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Major Kim Marchand

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Revolutionizing the CME for Pan-Domain Operations: Unmasking Invisible Horses With Cultural and Structural Innovation

Major Kim Marchand

REVOLUTIONIZING THE CME FOR PAN-DOMAIN OPERATIONS: UNMASKING INVISIBLE HORSES WITH CULTURAL AND STRUCTURAL INNOVATION

AIM

1. What do barrier planning, water supply, heavy equipment operations, drafting and survey, geospatial analysis, force protection, and firefighting all have in common?[1] These disparate fields capture just a fraction of the broad, "jack-of-all-trades" expertise that defines the Canadian Military Engineers (CME), an attribute increasingly in demand across the pan-domain environment.[2]

2. This paper critically evaluates how the CME can transform into a more agile force by reforming legacy practices and embracing cultural, structural, and technological change. Failure to modernize risks leaving the CME – and Canada's military capacity – vulnerable to adversaries who already leverage digital, cyber, and pan-domain technologies to achieve decision advantage.[3] In line with strategic frameworks like Our North, Strong and Free (ONSAF), the Pan-Domain Force Employment Concept (PFEC), and Pan-Domain Command and Control (PDC2), the analysis offers actionable recommendations for senior leaders.

INTRODUCTION

3. The imperative to evolve is clear. The Department of National Defence (DND) and the Canadian Armed Forces (CAF) are undergoing a fundamental transformation. Through ONSAF, the CAF has committed to becoming a "digitalized and networked force" capable of operating across multiple domains.[4] This strategic direction, reinforced by PFEC and PDC2 framework, requires integration across air, cyber, land, maritime, space and the information environments.[5]

4. Three concurrent pressures drive this transformation. First, Great Power Competition (GPC) has evolved beyond conventional military rivalry to include hybrid warfare, where adversaries blend traditional capabilities with emerging technologies and information operations.[6] Second, climate change increasingly threatens legacy infrastructure and amplifies operational demands, particularly in Canada's Arctic region.[7] Third, rapid technological

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[1] MILENGCOE MilEngCoe Miltary Engineering Centre of Excellence, "NATO Military Engineering Centre of Excellence: Canada," Military Engineering Centre of Excellence, accessed January 17, 2025, https://milengcoe.org:443/nations/Pages/Canada.aspx.

[2] The Canadian Armed Forces employs the term "Pan-Domain" in PFEC, whereas some allies and partner militaries use "Multi-Domain" or "All-Domain". The concepts are effectively interchangeable.

[3] Canada. Department of National Defence, "Our North, Strong and Free: A Renewed Vision for Canada's Defence" (Ottawa, 2024).

[4] Canada. Department of National Defence, "ONSAF."

[5] Canada. DND, "Pan-Domain Force Employment Concept: Prevailing in an Uncertain World" (Ottawa: CJOC, 2023), 8.

[6] NATO, "NATO 2022 Strategic Concept" (Madrid, Spain, 2022), 2–4, https://www.nato.int/cps/en/natohq/topics_56626.htm.

[7] Canada. Department of National Defence, "ONSAF"; NATO Science and Technology Organization, "2023 Highlights Science and Technology Organization: Empowering NATO's Technological Edge" (NATO STO, 2023).

advancement – especially in artificial intelligence (AI), data analytics, and autonomous systems – is reshaping military capabilities and decision-making processes.[8]

5. The CME occupy a distinctive position in this evolving landscape. Their cross-command adaptability and diverse technical expertise – from geospatial analysis to infrastructure resilience – position them as natural enablers of pan-domain operations. However, maximizing this potential requires more than technological adoption. It demands systematic examination of legacy practices, structural barriers, and cultural assumptions that may impede innovation. This paper examines how the CME can evolve into a more adaptable force by:

a. Identifying and removing outdated practices ("invisible horses").

b. Strengthening interdisciplinary collaboration and knowledge sharing.

c. Implementing innovation pathways to provide targeted technological solutions.

