," Lean Production, accessed April 25, 2023, https://www.leanproduction.com/theory-of-constraints/.
[153] Stanley C. Gardiner, John H. Blackstone Jr, and Lorraine R. Gardiner, "The Evolution of the Theory of Constraints," *Industrial Management (Des Plaines)* 36, no. 3 (1994): 14–15; Anderson, *Kanban*, 5–6.

TOC offers two additional strengths over other management models. Combining methods from TQM and Lean enable root cause analysis to differentiate between physical, policy, paradigm, or market constraints, where Goldratt found that policy constraints were the most common yet most challenging to solve[154]. The second additional strength is the ability to focus metrics by isolating components of the system for increased attention, and restricting the effort needed for metric collection and analysis to critical paths[155]. Careful selection of metrics for goal attainment is stressed by authors in other fields, which reinforces the value of this strength[156]. Some criticism of the TOC model suggests decreased ability to generate optimal scheduling in a product-mix/multiple-constraint problem, and more generally a lack of empirical or case studies to lend academic credibility to the theory[157].

DevOps

The 'DevOps' discipline emerged to support information technology service provision with significant influence from Lean management, TOC, and the Agile community[158]. 'DevOps' represents the cross-functional fusion of Development and Operations teams in support of product lines or services. Other functions, such as security, are also members of these cross-functional teams and for this reason alternate discipline names such as 'DevSecOps' have been suggested[159]. The DevOps philosophy stresses the importance of (project or feature) flow, feedback, continual learning, and experimentation. Key tools suggested for DevOps includes

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[154] Lean Production, "Theory of Constraints (TOC)"; Dettmer, "Quality and the Theory of Constraints," 4–5.
[155] Dettmer, "Quality and the Theory of Constraints," 5–6.
[156] Muller, *The Tyranny of Metrics*, 175–83; Doerr, *Measure What Matters*, 52–57.
[157] Tien-Chun Hsu and Shu-Hsing Chung, "The TOC-Based Algorithm for Solving Product Mix Problems," *Production Planning & Control* 9, no. 1 (1998): 44, https://doi.org/10.1080/095372898234505; M. Gupta and D. Snyder, "Comparing TOC with MRP and JIT: A Literature Review," *International Journal of Production Research* 47, no. 13 (2009): 3735, https://doi.org/10.1080/00207540701636322.
[158] Kim et al., *The DevOps Handbook*, xxii–xxv.
[159] Forsgren, Humble, and Kim, *Accelerate*, 72.

value stream mapping to prioritize system resources, Kanban to visualize abstract workflows, and software tools for continuous deployment with monitoring to adapt to feedback in real-time[160]. The DevOps model of continuous improvement is based on the recognition of four kinds of work: business projects, IT operations projects, changes, and 'unplanned work'[161]. 'Unplanned work' is reactive effort to solve problems generated by shortcuts or partial fixes, which may be generated through inadequate or poorly understood systems and is also called 'technical debt'. DevOps draws from TOC and motivational theory to emphasize the need for slack in the system at non-constrained resources to "pay down technical debt" and promote a degree of autonomy in the workforce while doing so[162]. Risk acceptance for rapid experimentation[163] and 'stop-doing lists'[164] are disciplined approaches to 'fail fast' and avoid sunk cost fallacy. Like 'stop-doing' lists, Stephen Covey suggests the significance of determining the important but non-urgent tasks for system effectiveness, coming to the same conclusion – to succeed one must first define what they will not do[165]. The constraint-based planning model of TOC enables DevOps to isolate and communicate these challenges in abstract systems.

As seen in the discussion on 'loose coupling', the flexibility in DevOps is also the source of some of its criticisms. Although many DevOps best practices appear to promote all factors of

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[160] Kim et al., *The DevOps Handbook*, chaps. 2–5, 8–9, 14.
[161] Gene Kim, Kevin Behr, and George Spafford, *The Phoenix Project: A Novel about IT, DevOps, and Helping Your Business Win*, Third edition (Portland, OR: IT Revolution, 2018), 191–96.
[162] Kim et al., *The DevOps Handbook*, 69–71, 299–308; Forsgren, Humble, and Kim, *Accelerate*, 14–23, 122–23; Contributor, "Google's '20% Rule' Shows Exactly How Much Time You Should Spend Learning New Skills—and Why It Works"; Peter M. Senge, ed., *The Dance of Change: The Challenges of Sustaining Momentum in Learning Organizations*, 1st ed, A Fifth Discipline Resource (New York: Currency/Doubleday, 1999), 74.
[163] Saldanha, *Why Digital Transformations Fail*, 89.
[164] James C. Collins, *Good to Great: Why Some Companies Make the Leap--and Others Don't*, 1st ed (New York, NY: HarperBusiness, 2001), 139–43.
[165] Stephen R. Covey and James C. Collins, *The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change*, Revised and updated. Simon&Schuster edition (New York: Simon & Schuster, 2020), 172–83.

Pink's motivation model, some critics suggest that the major failure is lack of "considering team culture to address the human factor as it is more complex than the technical factor"[166]. Culture in this sense is focused on incentive systems which would be disrupted through the relationship with skills, processes, and structure as seen in the Galbraith Star model to be discussed in the section on change management. Another friction area in adopting DevOps is the contrast between DevOps practices and traditional compliance frameworks which have a high risk of misalignment and are likely to exacerbate challenges with trust[167], already a noted risk factor within the CA digital community[168]. With a potentially high cost to implement DevOps tooling, scaling across an organization may be too expensive in both cost and talent[169]. Despite these risks, some CAF analysis suggests implementation of DevOps to mitigate procurement challenges, encourage systems innovation, and develop a nascent analytics capability[170].

Change Management

This section provides a short summary on organizational design and change management models, due to their importance to culture. A full review of change management models is far beyond the scope of this paper as their selection requires appropriate choice of metaphors and associated models.

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[166] Muhammad Shoaib Khan et al., "Critical Challenges to Adopt DevOps Culture in Software Organizations: A Systematic Review," *IEEE Access* 10, no. Journal Article (2022): 14343, https://doi.org/10.1109/ACCESS.2022.3145970.

[167] David W. McKeown, "Continuous Authorization To Operate (CATO)" (Department of Defense, February 3, 2022), https://media.defense.gov/2022/Feb/03/2002932852/-1/-1/0/CONTINUOUS-AUTHORIZATION-TO-OPERATE.PDF. The DoD has proactively taken steps to address this concern, but Canada has no such policy.

[168] Khan et al., "Critical Challenges to Adopt DevOps Culture in Software Organizations: A Systematic Review," 14344; *Modernization Vital Ground: Digital Strategy*, 12.

[169] Eva Johnson, "What Is the Dark Side of DevOps?," June 1, 2016, https://content.intland.com/blog/agile/devops/what-is-the-dark-side-of-devops.

[170] Kenneth Bedley, "ACCELERATING CAF DIGITIZATION: IMPLEMENTING DevOps," Service Paper, JCSP 47, n.d., 3–5; Nicolas Gonthier, "Accelerating the Canadian Army's Digital Transformation," JCSP 48, 2022, 6–8.

Ester Cameron and Mike Green provide an extensive analysis of these concepts and describe four common metaphors for an organization: machines, political systems, organisms, and transformations[171]. These metaphors provide perspectives on the roles of individuals, power structures, psychology, complex adaptive systems, environmental changes, governance, and self-organizing systems. John Kotter uses a blend of these metaphors but excludes transformation, while Peter Senge has a similar blend with the exclusion of the machine metaphor. Selecting these two models therefore provides a brief yet rich sample of the change management literature. While not a change management model but an organizational design tool, the Galbraith Star has been selected to provide the holistic view advocated in the continuous improvement literature. A secondary selection criterion for the Galbraith Star is industry recognition in the ability of the model to define and influence culture change[172].

Galbraith Star

Figure 3.5 presents the Galbraith Star and the influences on organizational culture. Although the model was developed before information technology was widely distributed in work environments, recent analysis has shown the model maintains relevancy in an era of digital innovation with minor adaptations[173].

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[171] Esther Cameron and Mike Green, *Making Sense of Change Management: A Complete Guide to the Models, Tools and Techniques of Organizational Change*, 4th ed., Book, Whole (Philadephia, Penn;London; Kogan Page, 2015), chap. 3.

[172] Bill Fischer, "Innovation: Corporate Culture Is Not the Answer!," Forbes, accessed April 27, 2023, https://www.forbes.com/sites/billfischer/2011/10/24/innovation-corporate-culture-is-not-the-answer/.

[173] Robert Eirich, Björn Schäfer, and Max Ringlstetter, "An Organization Design Framework for Digital Innovation: Critical Review of Galbraith's STAR Model," in *ISPIM Conference Proceedings* (Manchester: The International Society for Professional Innovation Management (ISPIM), 2019), 4–8.

