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RECONSIDERING LINES OF MAINTENANCE

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AIM

1. This service paper recommends the elimination of lines of maintenance in the Canadian Army. Adaptability is at the core of the recommended change and is anchored on a need to reverse the tendency to centralize control of maintenance activity. An objective view is taken of the transient nature of the Army and a scientific approach to warfare, rather than attempting to reshape antiquated processes and procedures of Land Equipment Management System (LEMS). This text is meant to be a thought piece and as such, detailed adjustments of personnel, tooling and infrastructure would require additional consideration.

INTRODUCTION

2. The Corps of Royal Canadian Electrical and Mechanical Engineering (RCEME) is currently restructuring LEMS doctrine, after years of neglect, as part of a multi-faceted strategic initiative.[1] Thus timely are the recommendations suggested herein as they diverge sufficiently from the status quo to generate debate. The central theme of this service paper is the necessity for continual adaptability of LEMS. Its main recommendation rests with the elimination of lines of maintenance for it holds potential to yield a more responsive and relevant tactical maintenance system that will hold true to the tenets of LEMS.

3. The growing dissonance between the demands of the future of warfare and the seemingly rigid structure of LEMS will firstly be explored. Expected of this analysis, which will necessitate a fiercely short though relevant sidestep into academic literature, is a clear understanding of the requirement for adaptive organizations with flexible processes and procedures. Counter-

[1] Department of National Defence, B-GL-342-005/FP-000, *Strategic Management Plan: Horsepower for the 21st Century* (Ottawa: Director of Royal Canadian Electrical and Mechanical Engineering, 2014).

intuitively, it will address the necessary reversal of the tendency to centralize control of LEMS. Next, a brief overview of the origins of lines of maintenance before ending with the recommendation to remove such lines in favour of enhanced unit level maintenance capability and decentralized control.

DISCUSSION

The Counter Productive Rigidity of LEMS

4. LEMS[2] is too rigid of a system to remain effective today, let alone in the future, and shows no indication of letting go of the firm and centralized control it attempts to exert over equipment, the organizational structures that support it, and the people that fix it – the Corps of RCEME amongst others[3]. In contrast, the future is expected to demand greater adaptability of organizations and systems as they adjust to the evolution of technology and the uncertainty of the types of warfare. More strikingly, a reversal of trend in centralizing control is needed in order to promote adaptability. These ideas are expanded upon below.

5. A dramatic increase in flexibility is needed for LEMS to remain responsive to the equipment needs of the Canadian Armed Forces operations, and RCEME to remain relevant as its choice provider of land equipment maintenance activity. As a principle of sustainment[4], flexibility here relates to the adaptability of LEMS processes and structure of maintenance

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[2] Department of National Defence, B-GL-300-004/FP-001, *Sustainment of Land Operations* (Ottawa: DND Canada, 2010), 4-1. LEMS is "a fully integrated, coordinated and self-sufficient system that encompasses the entire spectrum of equipment management and is designed to support equipment from the factory through to the most forward fighting elements". Featured in this service paper is principally the tactical level of maintenance activities, organizations and procedures; therefore the latter portion of the definition of LEMS provided here from *Sustainment in Battle*.

[3] This study could be expanded upon to capture all elements that conduct maintenance activity of land based equipment such as the Royal Canadian Corps of Signals and, as a new dimension to LEMS, those in charge of repairing aviation assets in direct support to the Army. This study will, however, focus on RCEME when considering the providers of maintenance activity within LEMS.

[4] Department of National Defence, *Sustainment of Land Operations*, 2-2.

organizations, and perhaps most importantly, flexibility of mind. How can the alleged rigidity of LEMS be substantiated in a present environment of necessary accountability, which, intuitively, would demand order, predictability and control over military activity? It would seem that the Army would be best served by a centrally controlled equipment management system that delivers predictable and measurable results through a methodical approach and clear delineation of responsibilities of maintenance activity. After all, as Senior Lecturer in International Relations Antoine Bousquet suggests, "the practice of warfare can [be] understood as the attempt to impose order over chaos, to exert control where it most threatens to elude, and to find predictability in the midst of uncertainty".[5] An attempt to exert control is precisely what exists now within the LEMS and it apparent by its rigidity. One should consider the clear and ingrained distinction of organizations, tooling, parts, technician qualifications and infrastructure between a unit maintenance element and the one formed in its parent formation. Further indication of rigidity comes from the monumental inertia to change that stems from the long standing compartmentalization of technical trades, hierarchal structures of maintenance organizations, culture of self preservation of role, and inflexible establishment of contractual support for the furnishing of parts. While there is merit in imposing structure to attain control and predictability – and some comes from external sources such as the Army driven limits on training days -, it comes at the immense cost of inertia to change and a stagnant system structure.

