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INFORMATION TECHNOLOGY AND THE FUTURE DEFENCE WORKFORCE

Maj J.S. Estrela

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Maj J.S. Estrela

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AIM

1. To analyze requirements for the future Information Technology (IT) workforce in the Canadian Armed Forces (CAF) and Department of National Defence (DND) as driven by current and forecasted competency gaps. As such, it will examine the rationale for increased science, technology, engineering, and mathematics (STEM) knowledge as a core competency in the defence workforce with particular focus on IT and computer science.

INTRODUCTION

2. The Information Age has driven the increased importance of IT in today's strategic environment as combatants seek to achieve information dominance on operations. This involves capitalizing on new technological advancements to better enable the CAF operational functions. The CAF has continually evolved its IT capabilities, starting with early radio and telegraph systems all the way to the sophisticated Communications and Information Systems (CIS) of today.

3. Concomitant with this evolution has been the development of organizational competencies needed to support new technology. With forecasted requirements for artificial intelligence (AI) and automation as well as current competency gaps, the required makeup of the defence IT workforce will continue to change. This analysis will explore these evolving requirements by defining the need, looking at IT workforce modernization in other militaries, and identifying areas of exploration to build such expertise in the CAF.

DISCUSSION

Defining the Need for the Future IT Workforce

4. An immediately apparent issue with the IT workforce is that increased digitization over the past four decades has not yielded a "corresponding growth in software experts" in a manner similar to other technology fields such as nuclear propulsion or aeronautics.[1] This is generalized by the US Defence Innovation Board (DIB), a body tasked with providing advice on innovation to the US Department of Defense (DoD), in their recommendation that the US needs to institutionalize computer science in the military.[2] The DIB foresees the future of warfare as "increasingly software-centric. . . [y]et the Department is significantly challenged in its ability to develop, use, update, or acquire modern software."[3] DoD's key deficiency in this area is not based on industry skill gaps, but rather, is challenged by its own ability to "grow and maintain adequate computer science capability and capacity for the wide range of software-centric requirements that are unmet today and will only continue to grow."[4] These human capital issues arise because of an outmoded mentality that perceives the outsourcing of IT as the solution of choice, which has led to an overreliance on industry and personnel support contracts.

5. Pointing to "mounting evidence in the military, federal government, and private industry", US Army officer Colonel John Kilgallon sees this reliance on industry as leaving the "organization without the talent needed to oversee outsourced work" and make critical decisions

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[1] Jim Perkins, "The Next New Military Specialty Should Be Software Developers," last modified 22 January 2018, https://warontherocks.com/2018/01/next-new-military-specialty-software-developers/?utm_content=buffer5feb0&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer.

[2] United States of America Department of Defense, "Defense Innovation Board Recommendations," last accessed 29 January 2018, http://innovation.defense.gov/Recommendations/.

[3] *Ibid.*

[4] *Ibid.*

on capability investment.[5] As a result, industry retains too much control over systems development without adequate direction, leading to mismatches between capabilities and end-user needs.[6] As a result, improving organizational STEM competencies would lead to more effective IT acquisition. Properly trained acquisition personnel with direct experience in engineering would be uniquely suited to translate user requirements to technical specifications and provide needed oversight.[7] While this system is partially in place in the CAF where personnel in engineering occupations fill project staff roles, increased emphasis should be placed on matching unique technical knowledge to specific projects as part of wider talent management activities, particularly where specialization is required due to complexity or completely new technology.

6. Lifecycle maintenance of procured software would also benefit from a more technically competent workforce. Military industry has typically retained ownership over source code and often does not provide the requisite tools to allow the customer to extend or maintain their applications. Coupled with the lack of organic development resources, the military has had to trust the supplier to modify code; however, these resources can be sensitive to budgetary constraints and not survive the life of the software. As a result, changes required to "adapt to new conditions, incorporate new features, or eliminate flaws" can only be performed by the source code proprietor leading to slow, unresponsive development.[8] If IT is more accurately

[5] John C. Kilgallon, "Shaping the Army's Information Technology Acquisition Workforce in an Era of Outsourcing," (Senior Service College Fellowship Paper, United States Army War College, 2009), iii, http://www.dtic.mil/dtic/tr/fulltext/u2/a511554.pdf.

[6] *Ibid,* 7.