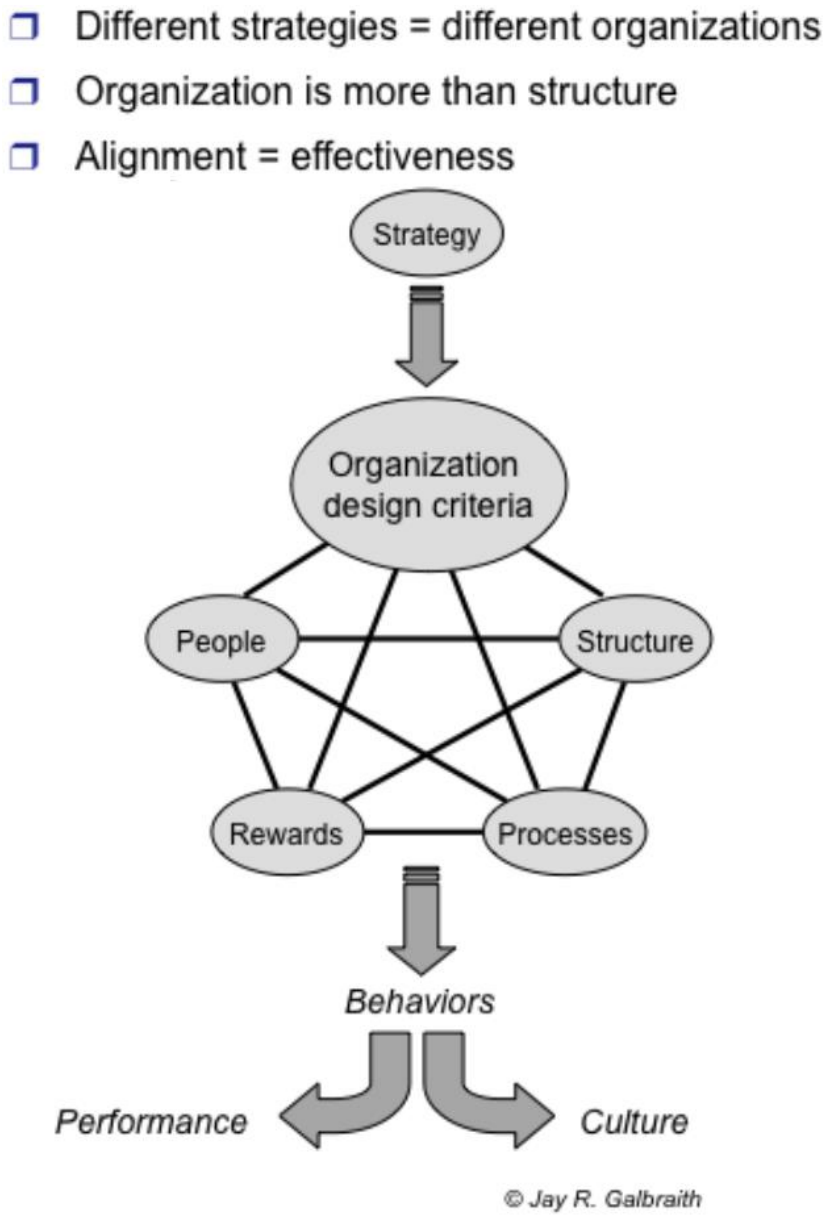

Figure 3.5 – Galbraith Star
Source: Galbraith, Star Model, 5

The five categories and their inter-relationships provide a glimpse into the resulting individual behaviours and by extension the overall organizational culture. The Galbraith Management Consultants professional website maintains updates to the original model, which is

summarized below[174]. Each category is comprised of a set of parameters to provide further elaboration. Strategy is comprised of goals, objectives, and tasks, which aids selection of an organizational form. Structure encompasses specialization, shape (or span of control), distribution of power (centralized versus decentralized), and departmentalization. Vertical and horizontal processes control the information and decision-making elements of the organization. Rewards symbolize the incentive (and disincentive) structures for the organization, and although the model is largely focused on extrinsic factors based on motivation theory when it was developed, intrinsic motivation has been recognized in later updates. The people category defines human resource policies, including skills management and professional development.

A deeper investigation into the impacts of specialization and departmentalization parameters within the structure category on forming and running cross-functional teams found that professional personal networks are a significant contributor to effective teams, with suggestions of models to achieve socialization such as communities of practice and rotational assignments[175]. Further analysis has suggested that to be applicable for digital innovation, the 'people' category could be divided to discern between the original staffing perspective and the emerging skills framework perspective with the dependency on knowledge[176]. The Galbraith Star's representation of how the combination of factors, especially processes and incentive structures, addresses critical elements of barriers to culture change are a key insight. Recent research has shown three common barriers to implementing culture change as lack of connecting

[174] Jay Galbraith, "Star Model," 2–4, accessed April 26, 2023, https://www.jaygalbraith.com/images/pdfs/StarModel.pdf.
[175] Jay Galbraith, Diane Downey, and Amy Kates, "How Networks Undergird the Lateral Capability of an Organization-Where the Work Gets Done," *Journal of Organizational Excellence* 21, no. 2 (2002): 67–70, https://doi.org/10.1002/npr.10021.
[176] Eirich, Schäfer, and Ringlstetter, "An Organization Design Framework for Digital Innovation: Critical Review of Galbraith's STAR Model," 16.

culture to outcomes, attempting decree-based culture change, and stopping change efforts too early[177]. In other words, that research suggested that culture emerges from habits, not intent.

Kotter's 8-Step Model

The original eight-step model was both lauded and criticized. Proponents of the model suggested it provided a useful method to develop a roadmap of activities to solve complex challenges when augmented with domain expertise[178]. Critics of the model suggested that the linear nature and lack of network perspective caused change initiatives to be perceived as isolated events with limited internal acceptance[179]. Kotter updated the original model in 2014, presented as Figure 3.6, to address these concerns. The major differences are in steps four and seven, where the originals were respectively "communicate the vision" and "consolidate improvements and produce still more change"[180]. Kotter describes the philosophy behind these changes as a new mental model of organization flow where a hierarchical structure incapable of rapid external adaptation can be augmented by a volunteer-driven network organization designed for innovation[181]. This simultaneous hierarchical-network approach is an implementation of Weick's concept of concurrent tight-loose coupling in an organization[182]. Such a perspective

[177]John Kotter, Vanessa Akhtar, and Gaurav Gupta, "Overcoming Obstacles to Successful Culture Change," *MIT Sloan Management Review* 62, no. 4 (2021): 1–3. Recognizing the difficulty in measuring culture, the recommendation is to measure behaviours or actions in a scientific manner.
[178] David E. Lambert, "Addressing Challenges to Homeland Security Information Sharing in American Policing: Using Kotter's Leading Change Model," *Criminal Justice Policy Review* 30, no. 8 (2019): 1272, https://doi.org/10.1177/0887403418786555.
[179] "Where Kotter's 8 Steps Gets It Wrong," accessed April 27, 2023, https://www.strategies-for-managing-change.com/where-kotters-8-steps-gets-it-wrong.html; Cameron and Green, *Making Sense of Change Management: A Complete Guide to the Models, Tools and Techniques of Organizational Change*, 125–27.
[180] John P. Kotter, "Leading Change: Why Transformation Efforts Fail," *Harvard Business Review* 73, no. 2 (1995): 59–67.
[181] John P. Kotter, *Accelerate: Building Strategic Agility for a Faster-Moving World*, Book, Whole (Boston: Harvard Business Review Press, 2014), chaps. 1–2.. Additionally, on P. 35 Kotter suggests rate of engagement is ideally 5-10% of managers and employees, which encourages idea and knowledge transfer throughout the hierarchy.
[182] Orton and Weick, "Loosely Coupled Systems: A Reconceptualization," 204–5.

relies on building and sustaining intrinsic motivation for personnel to commit to creative work in addition to their hierarchical tasks, endorsed by senior leadership acting as role models for how to value and engage the network. Essentially this means that network volunteers harvest ideas from everywhere, but innovation is driven within and for the organization, cognizant of embedded culture. A potential risk is leadership de-valuation of network efforts through lack of resources or authorities provided to network personnel to innovate, with the likely effect of quashing future intrinsic motivation.

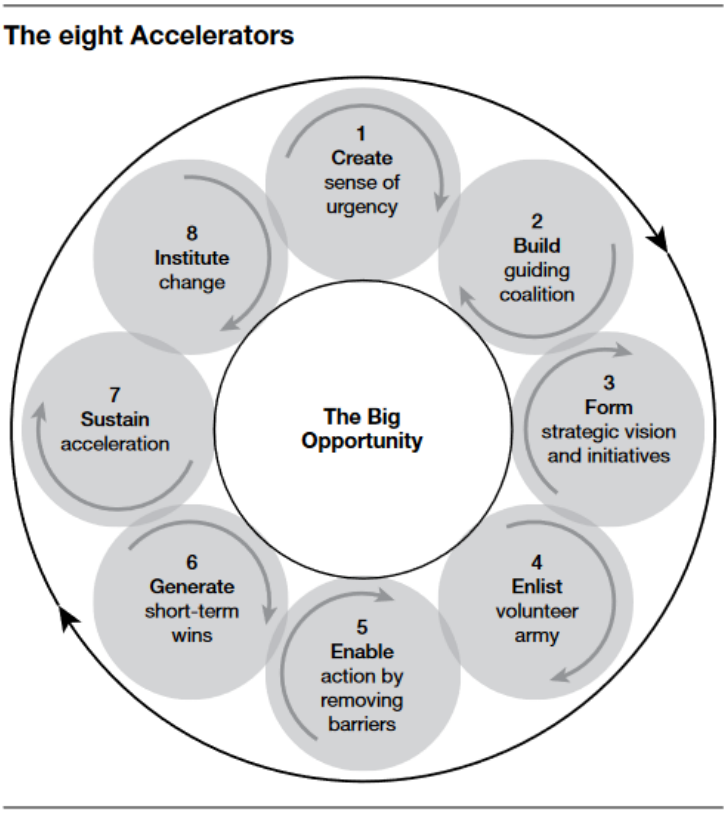

Figure 3.6 – Kotter's 8 Accelerators
Source: Kotter, *Accelerate: Building Strategic Agility for a Faster-Moving World*, 28

Senge Systemic Model

Figure 3.7 provides a representation of the model presented by Peter Senge and others in *The Dance of Change*, heavily influenced by biological processes, where organizational growth

is held in tension with competing limiting processes for resources as frequently observed in the natural world[183]. Each section in this model captures the main sentiment of the obstacles faced during a change initiative, and the supporting literature acts as a practitioner's guide by providing a range of tools to explore and mitigate the limiting factors. Similar to Kotter's updated work, there is a strong emphasis on information passing and intrinsically motivated networks. The trust component of these networks provides reinforcement and perceived value amongst participants, which are addressed through simultaneously executed processes presented in Figure 3.8. Many of the processes in the model are generated by limitations in trust or human psychology, often with recommendations to mitigate through learning activities such as sending people outside the organization to learn from others[184]. The overall theme is to pursue iterative cycles of learning and adapting to likely challenges along the path, rather than a single large planning effort and mass implementation[185]. The main criticism of this model is that designing organizational change through abstract models and attempting to modify the way individuals think may alienate them and degrade the change effort[186].