6. Evidence of change does exist in the recent RCEME Strategic Vision[6], which addresses issues within LEMS. The problem lies in the inherent inflexibility that is built in; witness the quest to accurately pin point ideal career progressions, the development of standard operating procedures, and the development of future force employment concepts for purposes of predicting

[5] Antoine Bousquet, *The Scientific Way of Warfare* (New York: Columbia University Press, 2009), 10.
[6] Department of National Defence, *Strategic Management Plan ….*

solutions. While the strategic vision is a refreshing instance of wanting to adapt, its focus rests on the notion that a neatly organized and prepared command and control structure will enable the lower levels. Missing is the notion that lower levels, given the right latitude, can enable the higher levels of the structure. This idea of decentralized control will be unfolded in the next sections.

Scientific View of Warfare – Embracing Chaos

7. In *The Scientific Way of Warfare*, Antoine Bousquet compacted centuries of scientific development into a series of useful metaphors to understand its impact on militaries and the conduct of warfare. These metaphors include the clock, the engine, the computer and the network, and each will be summarized below and brought into the context of LEMS.

8. The clock represents the predictable sequencing of battlefield actions to circumvent the inability to communicate on battlefields of past centuries. It seeks to "reduce individual initiative"[7], as Frederick the Great sought to accomplish, and promote predictability of action. The clock metaphor also "scrutinizes individual parts [of a system] or sequences of events that could be reliably distinguished, measured, and compared […]"[8] – the aforementioned rigidity of LEMS resonates in Bousquet's definition.

9. The thermodynamic properties of the engine speak of increased fluidity of military action, but also "[reversed] the relationship of the labourer to his tools".[9] The engine brought the automation of processes, unprecedented mobilization of soldiers, and a level of unpredictability caused by a departure from mathematical precision of clockwork to the mathematics of

[7] Antoine Bousquet, *The Scientific Way of Warfare*, 56.
[8] *Ibid*, 42.
[9] *Ibid*, 67.

probability inherent to the science of thermodynamics[10]. It is the engine and the industrialization that surrounded this technology that brought the railway, the vehicles, and the increased lethality and firepower on the battlefield. Along with these came the necessity the predictably sustain large forces and ergo Moltke's three-tier supply system that is featured further in this text. The mechanization of forces stemming from the development of the engine also marks the birth of the founding elements of LEMS in the Canadian Army.

10. The computer was invented, in part, to establish control over uncertainty inherent of thermodynamic science and the management of increasing amount of battlefield information. The computer brought about the concept of cybernetic warfare, which was immense progress in the management of information and relied on a closed loop of feedback and has extensively satisfied, though not extinguish, the eternal quest for additional information and ways to control actions. Command and control systems depend on information management and seek to attain a measure of order by its ability to do so. Of course a myriad of applications stemmed from the advent of computers and continue today to be featured. But the issue at hand is "the inherent limitations of [cybernetic warfare in its] attempt to make war into an entirely controllable and predictable activity".[11] This is where the development of the LEMS framework has, presumably, stagnated; there is no leniency for disorder or chaos. It is thought that there is a direct correlation on increased LEMS responsiveness and the maximizing of amount of information pulled from the very lowest level to the top, where control is centralized.

11. Lastly, the current scientific development of warfare is seen through the image of a networked environment in which systems can flourish amid chaos using decentralized

[10] *Ibid*, 70.
[11] *Ibid*, 161.

command.[12] A fulsome exposition of complexity theory to understand Bousquet's point is outside the scope of this paper. A few key concepts worth outlining are expanded upon below.

12. "Chaos breeds life, when order breeds habit".[13] Chaos does not mean a complete lack of order. Rather, chaotic models obey deterministic laws that may have been omnipresent in hidden patterns. The patterns may be quite simplistic though present in individual components of a system. It is the congregation of these components in which complexity arises. Consider here a parallel with the popular axiom in RCEME speak: "we are a regiment of many small units".[14] Because "disorder finds its own order"[15], tight control imposed from the top down onto the many small units may well be hindering the attainment of a larger scale order that would presumably be more suitable and adaptable than the present status.