[7] John C. Kilgallon, "Shaping the Army's Information Technology Acquisition Workforce in an Era of Outsourcing," (Senior Service College Fellowship Paper, United States Army War College, 2009), x, http://www.dtic.mil/dtic/tr/fulltext/u2/a511554.pdf.

[8] United States of America Department of Defense, "Defense Innovation Board Recommendations," last accessed 29 January 2018, http://innovation.defense.gov/Recommendations/.

viewed as a weapons system and developers are seen as analogous to the technicians that support such systems, it is logical to ensure that the same type of maintenance is in place.[9]

7. Another important consideration is how integrating advanced technologies fit into a Capability Maturity Model (CMM), a term initially used to describe the formalization of software development processes but possessing wider applicability.[10] Using AI as an example, the CAF would likely seek to jump to the most sophisticated algorithms using a major procurement; however, this strategy will fail without a supporting bedrock of knowledge. A better approach would be to mature by evolution, starting with building the data science knowledge required to understand AI and piloting small organic development projects with a view towards incremental progression. As Bandopadhyay notes, successful maturation of AI is not defined by the technology used but rather, by the ability of the organization "to drive massive changes in the ways people do their day-to-day business, and hone new capabilities."[11] Such massive changes result from the aggregation of small changes and require technical expertise to guide the direction of capability development. Simply trying to procure one's way to maturation will not achieve this end.

Examples of IT Workforce Modernization in Other Militaries

8. DoD is spearheading several initiatives towards IT workforce modernization. The DIB has called for a computer science career track that would allow service members to specialize

[9]Jim Perkins, "The Next New Military Specialty Should Be Software Developers," last modified 22 January 2018, https://warontherocks.com/2018/01/next-new-military-specialty-software-developers/?utm_content=buffer5feb0&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer.

[10]Wikipedia Foundation, "Capability Maturity Model," last accessed 30 January 2018, https://en.wikipedia.org/wiki/Capability_Maturity_Model

[11]Topati Bandopadhyay, "The VCMM [Value-Capability Maturity Model] of AI: 5 A-Stages," last modified 22 July 2017, https://www.linkedin.com/pulse/value-capability-maturity-model-intelligent-5-dr-tapati-bandopadhyay/.

while protected "from pressures to rotate into unrelated roles."[12] This career track is not restricted to programmers, recognizing the role of "engineers . . . designers, product managers, security experts, and user experience researchers" in the overall schema.[13] Additionally, the DIB has recommended recruiting data scientists that can apply relatively simple industry-standard techniques, provide an interface to academia and the private sector, and understand "how to build and interpret algorithms at all levels of organizations."[14] Ultimately, these recommendations point to the need for the CAF to adopt industry-like approaches to human capital instead of viewing itself simply as a customer of these services.

9. A key aspect of institutionalizing core competencies is proximity to users. The DIB recommends adopting the industry practice of embedding software teams that are directly responsible to commanders at all levels in order to tighten the responsiveness loop.[15] An example of this is evident with the US Defence Digital Service (DDS), a related initiative to the DIB geared toward solving military IT problems.[16] Members of the DDS recently deployed to Afghanistan where they were able to work directly with users and code solutions to previously onerous manual tasks. This included a piece of software called ANET used for planning and tracking of mentorship activities. DDS was able to re-engineer the software, fix broken functionality, and optimize features to reduce report generation time from hours to minutes.[17]

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[12] United States of America Department of Defense, "Defense Innovation Board Recommendations," last accessed 29 January 2018, http://innovation.defense.gov/Recommendations/.

[13] *Ibid.*

[14] *Ibid.*

[15] *Ibid.*

[16] Issie Lapowsky, "Meet the Nerds Coding Their Way Through the Afghanistan War," last modified 27 May 2017, https://www.wired.com/2017/05/meet-nerds-coding-way-afghanistan-war/.