[183] Senge, *The Dance of Change*, chap. 1.
[184] Senge, 77.
[185] Cameron and Green, *Making Sense of Change Management: A Complete Guide to the Models, Tools and Techniques of Organizational Change*, 141.
[186] Bente Elkjaer, "The Dance of Change: The Challenges of Sustaining Momentum in Learning Organizations. A Fifth Discipline Resource," *Management Learning* 32, no. 1 (2001): 154–55, https://doi.org/10.1177/1350507601321015.

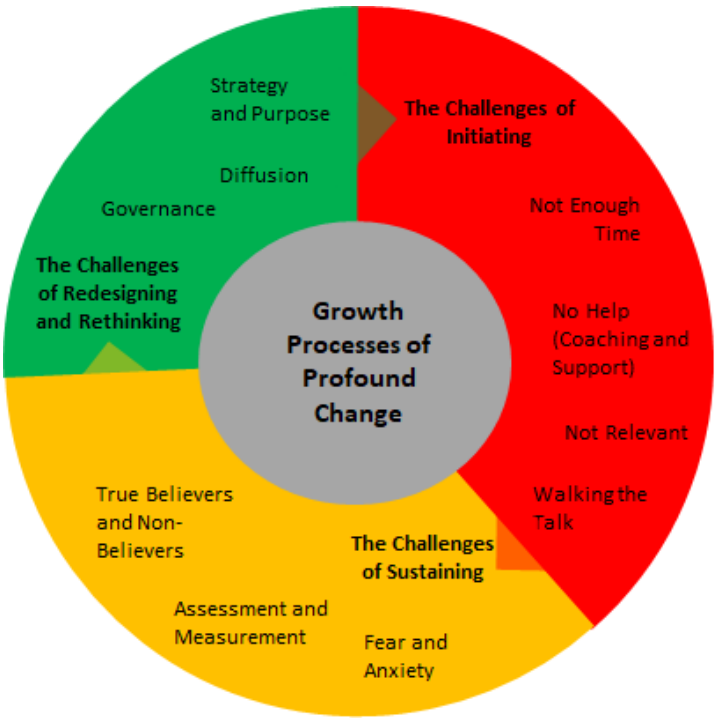

Figure 3.7 – Senge Systemic Model of Change (Re-creation)
Source: Senge, *The Dance of Change*, 28

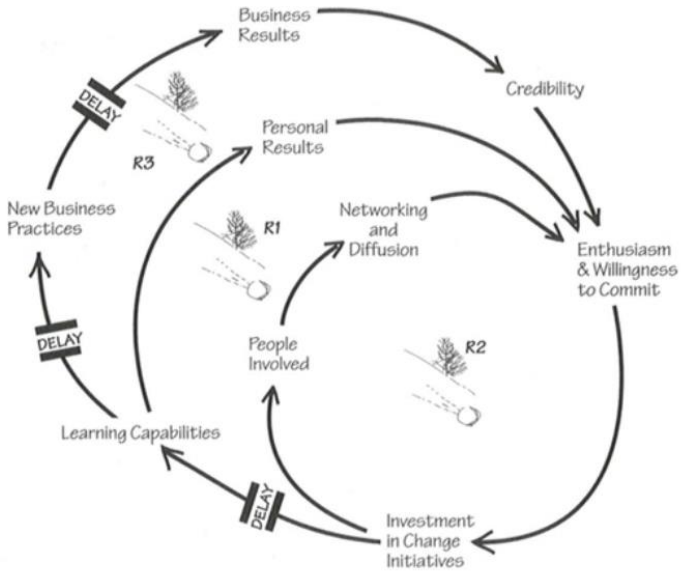

Figure 3.8 – Simultaneous Growth Processes
Source: Senge, *The Dance of Change*, 53

Digital Transformation Implementation Model

This section combines the *Digital Campaign Plan* model, the global and policy context, occupational implications, continuous learning, continuous improvement, and change management models to develop an overall implementation framework. Most of the variables and relationships assessed are captured in a system dynamics diagram in Figure 3.9. Relationships in this diagram are only captured in an abstract sense as the degree and type of influence will depend on context. Figure 3.10 reduces the model to a tractable level by collapsing related factors to enable assessment of cases studies to facilitate extraction of best practices. Many of the variables which remain in this reduced model are still mediating factors in the sense that they impact the practices but are not the focus. The key areas for investigation in the case studies are skill frameworks for digital literacy to assess upskilling, continuous learning via experimentation and external engagement, and methods of continuous improvement to examine approaches to experimentation. For this system to be sustainable the links between performance, intrinsic motivation, and continuous learning are considered to be key mediating variables. Based on the Galbraith Star model, culture change is a dependent variable resulting from behaviours which are generated from the system.