13. "Nature is fundamentally non-linear"[16] despite science's early attempts to breed order and linearity. Complex systems need to be adaptive to survive. The study of non-linear systems indicates that the modification of the system's behaviour and indeed its very structure through "positive feedback"[17] is a possible and desirable function. This is crucial to the understanding of complex systems; by their very nature they are adaptive and not necessarily bound by a pre-determined desired fixed state. LEMS is a complex system though is currently bound by pre-determined ideals, set parameters, artificial administrative and bureaucratic impositions and a range of aspects of rigidity as previously stated.

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[12] Antoine Bousquet, *The Scientific Way of Warfare*, 161.
[13] *Ibid*, 163. Henry Brooks Adam quoted by Bousquet.
[14] Department of National Defence, *Strategic Management Plan ….*
[15] Antoine Bousquet, *The Scientific Way of Warfare*, 169.
[16] *Ibid*.
[17] *Ibid*,165. Positive feedback "is present when disturbances are amplified and thus move the system further away from its point of origin", a behaviour that is certainly alien to anyone wanting predictability. Negative feedback, on the other hand, is what is typically considered as the input of a system in which the latter stabilizes itself to a desired equilibrium.

14. The recent apparition of Network centric warfare (NCW) falls short of desirable outcomes and misses the point of complexity theory. Bousquet explains that the growing popularity among military theorists on NCW has value in that it promotes the establishment of networks – a necessary condition for decentralized control. The problem lies in that NCW has enhanced the ability to exercise centralized control by linking sensors, shooters and decision makers, thus giving commanders a sense of knowledge and *control* of the battlespace. Again, information superiority seems to be the aim and a consequence is the necessity in having complete faith in networks for higher command tiers to exercise command and control.[18] A simple though relevant case in point in LEMS is the increasing emphasis on quasi-real time pull of data from the lower levels – via the system of record of the day -, which falls short once a formation deploys in the field. Connectivity loss instantly stymies the best laid plans and forces a return to ad hoc and decentralized actions from technicians who want nothing but serviceable equipment in the hands of operators. Interestingly, the default setting when disorder, or chaos, arises, is exactly what Bousquet is suggesting; the lower levels contribute to finding solutions, which in turn establishes a level of stability, or order, to the greater system.

15. Lastly is the idea that "evolution thrives in systems with a bottom-up organization, which gives rise to flexibility".[19] This does not discount the need for top down direction and control measures, though opens the dialogue to a counter intuitive idea that decentralized and semi-autonomous systems "can operate more effectively and with great degree of adaptability".[20] Decentralized control needs a network to function and the system must permit lower levels of

[18] *Ibid*, 219-222.
[19] Antoine Bousquet, *The Scientific Way of Warfare*, 180. Prirogine and Stengers quoted by Bousquet.
[20] *Ibid*, 182.

hierarchy to explore, adjust and develop suitable structures and processes.[21] This is far from reality within the LEMS framework; centralized control is fiercely sought and lower level autonomy is extremely limited. Consider the relative simplicity of a brigade level exercise in which rather intuitive solutions to resource and structural issues are stymied by centralized control measures such as administrative rights to systems of records, cumbersome task order control spreadsheets, scales of parts issue dictated by higher command, and a myriad of other facets that leave maintenance organizations but a grouping of technicians at the mercy antiquated processes.

16. When referring to these metaphors, it would seem that LEMS doctrine was structured to be like clockwork of discrete and calculated movement, established during the early period of the engine, was patched to function during the informational age of the computer, and has since failed to accept the potential of decentralization of control and the value of adaptive systems. A suggestion follows in which these very aspects are featured.

Removal of Lines of Maintenance

17. Lines of maintenance were created, certainly for the Allied Forces, during the First World War.[22] The basic principle was to ensure expediency and light foot print of the forward units with the provision of recovery assets and resources for light repairs. "Working reward, maintenance support [was] progressively provided by better equipped, and more sophisticated

[21] *Ibid*, 210. Here Bousquet refers to the concept of swarming and uses the analogy of an ant colony. While individual ants are unaware of the entirety of information surrounding its activity, the collective input for multiple ants results in an efficient system.