[17] *Ibid.*

10. While this provides an example of industry support to a deployed force, it is interesting to note that it did not require exotic skill sets and was seen as "pretty humdrum by Silicon Valley standards."[18] This indicates that such projects could be undertaken by organic resources while leveraging industry to solve the most complex problems. Ultimately, establishing core IT expertise does not require the military to do everything itself, but rather, find the best mix of uniformed personnel, public servants, and industry experts to support its needs, particularly considering deployability, continuity, and talent management issues. To that end, DoD is engaging in several initiatives, including:

a. Expanding the Secretary of Defense (SECDEF) Executive Fellows Program to "allow service members to serve in top industrial institutions – including places like Microsoft, Amazon, SpaceX, and Accenture."[19]

b. Seeking "Lateral Entry Authority" to allow services to recruit experts and specialists in "high skill; difficult to fill" positions to join the military at a mid-career level.[20]

c. Establishing a public-private talent exchange between the military/public service and industry, a similar concept to foreign military exchanges but targeted at technological knowledge sharing.[21]

d. Direct hiring of students and recent graduates into the defence public service and increasing authority to employ Highly Qualified Experts (HQE) in key positions.[22]

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[18] *Ibid.*

[19] United States of America Department of Defense, "Fact Sheet: Building the First Link to the Force of the Future," last accessed 28 January 2018, https://www.defense.gov/Portals/1/features/2015/0315_force-of-the-future/documents/FotF_Fact_Sheet_-_FINAL_11.18.pdf.

[20] *Ibid.*

[21] *Ibid.*

[22] United States of America Department of Defense, "Fact Sheet: The Next Two Links to the Force of the Future," last accessed 28 January 2018, https://www.defense.gov/Portals/1/features/2015/0315_force-of-the-future/Fact-Sheet-The-Next-Two-Links-to-the-Force-of-the-Future.pdf.

11. A more direct example of military IT workforce modernization is seen in the Israeli Defence Force (IDF). They recently established the *Matzpen Unit,* a military unit employing hundreds of experts and functioning as a software clearing house for the IDF.[23] Leveraging training received in IDF schools, they handle both major software acquisition and direct support to combat elements using open source software and custom code.[24] In addition, the IDF has established *Unit 3060,* a unit responsible for "developing data systems for intelligence officers" and includes a data science laboratory staffed by military personnel with close links to academia and the technology sector.[25] This unit leverages machine learning (ML) and AI to translate big data into intelligence, targeting information, and visualization in direct support of command decision making.[26] Both of these examples show that IT can function as a weapons system with the right competencies in place and that such competencies are not in the realm of the impossible for the military. Another advantage to this approach for the CAF would be that these types of units could be located in major technological hubs in big Canadian cities, thus providing a close link to local academia/industry and a recruiting base amongst the urban population.

Areas of Exploration for the CAF

12. Given the existing knowledge base in the CAF, it can adopt similar approaches to IT workforce modernization as the US and Israel by establishing new and expanding existing programmes. One strategy already in use by the CAF is attracting STEM undergraduates by offering paid education or debt relief in exchange for service. This programme could be

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[23] Ami Rojkes Dombe, "Software-Based Military," last modified 21 March 2015, http://www.israeldefense.co.il/en/content/software-based-military.

[24] *Ibid.*

[25] Nati Yefet, "Israeli Army Unveils Secret Data Science Unit," last modified 3 January 2018, http://www.globes.co.il/en/article-israeli-army-unveils-data-science-unit-1001218102.

[26] *Ibid.*

expanded to incorporate college diploma and post-graduate students to be considered alongside lateral entry and current compensation review initiatives. The key distinction with this strategy is the need to offer unique career paths to technical officers and non-commissioned members (NCM) tailored to specific roles, expectations, and requirements.[27] Marne Levine, Chief Operating Officer (COO) of Instagram and DIB member, sees a parallel in industry where STEM specialists are offered "a clear career trajectory and promotions within their area of expertise" instead of being "systematically disadvantaged in the promotion process and . . . [rarely being given] the right opportunities to develop, advance, and apply their skills and knowledge."[28]

13. Another possibility is to make better use of sponsored post-graduate studies, where the CAF can identify new fields of expertise applicable to strategic priorities and offer them to existing CAF members or new recruits with the requisite background. This need not be limited to post-graduate studies but could also target industry training certifications or college technical programs similar to the approach with CAF Cyber Operators. A key consideration is to ensure that future employment is not limited to a short period of work with the sponsor, but to make such programmes applicable to wider progression within the field. This would help to ensure that these members do not suffer from a "lack of utilization and continued development", which may entice them to leave for the private sector.[29] As Eric Schmidt, DIB member and Alphabet Executive Chairman, has noted by analogy: "the military will train experts such as pilots only to

[27]United States of America Department of Defense, "Defense Innovation Board Recommendations," last accessed 29 January 2018, http://innovation.defense.gov/Recommendations/.