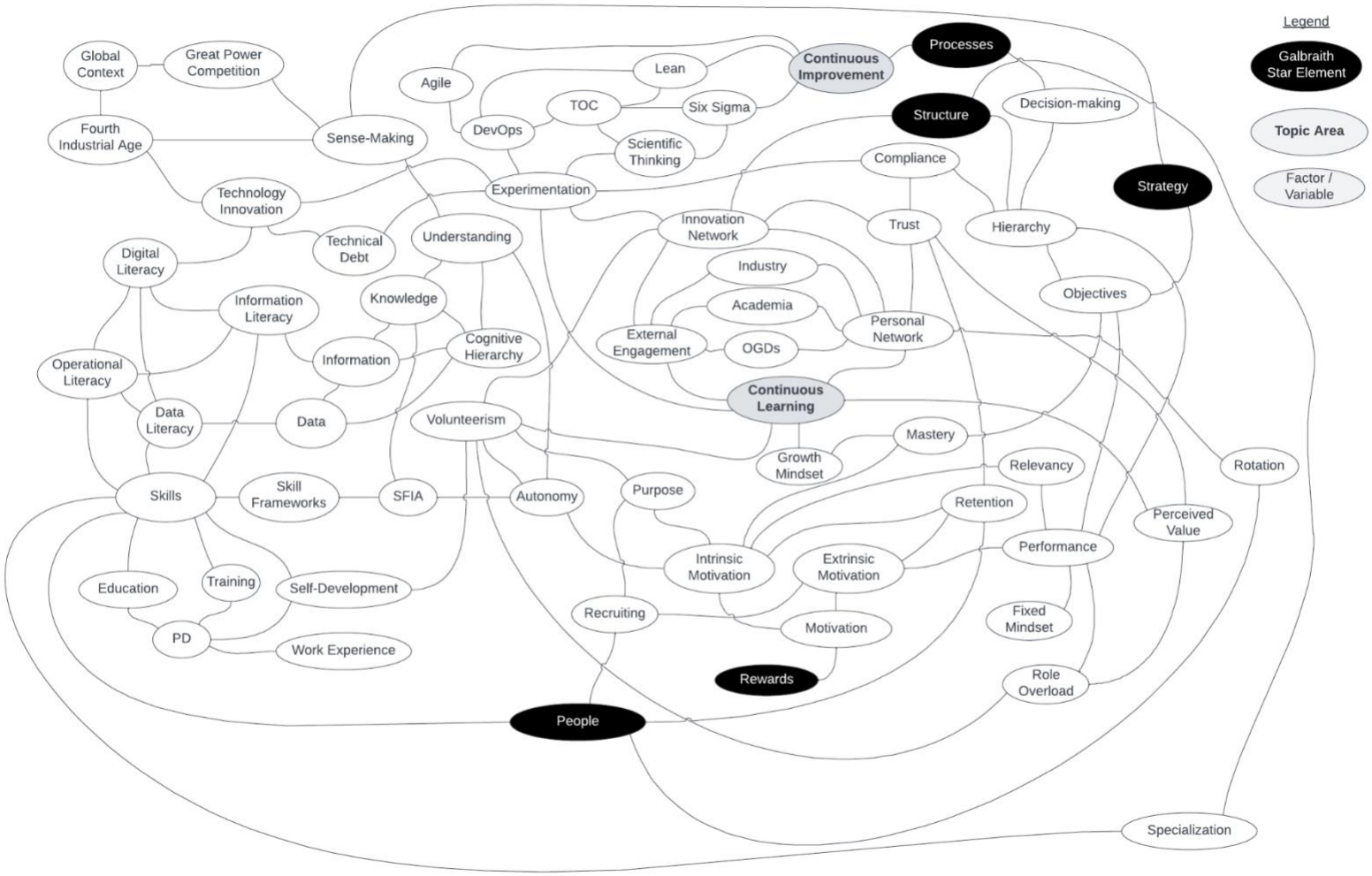

Figure 3.9 – Systemic Dynamics View of Context and Literature Review

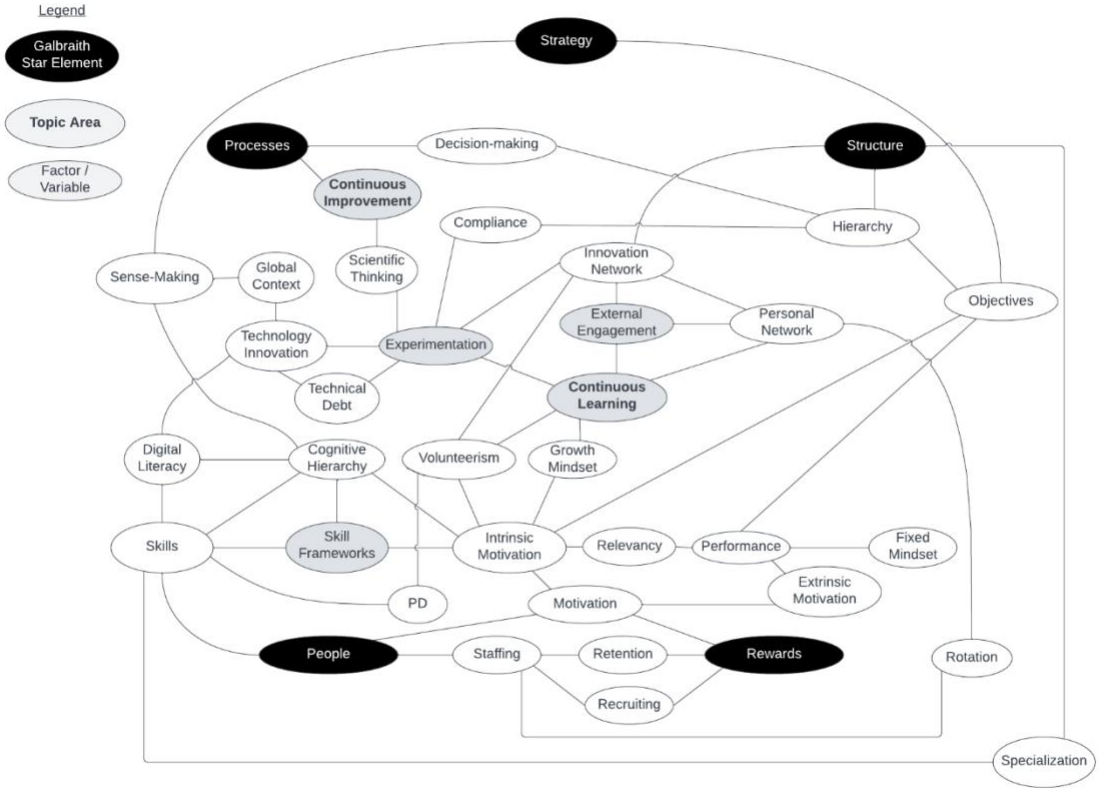

Figure 3.10 – Digital Transformation Implementation Model

Chapter Summary

Several models related to continuous learning, continuous improvement, and change management were reviewed using the Galbraith Star model as a tool to draw out relationships between the elements of the *Digital Campaign Plan*. Continuous learning highlighted the importance of digital literacy and related competencies including data, information, and operational literacy. Viewing development of these literacies from an educational design perspective suggested the importance of using skill frameworks such as SFIA to prepare role-based profiles and align with occupational specifications. Continuous improvement was

examined from the perspective of industry management and production models to determine the impact of structure and process on personnel and culture, particularly when changing between models. The primary observations were reinforcement of continuous learning through daily experimentation, importance of cross-functional teams for trust, and recognizing the criticality of a growth mindset to develop innovation. From the change management literature, the primary theme was the effect intrinsically motivated networks have on information passing and supportive actions. These network structures were suggested as complementary to existing hierarchical structures, populated with a critical mass of volunteer personnel occupying dual roles. The Galbraith Star suggests that achieving culture change can only be enabled when the supporting organizational design enables actions aligned with the desired change, which is the basis for the assessment model to view case studies in the next chapter.

CHAPTER 4: CASE STUDIES

Case Study Selection

Other CAF researchers have used the case study methodology to study aspects of digital transformation, such as the study of why the CAF should adopt DevOps. That research project examined the Canadian Joint Battlespace Management Capability (JBMC) and the US Air Force 'Kessel Run' initiative[187]. The JBMC case study reviewed Canadian challenges with fielding software solutions while lacking digital readiness, a negative outcome due to inflexible procurement policy and lack of leadership support. The Kessel Run case study examined the benefits of adoption of military-industry fusion to apply DevOps practices in an operational environment to solve an air-to-air refuelling problem. A successful instance, this case highlighted knowledgeable leadership adapting policy for a changed environment and potential benefits of working with small companies[188].

The sample space of possible case studies for this research is much larger than the DevOps study discussed above which was restrained to military cases. A recommendation for qualitative case study selection is to clarify exactly what the cases are, the possible universe of cases, logic of comparison, and whether or not there is theory-testing[189]. Instead of suggesting a novel theory, this research is seeking to extract best practices or warnings from cases to guide CAF implementation of digital transformation. The purpose of the model in the previous chapter is to form common comparison criteria, although any given case is expected to match a subset of variables rather than the complete model. The model will be used to guide the research into the

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[187] Kenneth Bedley, *Closing the Tech Gap: A CAF Startup Model for Digital Transformation*, vol. JCSP/PCEMI 47, DRP (Canadian Forces College, 2021), chaps. 5–6.
[188] Bedley, JCSP/PCEMI 47:89.
[189] Audie Klotz and Deepa Prakash, *Qualitative Methods in International Relations: A Pluralist Guide*, Book, Whole (New York;Basingstoke [England]; Palgrave Macmillan, 2008), 43–48, https://doi.org/10.1057/9780230584129.

selected organizations. This leaves defining the possible universe of cases, and exactly what is being examined.

The thesis presented in the introduction has several qualifiers, but the essential question is addressing the impact of digital upskilling to enable digital transformation using a holistic organizational design model to assess the probability of success. The CAF has attempted transformation before by isolating factors of organizational design and failed, such as with Lieutenant-General Andrew Leslie's attempt to rejuvenate "the teeth" of the fighting elements by gutting institutional support[190]. Therefore, any case needs to consider some combination of multiple organizational design factors from the Galbraith Star.

The possible universe of cases is large. Allied militaries, public sector organizations, industry, academia, and non-profits provide a first layer of review. Relative scaling is an isolating factor based on the assumption that change management in a small organization such as a start-up will be fundamentally different than a large organization bound by government regulations such as the CAF. Although there may be exceptions, this reduces the search space to allied militaries, public sector organizations, and industry. Few Canadian public sector organizations come close to the total size of the Defence Team[191], although preliminary research examined the efforts of larger departments. Recent government policy has set an expectation to move toward digital services[192], which was reinforced by some previous case studies on organizations such as Employment and Social Development Canada[193]. Given the recent

[190] Engen, "When the Teeth Eat the Tail," 11–12.
[191] Treasury Board of Canada Secretariat, "Population of the Federal Public Service by Department," statistics, July 12, 2012, https://www.canada.ca/en/treasury-board-secretariat/services/innovation/human-resources-statistics/population-federal-public-service-department.html.
[192] Treasury Board of Canada Secretariat, "Government in a Digital Age," November 17, 2020, https://www.canada.ca/en/government/system/digital-government.html.
[193] PricewaterhouseCoopers, "Optimising Public Service Delivery for Employment and Social Development Canada," PwC, accessed May 4, 2023, https://www.pwc.com/gx/en/about/case-studies/esdc.html.

publication of the *CAF Digital Campaign Plan* and available case studies on the larger organizations, it was assumed that drafters of this plan would have consulted these public sector cases, so this area of review was deselected[194]. Selection criteria then focused on allied militaries and industry. Restricting the scope of "Five Eye" (FVEY) nations would address possible security constraints within digital transformation. Although the sizes of entire FVEY militaries are quite different from the CAF, single services are relatively close. Preliminary research isolated a viable case in the United Kingdom's (UK) Royal Air Force. This case selection additionally avoids Army-centric bias which is present in the research and examples provided in chapters 2 and 3. Industry cases are much broader, so a deliberate selection was made to include one organization within the defence and security sector, and one outside. Thales was selected as the defence organization based on current and historical engagement with the CAF, to investigate similarities and differences. LifeLabs was selected as the non-defence organization as the medical industry often has comparable hierarchical and regulatory constraints. Further research in this domain could expand on the cases, such as the Canadian banking sector[195], or specific initiatives in allied militaries[196].

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[194] If this assumption is incorrect, additional research in such cases is recommended.

[195] "BMO's Commitment to Digital Readiness Recognized with Two Business Transformation and Operational Excellence Awards - Dec 3, 2020," accessed April 30, 2023, https://newsroom.bmo.com/2020-12-03-BMOs-Commitment-to-Digital-Readiness-Recognized-with-Two-Business-Transformation-and-Operational-Excellence-Awards.

[196] "Project Convergence 2022 to Demonstrate Futuristic Joint, Multinational Warfighting Technologies," www.army.mil, accessed April 30, 2023, https://www.army.mil/article/260345/project_convergence_2022_to_demonstrate_futuristic_joint_multinational_warfighting_technologies; Dale L. Moore, "Naval Aviation AIRSpeed for Defense Standardization Conference," March 8, 2005, https://www.dsp.dla.mil/Portals/26/Documents/Publications/Conferences/2005/2005%20Briefs/2005-DSPConferenceBriefings-DMooreAIRSPEED.pdf. AIRSpeed is a United States Marine Corps program which integrates Lean, Six Sigma, and Theory of Constraints.

Case Study – LifeLabs

LifeLabs is a Canadian medical laboratory services company operating in British Columbia, Saskatchewan, and Ontario with 400 patient service centres supported by 19 laboratories and with over 7,400 employees[197]. In 2021 they averaged almost 80,000 patient visits per day and performed over 117 million laboratory tests. LifeLabs is focused on being a critical component of Canadian healthcare through digital integration with other stakeholders in medical services, including "individuals, physicians, health authorities, hospitals and more"[198]. These services are developed and maintained by investing in technology and relationships such as the 2021 partnering with Telus Health to offer improved mental health services[199], or the 2022 partnering with CareBook to provide individuals with data-driven analysis of health needs[200]. As a large medical organization, LifeLabs is subject to multiple regulatory standards and follows industry best practices for privacy and data security. While outside of the defence sector and much smaller than the CAF, the regulatory environment and security implications of business operations has several similarities. One minor difference is that information compromise would affect only individuals or organizations instead of the national interest and would therefore be considered as 'designated' instead of classified, which implies different constraints on integration efforts.