[22] Murray C. Johnston, *Le 50^e^ des artisans du Canada* (Borden: Fond Des Officiers Du GEM, 1997). Col Murray Johnston provides in his book a detailed account of the development of the British and Canadian maintenance organizations and procedures. No evidence is shown of attempts to organize maintenance resources in ways that differ considerably from having established lines, whereby there is an increasing deliberate nature of repairs as equipment is moved rearwards in the linear battlefields of both World Wars.

static [workshops]".[23] Historian Martin Van Creveld suggested that in fact a "three-tier supply system" had been created in the mid 19th century by Moltke the Elder, the Chief of Staff of the Prussian Army who sought to make more effective use of marching armies[24]. Albeit Moltke's system was focused on basic needs that preceded the necessity of spare parts, the general concept remains in use today. It is the marriage of convenience between the lines of supply and lines of maintenance that, in part, creates inertia of thought that inhibits the consideration of alternate delivery methods of equipment maintenance.[25]

18. Worthy of consideration is the removal of lines of maintenance at the tactical level. Conceptually, there would be a significant decrease of second line maintenance assets in favour of a moderate increase at the unit level. The latter would perform all repair functions of the tactical level with perhaps surge capability at the formation level. The potential is tremendous:

a. Increase of unit level commander influence and responsibility over the operational capability of his/her force. This could foster "equipment culture", a goal of the RCEME Strategic Vision[26];

b. Enable an increase in decentralization of control of maintenance resources, thus overall adaptability of LEMS. Commensurate latitude, within boundaries, would need to be given to unit maintenance organizations, or perhaps to formation level headquarters to adapt structures, procedures and processes;

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[23] Department of National Defence, B-GL-314-002/FP-001, *Maintenance in Battle: Volume 2* (Ottawa: DND Canada, 1989), paragraph 9.

[24] Martin Van Creveld, *Supplying War: Logistics from Wallenstein to Patton* (Cambridge: Cambridge University Press, 1977), 116.

[25] The composition of maintenance elements in each of the lines of maintenance changed somewhat during the World Wars and later with the creation of the Service Battalions in the late 1960s. However, the basic idea remains the same.

[26] Department of National Defence, *Strategic Management Plan …*. First Line of Operation of the RCEME Campaign Plan.

c. Empower, thus engage technicians to participate in the collective goal of adapting the organization and its processes. Anecdotal evidence indicates that technicians currently feel so constrained by the system that they are disengaged and therefore has led to weak organizations[27];

d. Simplification of management of parts, tooling and equipment. The intricate mixture of first line and second repair functions and part requirements currently renders a wholly inefficient maintenance process. One repair can straddle geographically distant organizations, supply and technical administration processes, and chains of command. This would require a divorce of LEMS from the traditional sustainment lines featured in the current doctrine;

e. Respects all of the time-tested tenets of LEMS.[28] Notably, equipment would be repaired as far forward as possible; and

f. Provides a first step in the creation of an adaptive complex system needed for LEMS needs to cope with the elusive and transient nature of the future of warfare. It could spark a much needed culture change towards adaptability.

CONCLUSION

19. The aforementioned current state of the LEMS framework bears repeating; it promotes centralization of control through a draw of information from the lowest levels, it suffers from

[27] Based on the author's experience in commanding technicians.

[28] Department of National Defence, B-GL-342-001/FP-001, *Land Equipment Management System* (Ottawa: Director of Army Doctrine, 2001), 7-8.

inertia to change by way of rigidity in structure, processes and culture, and attempts to "tinker with the inner structure of its framework in order to preserve it"[29].

20. To remain responsive to the needs of the Canadian Armed Forces, the LEMS framework should be thought of as a complex adaptive system. It would be prudent to consider reversing the trend of centralization of control. Affording an element of decentralized control of maintenance assets, structures and processes could assist in creating an adaptive LEMS – one that favours solutions from the bottom up.

21. A recommended initial step in this direction is the migration of tactical maintenance functions to the unit level by the removal of lines of maintenance. It would assist in holding commanders accountable for their equipment readiness, afford simplicity of execution, enable the move toward decentralized control of maintenance activity, and lessen morale-dropping system constraints.

[29] Antoine Bousquet, *The Scientific Way of Warfare*, 190.

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