DISCUSSION

Strategic context and drivers

6. The current security environment presents three interconnected challenges that directly impact CME operations. First, GPC has evolved beyond conventional military rivalry. Russia's actions both in Ukraine and the broader European theatre, and China's Arctic ambitions demonstrate how adversaries blend conventional capabilities with a diverse array of unconventional approaches, including cyber operations, critical infrastructure sabotage, and economic leverage. For example, recent reports highlighting how Russia has employed chartered vessels to damage critical undersea cable infrastructure, limiting the attributability of these attacks.[9]

7. The second challenge is climate change, which creates two distinct pressures on CME operations. The increased frequency of domestic operations (floods, wildfires, infrastructure failure) strains response capabilities, while evolving environmental conditions, particularly in the Arctic, threaten the stability and accessibility of legacy infrastructure.[10]

8. Third, technological acceleration, as identified in the NATO's Science and Technology Organization (ST&O) "2023 Highlights" [11] report, is reshaping military engineering through four key trends:

a. *Intelligent* through AI and autonomous systems.

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[8] NATO Science and Technology Organization, "2023 Highlights ST&O," 4–7.

[9] Raul Pedrozo, "Safeguarding Submarine Cables and Pipelines in Times of Peace and War," *International Law Studies* 106, no. 1 (January 23, 2025): 46, https://digital-commons.usnwc.edu/ils/vol106/iss1/2.

[10] Rodrigue Tanguy et al., "Pan-Arctic Assessment of Coastal Settlements and Infrastructure Vulnerable to Coastal Erosion, Sea-Level Rise, and Permafrost Thaw," *Earth's Future* 12, no. 12 (2024): 1–3, https://doi.org/10.1029/2024EF005013.

[11] NATO Science and Technology Organization, "2023 Highlights ST&O."

b. *Interconnected* via advanced networks.

c. *Distributed* across multiple domains.

d. *Digital* leveraging data and analytics.

9. This evolution demands new approaches to force employment and capability development, particularly in how we integrate emerging technologies while maintaining interoperability with allies. The NATO framework provides both validation of Canada's pan-domain approach and opportunities to accelerate capability development through allied cooperation.

CME capabilities and "invisible horses"

10. The CME's strength lies in its distributed expertise across the entire Canadian Armed Forces. True to their motto "UBIQUE," CME members serve throughout the CAF – primarily in the Canadian Army (CA) and Royal Canadian Air Force (RCAF), while also supporting the Royal Canadian Navy (RCN), Canadian Joint Operations Command (CJOC), and Canadian Special Operations Forces Command (CANSOFCOM).

11. This comprehensive capability spans Combat Engineers providing close support to maneuver units, Construction Engineers delivering critical infrastructure support, and Geomatics personnel enabling operations through spatial analysis. Rather than representing a dilution of expertise, this "jack-of-all-trades" approach has evolved to "pan-domain professionals".

12. However, maximizing these distributed capabilities requires identifying and addressing organizational "invisible horses" – legacy practices that persist through institutional inertia rather than operational necessity. Imagine this story.[12] In the spring of 1936, Admiral Henri Vallière conducted a tour of a recently modernized French artillery battalion stationed near Verdun. After transitioning from horse-drawn cannons to motorized artillery – significantly boosting mobility – the unit showcased it to the Admiral. During the demonstration, a truck carrying a 75mm field gun roared across the training ground. Soldiers swiftly unloaded the weapon, fired three precise rounds, and reloaded in under a minute. The Admiral praised the efficiency, then narrowed his gaze at two privates standing rigidly behind the truck, their hands clasped behind their backs.

a. "Captain Dubois," he asked the unit commander, "why are those men stationed there?"

b. "They're holding the horses, sir," Dubois replied.

c. "But there are no horses," the admiral countered.

[12] Loose interpretation of the metaphor used by Ben Zweibelson, a retired US Army Infantry Officer and program director for the JSOU 'SOF design and innovation' in: *Leading Design 1 | Ben Zweibelson, Philippe Beaulieu-Brossard & Imre Porkoláb | TEDxBudapestSalon*, 2020, sc. 1 minute, https://www.youtube.com/watch?v=e0MoANAQ_xY.

d. Dubois shifted uneasily. “The role was never reassigned. They’ve always stood there during drills – even after the trucks arrived.”