With the emphasis on digital integration, LifeLabs had a strong incentive to improve digital services and security. In fall of 2019 the company paid criminals after sensitive

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[197] "GRI Index 2021 – LifeLabs," accessed May 5, 2023, https://lifelabs.com/gri-index-page-2021/.
[198] "Digital Health Solutions – LifeLabs," accessed April 29, 2023, https://www.lifelabs.com/corporate-customers/digital-health-solutions/.
[199] "IT Business LifeLabs Joins Hands with Telus Health to Improve Virtual Mental Health Service Offerings in Ontario ITBusiness.Ca," May 7, 2021, https://www.itbusiness.ca/news/lifelabs-partners-with-telus-health-to-improve-virtual-mental-health-service-offerings-in-ontario/118052.
[200] Carebook Technologies Inc, "Carebook and LifeLabs Working Together to Deliver Personalized, Digital Healthcare Insights," accessed April 29, 2023, https://www.newswire.ca/news-releases/carebook-and-lifelabs-working-together-to-deliver-personalized-digital-healthcare-insights-887166395.html.

information for about 15 million customers was comprised[201]. A subsequent investigation suggested that inadequate security and information policies were the cause[202]. After the incident notification to authorities, LifeLabs was credited with taking reasonable steps to mitigate the loss and prepare against future incidents. One measure was appointment of a Chief Information Officer to lead a digital transformation initiative to improve services and security.

Renewed emphasis on digital transformation was not starting in isolation. LifeLabs previously developed patient portals through a wholly owned subsidiary to provide individuals with online access to lab results, which suggests a degree of integrated data practices were already in effect[203]. The impact of COVID-19 in the health sector accelerated some pressures related to company culture and streamlining business practices, similar to how the international security situation impacts western militaries. A few significant projects undertaken in this timeframe include replacing a 20-year-old laboratory information management system, developing high-volume chemistry testing, advanced genetic testing, and both 'FlyClear' and 'WorkClear' programs in support of COVID-19 protocols[204].

The ability of LifeLabs to stabilize digital initiatives and then rapidly transform appears to have been based on multiple lines of effort. Built on a holistic understanding of the system by

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[201] C. B. C. News ·, "LifeLabs Pays Ransom after Cyberattack Exposes Information of 15 Million Customers | CBC News," CBC, December 17, 2019, https://www.cbc.ca/news/canada/british-columbia/lifelabs-cyberattack-15-million-1.5399577.

[202] HealthITSecurity, "Inadequate Security, Policies Led to LifeLabs Data Breach of 15M Patients," HealthITSecurity, July 1, 2020, https://healthitsecurity.com/news/inadequate-security-policies-led-to-lifelabs-data-breach-of-15m-patients.

[203] "LifeLabs, a Proud Member of the Digital Technology Supercluster, Winner of Federal Funding and Poised to Supercharge Canada's Economy and Technology Sector – LifeLabs," accessed April 29, 2023, https://www.lifelabs.com/lifelabs-a-proud-member-of-the-digital-technology-supercluster-winner-of-federal-funding-and-poised-to-supercharge-canadas-economy-and-technology-sector/.

[204] "Keith G. Hunt – LifeLabs," *Vanguard Law Magazine* (blog), accessed April 29, 2023, https://magazine.vanguardlawmag.com/html5/reader/production/default.aspx?pubname=&edid=92a033b8-8c10-4979-a2a1-81cac022eb0b; "Improving Health through Automation – LifeLabs," accessed April 29, 2023, https://www.lifelabs.com/about-us/innovation/improving-health-through-automation/; "LifeLabs Inc," *GlobalData Company Deals and Alliances Profiles* (London: GlobalData plc, 2021), 17, 23.

business and technical leadership, clear business outcomes with measurable targets expressed as key performance indicators were established while skills gaps in the workforce were addressed amidst iterative system upgrades based on the principle of loose coupling[205]. In this strategy, digital transformation was conceived as a series of discrete projects continuously delivered to build and sustain momentum[206]. Since project delivery was focused on iterative cycles with boundaries defined by system interfaces, initiatives could be developed asynchronously either internally or through external implementation[207]. The rapid fielding of projects of varying sizes by a small technical staff population implies high use of project or sub-project delegation frequently used in Lean or DevOps practices. This analysis is reinforced by focused hiring efforts to improve change management processes and employment of cross-functional teams[208]. Further, public announcements of partnerships and legal support in negotiations[209] emphasizes rebuilding post-breach trust by increased engagement with other industry professionals, enabling a degree of transparency.

The 2019 data breach suggests limited digital literacy in the sense of operational or cybersecurity literacy. Skill frameworks were not a prominent feature in this case, likely due to the time pressures to mitigate immediate crises from both the data breach and the concurrent emergence of COVID-19 with high impact in the medical sector. An average of 25 hours of professional development per employee in 2021 was noted through the use of mechanisms such

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[205] *The Competitive Advantage of Cyber Security (w/ Mike Melo, LifeLabs) - Cyber Security Matters*, 2021, sc. 9:20-16:40, https://www.youtube.com/watch?v=Ip9F646qZ8A; "Swae Case Study: How LifeLabs Used Swae to Solve a Costly Industry-Wide Talent Retention and Attraction Challenge in Less Than 30 Days | Swae," accessed May 6, 2023, https://swae.io/blog-5-min-read/how-lifelabs-used-swae-to-solve-a-costly-industry-wide-talent-retention-and-attraction-challenge-in-less-than-30-days/.
[206] "CIO Exec Council: LifeLabs' Small-Project Delivery Strategy," CIO, accessed May 5, 2023, https://www.cio.com/article/280501/it-strategy-cio-exec-council-lifelabs-small-project-delivery-strategy.html.
[207] "Keith G. Hunt – LifeLabs."
[208] Nicole Desloges, "Post," LinkedIn, 2019, https://www.linkedin.com/posts/nicoledesloges_opportunity-to-make-a-difference-activity-6549259097315823616-uo3Z/?utm_source=share&utm_medium=member_desktop.
[209] "Keith G. Hunt – LifeLabs."

as LifeLabs LinkedIn Learning Corner as well as "competency training and assessments", although the details were not publicly available[210]. Given the legal pressure resulting from the data breach, it is assumed that LifeLabs used these internal training mechanisms to enable baseline digital literacy as a compliance measure, reinforced by a reported 94% completion rate for policy training related to cyber security and IT acceptable use[211].

For transformative changes, LifeLabs appears to leverage partnerships and external engagements to develop personnel. They are a member of the Digital Technology Supercluster, part of an overall Government of Canada innovation strategy[212]. This innovation partnership aligns talent and skill development in several service areas, including digital health, through engagement techniques such as ideation workshops and industry summits[213]. A notable example of an event from this partnership is the 21st Annual Healthcare Summit with a goal of "Creating a Unique Nexus of Industry, Government, and Academia by Connecting and Educating People in the Age of Digital Transformation"[214]. The summit agenda included topic areas such as data protection regulations and continuous learning in the healthcare system supported by data literacy. The emphasis on data literacy as a foundation to enable digital transformation aligns with the model discussed in the cognitive hierarchy where data literacy is suggested as the base for digital literacy. Events such as these would help to evolve internal training programs and inform participants of the value proposition offered through focus on skill development in these areas.

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[210] "GRI Index 2021 – LifeLabs," sec. 404.
[211] "GRI Index 2021 – LifeLabs," secs. 412–2.
[212] "LifeLabs, a Proud Member of the Digital Technology Supercluster, Winner of Federal Funding and Poised to Supercharge Canada's Economy and Technology Sector – LifeLabs."
[213] "Digital Supercluster 2021/2022 Annual Report: Ahead of the Curve," Digital Supercluster, 47, accessed April 30, 2023, https://www.digitalsupercluster.ca/annual-report/2021-22/.
[214] "Agenda At A Glance - 21st Annual Healthcare Summit," *Reboot Communications* (blog), accessed April 30, 2023, https://www.rebootcommunications.com/events/healthcare-summit/agenda_at_a_glance/.

The main lessons for the CAF in this case are the use of risk thresholds to enable delegation, external engagement through partnerships, and iterative fielding to support operations while concurrently developing personnel. When looking at risk thresholds, a major criticism of the CAF's ability to rapidly field solutions is due to Treasury Board delegation authorities based on complexity and risk assessments which are better suited for platform-centric acquisition models[215]. With increasing volumes of transactions and decreasing human capital, the logic behind government financial regulation complicates DND/CAF ability to enable risk-bounded automation such as low-value claim processing, yet this is exactly where digital transformation leads[216]. In cases such as automated claim processing, which is suggested in the AI strategy[217], risk mitigation could be provided through AI-driven anomaly-based detection. While this example may appear relatively simple, some second-order impacts would be required changes in policies, fielding of systems, and training over-worked financial management personnel throughout the organization. A possible cause for resistance to initiatives such as these is lack of understanding of the supporting technologies and limitations on their use. As seen in the insurance industry[218], AI systems are becoming common to assist underwriting and aid in fraud detection, freeing valuable human capacity for more complex tasks. Iterative and evolutionary tasks such as these examples are where continuous improvement methods such as the Lean-based "Toyota Kata" offer clear value: with a clear understanding of intent, describe the current

[215] Bedley, *Closing the Tech Gap: A CAF Startup Model for Digital Transformation*, JCSP/PCEMI 47:38–44.
[216] National Defence, "DAOD 1016-0, Expenditure Management," policies, November 13, 2013, https://www.canada.ca/en/department-national-defence/corporate/policies-standards/defence-administrative-orders-directives/1000-series/1016/1016-0-expenditure-management.html; Saldanha, *Why Digital Transformations Fail*, 128.
[217] National Defence, *Department of National Defence and Canadian Armed Forces Artificial Intelligence Strategy*, 25.
[218] "How AI Is Radically Changing the Insurance Industry - Businessnewsdaily.Com," Business News Daily, accessed May 7, 2023, https://www.businessnewsdaily.com/10203-artificial-intelligence-insurance-industry.html.

and target conditions, and then experiment towards the target condition[219]. This process relies on broad delegation of authority to enable junior personnel freedom to experiment, with a parallel coaching system providing a natural risk oversight and mitigation strategy.