[28]Military.com Network, "Defense Innovation Board Tackles DoD's Talent Management Woes," last modified 24 October 2017, https://www.military.com/dodbuzz/2017/10/24/defense-innovation-board-tackles-dods-talent-management-woes.

[29]*Ibid.*

force them out of their specializations and into other jobs if they seek to move up in rank", which can be a workplace dissatisfier.[30]

14. This does not negate the need for generalists or the development of cross-cutting competencies. Senior CAF leaders in technological roles require a balance of technical, managerial, staff, and leadership skills across different areas such as data science, IT support, software development, cyber operations, project management, etc; however, this proposal seeks to optimize talent usage by offering unique career paths based on goals, skills, and service requirements while removing barriers to advancement for occupations that may not fit the current mold. As Kilgallon remarks, "[n]ot all engineers want to manage, but most want to advance . . .[the military] could establish technical directors at each level of the hierarchy who would advise the program leadership on technical matters, and directly coordinate with lower level technical leadership to resolve issues."[31] These technical directors could follow a tailored path that sees them go "from program engineer to lead systems engineer to technical director at higher grade levels."[32]

15. Some of this analysis may sound focussed on officers; however, there are many opportunities applicable to NCMs. The military should investigate creating new occupations to address identified capability gaps as it did by creating Cyber operations trades and can further leverage allied experience in this area. Some examples include the US Air Force Computer

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[30] Aaron Mehta, "Pentagon Tech Advisers Want Special Career Track, 'Innovation Elevator' for Big Thinkers," last modified 26 October 2017, https://www.defensenews.com/pentagon/2017/10/26/the-pentagons-tech-advisers-want-special-career-track-innovation-elevator-for-big-thinkers/.

[31] John C. Kilgallon, "Shaping the Army's Information Technology Acquisition Workforce in an Era of Outsourcing," (Senior Service College Fellowship Paper, United States Army War College, 2009), 31, http://www.dtic.mil/dtic/tr/fulltext/u2/a511554.pdf.

[32] *Ibid.*

Systems Programming trade which employs NCMs in software development and the New Zealand Army Operational Support & Information Specialist trade that provides functional Information Management experts to Army units. The key consideration for NCMs is to rethink compensation. While the government will not able to pay as much as industry, compensation based on skills, experience, and most importantly, value created, should drive re-engineering of the pay system away from solely rewarding rank and tenure. Other areas to explore are fast tracking junior technical talents towards initiatives like the Army Technical Warrant Officer programme or creating similar technical specializations for lower ranks with appropriate incentives.

CONCLUSION

16. The CAF must look at IT workforce modernization as part of true organizational transformation and focus on establishing computer science as a core competency required for modern warfare. A useful comparison is provided by General Electric (GE); a former industrial company that foresaw strategic shifts based on the development of Internet technology, adapted accordingly by attracting talent from Silicon Valley, and thus, transformed its ability to remain competitive in the future.[33]

17. This paper has defined the need for similar organizational transformation in the CAF/DND. There is a need to decrease reliance on industry by using organic talent to improve acquisition, increase system supportability, quickly respond to user requirements, and guide maturation of next generation IT. This paper has looked at initiatives underway by US DoD and

[33]United States of America Department of Defense, "Defense Innovation Board Recommendations," last accessed 29 January 2018, http://innovation.defense.gov/Recommendations/.

the IDF to improve the recruiting and management of STEM talent as well as its employment in a military context. Lastly, it has looked at areas of exploration for the CAF to grow STEM expertise including tailored career paths, expanded education, and options for NCM trades. Ultimately, the CAF must pursue this transformation in order to maintain battlefield advantage and, as SECDEF General Mattis has remarked, "move at the speed of relevancy."[34]

RECOMMENDATION

18. Conduct a review of the structure and management of the CAF IT/STEM workforce as an adjunct to current human resources modernization initiatives such as the Journey.

[34]Issie Lapowsky, "Meet the Nerds Coding Their Way Through the Afghanistan War," last modified 27 May 2017, https://www.wired.com/2017/05/meet-nerds-coding-way-afghanistan-war/.

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