13. This anecdote resonates within today’s CME context, where certain practices and platforms persist despite evolving operational requirements. Practices can linger long after their original purpose disappears. These rituals – “invisible horses” – reflect outdated roles, systems, or assumptions that persist merely because “they’ve always been there.”[13]

14. Today’s CME faces similar challenges. The Expedient Route Opening Capability (EROC), developed during Afghanistan operations, exemplifies this. While route clearance remains crucial, as evidenced in Ukraine, the platform-centric approach may no longer align with emerging hybrid threats identified in NATO’s Strategic Concept 2022.[14] Similarly, Engineer Battle Training Standards, many rooted in Cold War scenarios, require reassessment against ONSAF’s vision of a “digitalized and networked force.”

15. Design Thinking methodology offers a structured approach to identifying these “invisible horses.” By questioning established processes and challenging inherited assumptions, the CME can better align capabilities with pan-domain requirements. This involves:

a. Evaluating legacy systems against Emerging and Disruptive Technologies (EDT).

b. Reassessing traditional command structures in consideration of distributed operations.

c. Reviewing training standards through a multi-domain lens.

d. Identifying opportunities for AI and data analytics integration.

16. Ultimately, uncovering “invisible horses” requires systemic reframing: empowered engineers who challenge inherited norms can align CME structures, methods, and capabilities more closely with emerging realities. By stripping away these vestigial habits, the CME aims to foster a culture of innovation, ensuring that legacy procedures are not perpetuated to the detriment of efficiency, safety, or adaptability.

Knowledge Sharing and Interdisciplinary Collaboration

17. The CME’s distributed expertise across multiple commands presents three distinct modernization challenges. First, while this pan-CAF presence enables natural cross-domain integration, it complicates standardization of new technologies and processes. For example, Construction Engineers supporting RCAF operations may develop innovative solutions that could benefit Combat Engineers in the CA, but no formal mechanism exists to share these advances.

[13] AOD Network, *Breakaway: Reframing to Prevail – The Archipelago of Design*, sec. 1, accessed January 15, 2025, https://aodnetwork.ca/breakaway-reframing-to-prevail/.

[14] NATO, “NATO 2022 Strategic Concept.”

18. Second, knowledge sharing between specialized elements remains fragmented. Combat Engineers, Construction Engineers, and Geomatics personnel each possess unique expertise that could benefit the others, but collaboration often relies on informal networks rather than structured systems. This is particularly evident in areas like infrastructure resilience, where Construction Engineers' expertise could enhance Combat Engineers' field fortification capabilities.

19. Third, the absence of a unified innovation framework makes it difficult to coordinate and scale successful pilot projects across commands. While individual units may develop effective solutions – from advanced route clearance techniques to improved infrastructure management – the broader organization lacks systematic ways to evaluate and implement these innovations branch-wide.

20. However, these challenges are balanced by significant opportunities. The CME's comprehensive capability set – spanning combat engineering, construction engineering, geomatics, and specialized functions – provides natural pathways for innovation. For example, geomatics expertise traditionally focused on battlefield analysis could be leveraged for infrastructure lifecycle management and predictive maintenance.

21. The branch's training establishments, including the Canadian Forces School of Military Engineering and the School of Military Mapping, offer platforms for testing and validating new approaches. Additionally, specialized units like 1 Engineer Support Unit provide advanced technical engineering support that can be leveraged for both domestic and expeditionary innovation.

22. Success in modernization requires balancing innovation with core engineering excellence across all CME elements. This involves:

a. Developing clear governance frameworks for technology adoption.

b. Establishing formal knowledge-sharing mechanisms across commands.

c. Creating structured pathways for scaling successful innovations.

d. Maintaining strong connections with industry and academic partners.

Implementing Innovation pathways

23. The CME can advance its modernization through three interconnected pathways: professional networks, academic partnerships, and federal programs.

24. The branch's extensive professional network, including retired members in industry and academia, provides natural bridges between military requirements and technological solutions. Many former CME members occupy strategic positions in both public and private sectors, offering valuable insights into emerging technologies and cost-effective solutions. This network can be formalized through semi-annual military engineer industry symposia, creating structured opportunities for knowledge exchange.

25. Academic partnerships, particularly through RMC, CDA and Canadian universities graduate programs, offer a second critical pathway. These institutions can tackle real-world engineering challenges while maintaining academic rigor. For example, prior postgraduate studies during Op REASSURANCE ROTO 9 (2018) produced valuable operational insights that can be expanded through structured case studies and research partnerships.