Observed in the LifeLabs case, a potential mitigation to the risk-adverse nature of CAF leadership is to provide increased project authority to teams at the cost of leadership assuming increased financial risk. This implies pursuing several small-scale improvement projects to stay within financial delegation regulations, which would better support experimentation and iterative fielding, ideally within a continuous improvement framework such as DevOps. This model only works when backed by high levels of leadership digital literacy, specifically operational literacy, which is currently lacking[220]. The reason for this dependency is the need to establish leadership awareness of possibilities and trust across the implementation community. LifeLabs' use of external engagements highlights two ways to build digital literacy. At the leadership level, partnerships such as the Digital Technology Supercluster provide a venue to develop awareness of emerging trends and provides access to a community of practice. Socialization in such networks then provides a pathway to enable future skill development and opportunities for continuous learning within the CAF.

Case Study – Thales

The Thales Group is a global technology company headquartered in France and operating in 68 countries with over 77,000 employees, providing services in markets such as cybersecurity, defence and security, digital identity security, and more[221]. Thales Canada is the Canadian

[219] Rother, *Toyota Kata*, 75–76.
[220] Canadian Armed Forces, *Canadian Armed Forces: Digital Campaign Plan*, 18; *Modernization Vital Ground: Digital Strategy*, 11–12.
[221] "About Thales," Thales Group, accessed April 30, 2023, https://www.thalesgroup.com/en/global/group.

segment of the company, with more than 2,000 people. Two of the areas where Thales is currently working with DND includes participation in the Innovation for Defence Excellence and Security (IDEaS) program initiated by SSE as well as support to the Royal Canadian Navy through the Arctic and Offshore Patrol Ships and Joint Support Ships In-Service Support (AJISS)[222]. For an example of the degree of commitment to the IDEaS programme, Thales was the selected innovator for four projects worth approximately $3.9 million under the competitive project element[223]. AJISS is "the largest ISS contract in Canadian history", as an initial eight-year contract worth up to $800 million, with options extending to 35 years for a total value of $5.2 billion[224].

Thales has a long history of frequent adaptation and evolution. In a measure of global innovation using patents, research citations, and industry impact, Thales has continuously been named within the Clarivate Top 100 Global Innovators since 2013, with the exception of 2015[225]. With history stretching back as far as 1893, Thales and its precursors have regularly adapted to global markets through a combination of research and development paired with acquisitions and mergers[226]. The ability to shift and adapt suggests an organizational culture with a high degree of change capability, which has been suggested as the critical factor in enabling digital transformation[227]. A possible explanation for this flexible adaption is the use of hybrid processes

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[222] "In-Service Support," Thales Group, accessed April 30, 2023, https://www.thalesgroup.com/en/service-support.
[223] National Defence, "IDEaS 1b Project Recipients," October 26, 2020, https://www.canada.ca/en/department-national-defence/programs/defence-ideas/ideas-1b-recipients.html.
[224] "Royal Canadian Navy Taps Thales for In-Service Support for up to 35 Years," Thales Group, August 17, 2017, https://www.thalesgroup.com/en/worldwide/defence/press-release/royal-canadian-navy-taps-thales-service-support-35-years.
[225] Ed White and Mihnea Hanganu, "Top 100 Global Innovators 2023" (Clarivate, 2023), 15, https://clarivate.com/top-100-innovators/the-top-100/?clv-award-year=2023.
[226] D&B Hoovers, "Thales Profile," *Hoover's Company Records* (Fort Mill: Mergent, December 7, 2022), 7–9.
[227] Tim Smith et al., "Digital Transformation Value," Deloitte, February 14, 2023, https://www.deloitte.com/global/en/our-thinking/insights/topics/digital-transformation/digital-transformation-value-roi.html.

and structures. Thales uses a program called "Business Innovation & Growth" (BIG) to encourage design thinking as part of a parallel structure to support experimentation with space to 'fail fast' and adapt[228]. The BIG program forms part of the Thales continuous improvement ecosystem which leverages Lean and DevSecOps methodologies, also seen in practice in their Digital Factories[229]. With wide global distribution and shifting markets constrained by diverse regulatory frameworks, use of hierarchical structures supported by innovation networks focused on growth to exploit opportunities has proven very successful as Thales' revenue continues to grow.

Another major trend in Thales is significant attention to continuous learning. This is most evident in their use of digital factories, AI research centres, internal skill development, and external collaboration. Thales Digital Solutions is based in Montreal and offers services for design, data, cyber, and AI[230]. As part of the broader Thales Digital Factory enterprise with alternate locations in France and Singapore[231], there is emphasis on a "Digital Academy" providing access to agile learning platforms for continuous professional development[232]. This emphasis on personnel development is reflected in market research as one of the strengths of Thales, including their internal university[233]. Thales University was founded in 1988 and is now operating as the "Thales Learning Hub" with country-specific programs[234]. The Digital Academy

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[228] "BIG," Thales Group, November 29, 2018, https://www.thalesgroup.com/en/global/innovation/big.
[229] "Thales Digital Factory - Accelerating Digital Transformation," Thales Group, accessed April 30, 2023, https://www.thalesdigital.io/en/digital-platform/.
[230] "Digital Solutions in North America," Thales Group, accessed May 5, 2023, https://www.thalesgroup.com/en/americas/united-states/digital-solutions-north-america.
[231] "Thales Digital Factory Expands to Singapore," Thales Group, December 5, 2018, https://www.thalesgroup.com/en/group/innovation/news/thales-digital-factory-expands-singapore.
[232] "Digital Academy," Thales Group, accessed May 5, 2023, https://www.thalesdigital.io/en/digital-academy/.
[233] Fatema Mustafa, "Thales Group SWOT & PESTLE Analysis | SWOT & PESTLE," *SWOT & PESTLE.Com* (blog), December 5, 2017, https://www.swotandpestle.com/thales/.
[234] "Developing Our People," Thales Group, accessed May 5, 2023, https://www.thalesgroup.com/en/global/corporate-responsibility/people/developing-our-people.

is one of several offerings within the Learning Hub, with other offerings including topics such as leadership and change management[235]. Coordination of skill development is not evident through the use of a framework such as SFIA. However, emerging research on topics such as skill adjacencies[236] is reflected through Thales' focus on "talent development … based on anticipating changes in job families and trades"[237]. Thales' use of job families to develop a skills management initiative is further described as identifying and sharing technical skills blended with leadership and supervision.

Individual professional development is extended to collective learning and external engagement through extensive use of collaboration and partnerships. Partly enabled through their research centre and corporate accelerator AI@Centech[238], Thales contributes heavily to Scale.AI. Scale.AI is Canada's AI supercluster with a vision to support all areas of AI development such as talent training and an innovation hub for start-ups[239]. Additional partnerships are widely varied with over 500 instances across Canadian enterprises[240]. Some examples of these include IDEaS-like programs such as the Naval Technology Innovation Challenges in collaboration with COVE, or the multi-stakeholder Synergy program designed to accelerate Canadian small and medium-sized business development to "bring advanced military technologies to market"[241]. Globally, Thales has developed collaboration and partnerships with educational institutions to recruit and

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[235] "Thales Jobseeker" (Ontario Society of Professional Engineers, May 27, 2022), 2–3, https://ospe.on.ca/wp-content/uploads/2022/05/Thales-Canada_Jobseeker.pdf.
[236] Wilde, Smith, and Clark, "Organizations Need a Dynamic Approach to Teaching People New Skills."
[237] "Developing Our People."
[238] "AI@Centech," Thales, accessed May 5, 2023, https://www.ai-at-centech.com//.
[239] "Scaling up Canada's AI Potential," Annual Report (Scale.AI, 2022), 9, https://www.scaleai.ca/wp-content/uploads/2022/10/scaleai_rapportannuel_2022_en.pdf.
[240] "Tested. Trusted. Thales.," Thales Group, accessed April 30, 2023, https://www.thalesgroup.com/en/americas/canada/tested-trusted-thales.
[241] "Naval Technology Innovation Challenges," COVE, accessed May 5, 2023, https://challenges.coveocean.com/; "Thales Canada Introduces Synergy to Drive Innovation with Canadian SMBs," Thales Group, June 1, 2022, https://www.thalesgroup.com/en/canada/press-release/thales-canada-introduces-synergy-drive-innovation-canadian-smbs.

internally develop personnel[242]. In aggregate, Thales has demonstrated that external engagement is an inherent part of their structure enabling continuous learning, innovation, and trust, cornerstones upon which their digital transformation is built.

There are several lessons for the CAF to draw from Thales' approach to evolution and digital transformation. The two primary observations are the leadership emphasis on innovation through experimentation and investment in relationships beyond their internal structure. Both these programs require a degree of autonomy through delegation coupled with commitment of financial and personnel resources to explore the option space. In the case of Thales, it appears that senior leadership has internalized the benefits of continuous learning by guiding the company towards a continuous improvement framework enabled by industry-leading methodologies such as Lean and DevOps to transform both their digital and traditional services as shown by the Digital Factory, contributions to IDEaS, and fulfilling AJISS. Execution of this program appears similar to "Operation Speedboat", an analogy comparing traditional business processes to a cruise ship while the innovation network is a speedboat[243]. Thales has achieved this by directing their speedboats to explore disruptive ideas by agile start-ups and educational institutions as a guide for their business cruise ship the same way an army employs a reconnaissance element to guide an attack to determine threats and inform their main body. The methods Thales has used are echoed in literature: identifying digital champions, adding outside perspectives to internal innovators, and providing innovative frameworks a degree of flexibility within a risk tolerant environment. Although the newly created DND/CAF Digital Transformation Office appears to set the conditions for this framework, it is too early to tell if the

[242] "Developing Our People."
[243] Bangkok Post Public Company Limited, "Hacking the Future: Operation Speedboat," *Bangkok Post*, accessed May 6, 2023, https://www.bangkokpost.com/opinion/opinion/2070143/hacking-the-future-operation-speedboat.

supporting requirements will follow. It is essential to note that Thales has not isolated digital transformation to a central innovation hub. Thales' expanding network of Digital Factories has provided guidance and increased capacity to their broader enterprise, paired with development through the organization via the digital academy and a degree of personnel rotation.

While the discussion above is focused on leadership and external engagement, these approaches appear to work only when supported internally. Recalling the 'types of work' discussion on DevOps[244], three of the types have an internal focus. Two of these, IT operations (or self-improvement) and changes, rely on a growth mindset to provide relevancy and value. Through a history of organizational change and adaptation, Thales has demonstrated success in these areas, which suggests a link between their change capacity and broad organizational digital literacy enabled through participation in their innovation network as opposed to 'add-on' training. Although skill frameworks such as SFIA are not used, the use of job families and a proprietary skills management initiative is similar to the CAF. CFITES clusters jobs and skills using a job-based specification to reflect roles required by specific ranks and trades. Thales' ability to rapidly adapt their workforce suggests improved speed of job identification and re-alignment, which when paired with the half-lives of skills discussed earlier suggests that the management overhead of CFITES needs to be reduced to remain effective, but the structure itself is a viable mechanism.

[244] The 'types of work' were business projects, IT operations projects, changes, and 'unplanned work', where 'unplanned work' is reactive work resulting from technical debt.

Case Study – UK Royal Air Force

The UK's Royal Air Force (RAF) as part of the Ministry of Defence (MOD) has an established strength of approximately 30,000 regular, reserve, and civilian personnel[245]. Operating domestically and globally, the RAF's vision is to be "[t]he most operationally successful, agile and innovative Air Force in the world; always there for our nation" [246]. The RAF is currently engaged in 19 concurrent Air and Space operations, domestic and expeditionary, which are predominantly focused on Europe and the Middle East but stretch as far as the Falkland Islands[247]. Current operational priorities include Operation SHADER in Iraq and Syria to combat Daesh, NATO air operations in Eastern Europe and 24/7 Quick Reaction Alert to protect the UK homeland. The RAF's fleet is comprised of 27 different aircraft platforms, including combat air and mobility, as well as a plethora of ground-based capabilities including cyber, space operations, and force protection[248].

In 2018, the RAF formally recognized the changing nature of conflict would render the traditional approach to capability development obsolete as dwindling numbers of slightly more capable equipment would not meet the future operational demands in support of the MOD[249]. This perspective is echoed by other allied strategic planners, such as a former staff director for the US Senate Committee on Armed Services, although US implementation has been criticized as being slow to adapt and remaining overly platform-centric[250]. The RAF Deputy Commander (Capability) highlighted five driving forces behind the need for rapid RAF change: increasingly less kinetic warfare as conflict moves into the grey zone, higher personnel capability related to

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[245] Andrew Drwiega, "Transforming the Royal Air Force," *Armada International* (blog), August 4, 2020, https://www.armadainternational.com/2020/08/transforming-the-royal-air-force/.
[246] Royal Air Force, "RAF Strategy," June 17, 2022, 7, https://www.raf.mod.uk/documents/word/raf-strategy/.
[247] "Global Operations," Royal Air Force, accessed May 6, 2023, https://www.raf.mod.uk/.
[248] "Aircraft," Royal Air Force, accessed May 1, 2023, https://www.raf.mod.uk/.
[249] Drwiega, "Transforming the Royal Air Force."
[250] Brose, *The Kill Chain*, 32.

equipment, increased global presence, improved personnel support systems, and ability to adapt to rapidly transforming technology[251]. Translating these strategic imperatives to short-term action to prepare the future force has resulted in the initiation of Project ASTRA, a "shake-up of the way we do HR, our bases, equipment and training", with emphasis on digital integration[252]. While operational output must continue, the strategy driving the campaign plan prioritizes institutional development reflected by the Chief of the Air Staff (CAS): "Our greatest legacy … is not the outstanding operational track record of today. Of much greater importance is that we design and start to build the Royal Air Force of the future." [253]

One of the RAF methods to inculcate Project ASTRA transformation has been to establish the 'RAF eXperimental' (RAFX) innovation hub at RAF Leeming[254]. Rather than a single isolated pocket of innovation, RAFX is a central node in an innovation network to provide greater support and therefore, increased chances of success; units are encouraged to develop initiatives at a local level which are then collected, tested, and shared through RAFX. This method encourages collaboration and sharing and could be viewed as a direct implementation of Kotter's parallel network structure, and addresses Senge's 'limiting processes' by ensuring broad awareness and support. The advantage of Project ASTRA is that it was led and supported from the CAS downwards to direct senior leadership to take ownership of their challenges and to encourage innovation across their forces. While grassroots initiatives placed the onus on the operational community to drive change, ensuring relevancy of projects and commitment once started, the funding model enabled sustainable change for projects deemed viable. Project

[251] Drwiega, "Transforming the Royal Air Force."
[252] "Astra - Campaign to Build the Next Generation Royal Air Force," Royal Air Force, accessed May 6, 2023, https://www.raf.mod.uk/.
[253] "Astra - Campaign to Build the Next Generation Royal Air Force."
[254] "RAF: Taking Digital Transformation to New Heights," December 16, 2021, https://technologymagazine.com/company-reports/raf-taking-digital-transformation-new-heights.

ASTRA effectively provides start-up funds when experimental low-level or equipment capability is needed beyond low-code or no-code solutions such as integrated dashboards. Proven capabilities are then moved onto unit operating plans as part of their lifecycle.

To minimize duplication of effort RAFX shares innovation efforts within the RAF. External collaboration through the wider MOD, such as with the Royal Navy and British Army, are enabled via Defence Digital. Defence Digital is part of UK Strategic Command, a Front Line Command established in 2013 to align joint capabilities including capability development, operational delivery, digital transformation, and other functions[255]. The DND equivalent would be the Chief Information Office, formerly Assistant Deputy Minister (Information Management)[256]. In support of the MOD's digital transformation, Defence Digital has recently established two significant programmes in support of MOD-wide digital innovation: the Defence Digital Foundry and the Defence Artificial Intelligence Centre (DAIC). The Defence Digital Foundry is expected to leverage DevSecOps practices to support development of user-facing digital services and analytics functions within approved information security regulations[257]. While nascent, DAIC is a nexus for collaboration across the wider UK defence community[258]. Focus areas for DAIC are enabling better understanding of AI, enabling MOD teams, and innovation through application of AI. When these programmes combine with Project ASTRA, the result is innovation encouraged by command with access to an overarching central service, enabled by collaboration with industry and academia, supported by Defence Digital.

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[255] "Defence Digital," GOV.UK, accessed May 1, 2023, https://www.gov.uk/government/groups/defence-digital.
[256] "Message from the Deputy Minister Regarding the Digital Transformation Office," December 6, 2022, https://www.canada.ca/en/department-national-defence/maple-leaf/defence/2022/12/message-deputy-minister-digital-transformation-office.html.
[257] "Defence Digital Foundry," GOV.UK, accessed May 7, 2023, https://www.gov.uk/government/groups/defence-digital-foundry.
[258] "Defence Artificial Intelligence Centre," GOV.UK, accessed May 1, 2023, https://www.gov.uk/government/groups/defence-artificial-intelligence-centre.

Internal personnel transformation is similarly rapidly progressing. A central component to Project ASTRA is to prepare for future skill requirements through the reduction of 68 trades or branches down to 11 professions[259]. This professional consolidation has already been mapped out and the transition plan is in progress[260]. Understanding the concerns individuals may have with these changes, the RAF has been proactive in communicating by explaining the logic and possible futures, ahead of time[261]. The move to greater generalization of structure is supported by increased use of skill profiles and is intended to improve the ability for personnel to move within the organization in more flexible roles based on competencies. Further, the focus on civilian qualifications for many skills is designed to enable personnel to move in or out of the organization, which would enable lateral hiring in some roles while permitting service members greater flexibility as they transition through life stages. Similar approaches have been investigated by the US[262], and Australia has already implemented a form of this model with the Total Workforce System[263]. To support the skill-based model, the Defence Digital Foundry is using the Digital, Data and Technology Profession Capability Framework, which complements the Success Profiles Framework used in the UK public service[264]. Although the framework uses different terms, it is similar to the skill and level approach of SFIA, defining elements of behaviours, strengths, ability, experience, and technical skill. DAIC has a similar role to the Digital Foundry to promote AI knowledge, skills, and career development.

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[259] Drwiega, "Transforming the Royal Air Force."
[260] Royal Air Force, "Introduction to Professions," February 2, 2022, https://www.ejsu.net/EJSUNET/wp-content/uploads/2022/02/Introduction-to-Professions.pdf.
[261] Royal Air Force, "RAF Professions - the Rumours and the Facts," February 17, 2022, https://www.ejsu.net/EJSUNET/wp-content/uploads/2022/02/Professions-the-rumours-and-the-facts.pdf.
[262] Dina G. Levy et al., "Evaluating Options for Expanding Lateral Entry into Enlisted Military Occupations" (RAND Corporation, January 1, 2004), https://www.rand.org/pubs/research_briefs/RB7562.html.
[263] "Total Workforce System Explainer," The Cove, accessed May 1, 2023, https://cove.army.gov.au/article/total-workforce-system-explainer.
[264] "Digital, Data and Technology Profession Capability Framework," GOV.UK, August 30, 2022, https://www.gov.uk/government/collections/digital-data-and-technology-profession-capability-framework.