26. Initiatives such as The Innovation for Defence Excellence and Security (IDEaS) and Mobilizing Insights in Defence and Security (MINDS) programs provides a third structured pathway for piloting novel concepts.[15] This pathway can help bridge gaps between operational requirements and emerging technologies.

27. Success through these pathways requires balancing innovation with core engineering excellence. The CME must foster a culture that encourages rapid experimentation while maintaining professional standards and safety protocols. This involves:

a. Developing clear evaluation criteria for new initiatives.

b. Establishing formal knowledge-sharing mechanisms.

c. Creating structured pathways for scaling successful innovations.

d. Maintaining strong connections with industry and academic partners.

CONCLUSION

28. The Canadian Military Engineers stand at a critical juncture where their distributed expertise across multiple domains positions them uniquely to support pan-domain operations. Their comprehensive capability set – spanning combat engineering, construction engineering, and geomatics – provides natural pathways for innovation and cross-domain integration.

29. However, maximizing this potential requires addressing three key areas. First, the identification and removal of "invisible horses" – legacy practices that persist through institutional inertia rather than operational necessity. Second, the strengthening of knowledge-sharing mechanisms across commands and specialties. Third, the development of clear innovation pathways that balance rapid experimentation with engineering excellence.

30. The CME's transformation from "jack-of-all-trades" to "Maven-of-all domains, pan-domain professionals" requires deliberate cultural and structural changes. Success depends on consistent alignment between top-down vision – expressed in ONSAF, PFEC, and PDC2 – and grassroots-level ingenuity.

[15] "How IDEaS Works - Canada.Ca," accessed January 15, 2025, https://www.canada.ca/en/department-national-defence/programs/defence-ideas/how-ideas-works.html; National Defence, "Mobilizing Insights in Defence and Security (MINDS)," December 16, 2020, https://www.canada.ca/en/department-national-defence/programs/minds.html.

RECOMMENDATIONS

31. This paper proposes a set of integrated recommendations that prioritize rapid modernization while preserving the core engineering excellence of the CME.

a. First, academic partnerships must be formalized with key research institutions such as the CDA, RMC and Canadian universities. By establishing enduring alliances with these and other academic bodies, the CME can facilitate the rapid prototyping of innovative engineering solutions. Such collaborations will not only provide access to cutting-edge research and advanced methodologies but will also stimulate a direct transfer of knowledge from academia to operational practice. This synergy is essential for bridging the gap between emerging research and the tactical needs of pan-domain operations.

b. Moreover, creating an environment that supports both bottom-up, lateral and top-down innovation is critical. The CME should adopt policies that empower unit-level personnel to spearhead groundbreaking ideas and implement experimental projects in a timely manner. Streamlining bureaucratic procedures and designating central oversight by senior leaders will help coordinate these grassroots initiatives. In doing so, the organization can ensure that innovative concepts are efficiently scaled and successfully integrated across different commands. Support mechanisms – such as dedicated seed funding and expedited approval pathways – will provide the necessary impetus for these experiments to transition into operational solutions without losing momentum.

c. A measured approach to modernizing legacy systems is also imperative. The CME must implement clear governance frameworks that set strict criteria for evaluating and replacing outdated platforms. New technologies, including advanced data analytics, AI-driven tools, and digital management systems, should only be adopted where there is demonstrable operational benefit. Concurrently, legacy systems that no longer contribute effectively should be phased out promptly. Targeted investment in interoperable and flexible technologies will enhance the branch's current capabilities while securing its competitive edge in a rapidly evolving security landscape.

d. Finally, fostering a robust culture of collaboration and innovation is essential to sustain these efforts over time. Establishing structured mechanisms for cross-functional knowledge sharing and regular engagement with industry experts, academic researchers, and internal stakeholders will create a continuous feedback loop that drives systematic improvement. By cultivating an environment where best practices are shared, and innovative ideas are embraced – rather than merely tolerated – the CME can successfully transition from a traditional "jack-of-all-trades" model to becoming "Maven-of-all trades, pan-domain professionals".

32. In conclusion, these recommendations offer a comprehensive pathway for the CME's transformation. Formalizing academic alliances, empowering dynamic innovation, modernizing legacy systems, and nurturing a collaborative culture are all essential elements that ensure the

CME remains at the forefront of operational excellence in an increasingly complex pan-domain security environment.

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