Within the MOD, the skills-based orientation is reflected in the new Digital Skills for Defence (DS4D) program to upskill the workforce, collaboratively designed in partnership with Microsoft[265]. DS4D is designed to foster a growth mindset across Defence, recognizing the short lifespan of skills in current markets and the need for continuous learning. DS4D intends to develop the program by using solutions such as low-code, no-code apps and by employing Microsoft Viva Learning. Microsoft Viva Learning is a type of learning management software (LMS) with similarities to Moodle, a popular implementation in universities, but integrated with Microsoft Teams and potentially acting as an aggregator for other LMS solutions.

As a holistic solution to a complex organizational design problem, Project ASTRA offers several lessons for the CAF. Ubiquitous digital upskilling is the prominent feature of this case, due to the focus of the RAFX integrator. Rather than focusing on the Defence Digital Foundry or DAIC, Project ASTRA's defining feature is the linking of leadership intent to local execution. Current Project ASTRA success is evident through several actions: clear articulation of objectives broadly disseminated across the force, adjustment of incentive and reward structures by the change to professions to signal a separation from historical patterns of bias, and industry engagement infused into RAF DNA through civilian qualifications and other professional development to enable experimentation from ideation to reality. Impacts on RAFX structure through hybrid allocation of experimentation support resources paired with intrinsically motivated junior personnel appears to be driving changes to funding and development processes unconstrained by the platform-centric mentality previously hampering the force.

The ability of Defence Digital to act as a unifying thread by further enabling single-service resources by using industry-proven best practices for continuous improvement is

[265] "Digital Skills for Defence: How the MoD Is Upskilling Its Workforce," Microsoft News Centre UK, April 28, 2023, https://news.microsoft.com/en-gb/2023/04/28/digital-skills-for-defence-mod-upskilling-workforce/.

preventing the balkanization which plagues similar CAF efforts[266]. In this regard, Defence Digital is perceived as a force multiplier by providing resources for upskilling as opposed to setting standards to be ignored and left to single-service implementation, which is the DND model that has received criticism[267]. While DND's CIO has similarities to Defence Digital, the difference in perception may be due to Defence Digital's ability to collaborate with industry and change process within existing security and procurement regulations. The assessment model from chapter 3 suggests that the ability to perform experimentation within a risk-tolerant compliance framework is necessary for continuous learning. In a similar manner, the US has proven this model by the use of DevOps and a continuous Authority to Operate framework[268]. The overall effect is that rather than hoarding innovation and experimentation, central services in successful cases are acting as amplifiers for successful experimentation initiated throughout the force where end-users drive relevancy by addressing issues affecting their lived experiences. The amplification focuses central services on removing barriers to single service innovators rather than consolidating services and imposing cookie-cutter solutions. A natural concern with this growth is long-term sustainability, which is why loose coupling and experimentation are important. While loose coupling enables services to vary implementation based on an agreed interface, experimentation requires a disciplined approach to avoid sunk cost fallacy. One suggestion separates day-to-day continuous improvement and higher potential projects needing support from central services, where the larger projects have short gateways to realize their

[266] Engen, "When the Teeth Eat the Tail," 14.
[267] Engen, 10.
[268] Nicolas Chaillan and Thomas Lam, "DoD Enterprise DevSecOps Reference Design" (Department of Defense, August 12, 2019), https://dodcio.defense.gov/Portals/0/Documents/DoD%20Enterprise%20DevSecOps%20Reference%20Design%20v1.0_Public%20Release.pdf; McKeown, "Continuous Authorization To Operate (CATO)."

potential and are scrapped if they do not meet these objectives[269]. This methodology is not viable for large-scale projects in DND without extensive policy changes[270], but the continuous improvement ecosystem could be enabled at the grassroots level within DND authorities.

The RAF approach to skill management is similarly transformational in nature. The MOD decision to use skill frameworks aligned with the UK public service offers clear advantages for members to transfer between the public service and the MOD. Alignment between industry-certified qualifications and these skill frameworks remains to be seen. In this case, alignment with the UK public service likely offered better flexibility than MOD alignment with SFIA because the underlying Success Profiles Framework would have a broader distribution of skills. The similar skills-based competency approach to support the move to professions offers significant flexibility for roles adapting as technology changes.

Chapter Summary

Examination of these three cases offered glimpses into possible CAF futures to improve digital transformation. The model from chapter 3 provided a necessary unifying focus to research and examine cases as the complexity of sub-elements of the Galbraith Star model can quickly become intractable. While each case has unique lessons which can be drawn, there were some clear trends present.

The most prominent, and consistent, observation was the heavy application of external engagement and partnerships with industry and academia to assist in designing and

[269] Saldanha, *Why Digital Transformations Fail*, 168–69. Saldanha describes a "10-5-4-1" system where given 10 projects, 5 are killed, 4 are expected to achieve '2x outcomes', and 1 is expected to achieve 10x disruption. Time horizons are given to this project methodology: 1-2-4-8-16, where the numbers are months for landscape assessment, design, hypothesis testing, development, testing, and deployment. Projects may be killed anywhere in this timeline, potentially to be later revived if technology matures or market conditions change.
[270] Bedley, *Closing the Tech Gap: A CAF Startup Model for Digital Transformation*, JCSP/PCEMI 47:36–44.

implementing digital transformation. All cases showed some degree of digital upskilling aided by some form of competency map, but the frameworks were widely varied and not aligned to any particular industry standard, although the RAF example was aligned with the UK public service. The only highlighted risk was that of limited digital literacy amidst ongoing digital transformation resulting in security breaches as was shown in the case of LifeLabs, which was overcome through a short-term combination of compliance measures and systems re-engineering.

Another common thread was use of DevOps methodologies by central supporting services to enable local innovation. A common link between DevOps and the Galbraith Star is the importance of direction: in DevOps this is achieved through a promulgated vision and value stream mapping, whereas in the Galbraith Star this is captured within the strategy element. One can find ‘strategy’ or a ‘concept of operations’ buried in various CAF orders, directives, policies, and similar work, but it is very rare to see clearly articulated value streams. Value stream mapping (VSM) would be a useful tool at the unit level and beyond for leaders and experts to assess dependencies and, in VSM terminology, ‘non-valued added’ activities. VSM requires little use of technology and relies on systems-level understanding augmented by relationships.

With geo-political analysis beyond the scope of this paper, what was not shown was the risk to future relevancy as a global security partner. However, all cases highlighted the importance of being able to adapt to changing technology, and the UK case in particular emphasized the need to maintain alignment with other defence elements. The recently formed Australia, UK, and US (AUKUS) security pact may offer a view to a Canadian future without

successful DND/CAF digital transformation, where traditional security partners continue to develop cyber and AI capabilities without Canada[271].

[271] "Was Canada Invited to Join AUKUS? Officials Mum but Stress No Interest in Subs - National | Globalnews.Ca," Global News, accessed May 6, 2023, https://globalnews.ca/news/8196164/aukus-defence-deal-canada-china-relations/.

CHAPTER 5: CONCLUSION

The resistance to external influence exacerbates the shortcomings of leadership.

– The Honourable Louise Arbour, Report of the Independent External Comprehensive Review of the Department of National Defence and the Canadian Armed Forces

The purpose of this research paper was to expand on existing models and observations from case studies to suggest an approach to DND/CAF change management in support of digital transformation. Potential indifference to the *CAF Digital Campaign Plan* and related strategies recently released may be due to a history of Defence Team transformation failures which emphasized short-term mission success at the cost of sustainability. CAF operational effectiveness was shown to be at risk due to a loss of internal integration and external adaptability. Further risk to CAF operational effectiveness has resulted from a widening skill gap, reconstitution crisis, and increasing information overload affecting member well-being and commitment. The effect of decreased operational effectiveness and strategic apathy may even risk Canada's future relevancy as a global security partner, as suggested by Canadian exclusion from the AUKUS security pact.

This research offers a possible path to aid a digital transformation implementation plan to navigate the impending challenges. Through assessment of the global context and related operational or policy considerations, insight into several factors of interest was applied to models within academic and business literature. Providing a bespoke DND/CAF model derived from an overlay of the Galbraith Star on these contextual factors, analysis of case studies demonstrated the importance of continuous learning and holistic implementation to achieve outcomes.

As suggested by the Galbraith Star, implementation efforts should be mutually reinforcing to guide changes to behaviour and change culture. While intrinsic motivation was a mediating variable, its importance cannot be overstated based on the impact to continuous

learning and continuous improvement through experimentation. With rapid changes in technology, individual and collective digital upskilling is necessary to overcome deficiencies in operational, information, and data literacy. However, improved literacy without necessary changes in obsolete or risk-adverse policy and processes may be even more harmful based on commitment theory. Institutional efforts to address change management such as those in the *AI* Strategy need support[272]. Project ASTRA has demonstrated the benefits of delegating innovation authorities, but the Defence Team still lacks the funding mechanisms and leadership engagement. Overcoming these challenges requires digitally literate leaders to encourage local experimentation, enabled by industry, and supported by central services with the necessary authorities.

The other prominent theme was a need for greater involvement through collaboration with industry and academia. From the case studies, the methods to achieve this are diverse: contracted design or implementation support, ideation workshops, conferences, summits, and more. While many of these activities already occur in some form as part of daily DND/CAF activities, this research highlighted the difference in scope and scale. To enable the factors discussed above, this engagement needs to be enabled throughout the organization, including at the lowest levels.

[272] National Defence, *Department of National Defence and Canadian Armed Forces Artificial Intelligence Strategy*, 17.

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