

LEMS JOURNAL

LAND EQUIPMENT MANAGEMENT SYSTEM JOURNAL

ISSUE 4

FEBRUARY • 2020

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National
Defence

Défense
nationale

Canada



MAINTENANCE 2.0

What does the future of maintenance in the Canadian Armed Forces look like?
MGen (Retd) Eldaoud has some interesting questions and challenges
to pose to you, the maintainer.

Read the letter on page 7.

Photo credit: Cpl Genevieve Beaulieu, LATVIA Imagery Technician.



Cover Photo: A member of 2nd Battalion, Princess Patricia's Canadian Light Infantry
in a Light Armoured Vehicle during Exercise KAPYONG MACE at CFB Shilo.

Photo credit: MCpl Louis Brunet, Canadian Army Public Affairs.



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LEMS Journal is an unofficial publication of the Canadian Armed Forces published by the Director General Land Equipment Program Management. The content of each article represents the views of the author or authors and does not necessarily represent official policy or opinion. The distribution of LEMS Journal is mainly done electronically. A digital version of this issue can be found at <https://www.canada.ca/en/departement-national-defence/corporate/organizational-structure/assistant-deputy-minister-materiel.html>. Unless noted otherwise, articles within this publication may be reprinted. Proper credit and a courtesy copy of the reprinted material would be appreciated.

ISSN Number: 2561-5874 Bilingual printed version



DIRECTOR GENERAL'S COMMENTS

Adapting to the Changing Environment

By BGen Rob Dundon

As Director General Land Equipment Program Management (DGLPEM), I am honoured once again to have the privilege of introducing the Land Equipment Management System (LEMS) Journal.

The well-written articles of this fourth issue continue to place emphasis on the importance of studying emerging technologies that undoubtedly will play a crucial role in our future defence capabilities. In this issue and future issues, if you expect to continue

seeing articles discussing topics such as Additive Manufacturing (AM) and Artificial Intelligence (AI), you are not likely to be disappointed.

Switching gears from conceptual to current capability, we continue to see great success in both the delivery and furtherance of Major Capital Projects. It is important that we have a venue such as this to share and learn from our collective experiences.

Since the last issue, the geopolitical atmosphere both domestically and internationally has changed. Whether it be the election of a minority government at home, or bold actions taken in the Middle East that threaten fragile peace and stability in the region, it is vital that we – as experts within our domains – strive to maintain both an awareness and understanding of how

this affects our business. How quickly we adapt to the changing environment can mean the difference between success and failure.

Finally, I would be remiss if I did not highlight the excellent work that some of our members are doing on outside of Canada (OUTCAN) postings in the service of our nation. I was delighted to read about these experiences and believe that it serves great purpose to share some of what is happening with our closest allies.

To all those who contributed to the publication of the issue, I send you my sincerest gratitude for a job well done.

NEXT EDITION

LEMS Journal is your forum for putting forward ideas, commenting on current or past articles, and sharing related experiences. The next edition of the *LEMS Journal* will be published in the summer of 2020. If you want to be a part of the next edition, please send your articles – or your ideas for articles – to LEMSJournalSGET@Forces.gc.ca no later than **April 15, 2020**.

Light Armoured Vehicle Upgrade Project Extends Usage By 15 Years or More

By Jacques Gobin

On July 22, 2019, eight months ahead of schedule, the Light Armoured Vehicle Upgrade Project (LAVUP) achieved a major milestone with the acceptance of its final vehicle delivery. Over a period of six-and-a-half years, the project upgraded 550 vehicles for the Canadian Army (CA). These upgrades will extend the life of the vehicle platform to at least 2035 — and will ensure that our soldiers are provided with the best equipment possible for today and tomorrow.

The Light Armoured Vehicle III (LAV III) originally entered Canadian service in 1999. The following year the US Army selected a derivative of the LAV III, which it eventually called the Stryker, for its rapid deployment capability. The LAV III performed extremely well on domestic and international operations, notably in Afghanistan. Lessons learned from operations led to increased stowage, add-on armour, and added vehicle and crew protection kits, all of which greatly increased vehicle weight. The resulting requirement for better mobility, and technological advances in day and night sensors and fire control systems, led to the initiation of LAVUP in 2009.

LAVUP improved the protection, mobility, and lethality of the LAV III platform, while maximizing command support and human interface factors. This 550-vehicle upgrade out of a total of 651 units in the LAV III fleet assures that the CA's flagship fleet will remain successful in the Army of Tomorrow's Contemporary Operating Environment. Separate projects are upgrading most of the balance of the fleet. The Light Armoured Vehicle Reconnaissance Surveillance System project is modifying 66 more vehicles and the Airspace Coordination Centre Modernization project has modified five of the vehicles.

A delivery period extending past six years is not typical for a vehicle project. But, as LAVUP is an upgrade project, this meant that the CA had to withdraw LAV IIIs from service in order to be improved. The rate at which the Army could withdraw vehicles while still having enough to conduct operations and training meant a longer-than-usual delivery period. The tipping point was reached in 2016 when the CA Commander designated the upgraded LAV — now known as the LAV 6.0 because of the nomenclature of the drivetrain — as the operational fleet. The Canadian Armed Forces subsequently deployed the LAV 6.0 to Operation REASSURANCE,

specifically for the NATO Enhanced Forward Presence Battle Group in Latvia.

Notwithstanding the lengthy delivery schedule, the design of the upgraded vehicle was done in a relatively short time, with the intent of having upgraded vehicles more rapidly available for operations. The result of this condensed development period was that a small number of non-critical items, such as cable brackets, were not installed on the production line. Instead, the vendor — General Dynamics Land Systems-Canada (GDLS-C) based in London, Ontario — has deployed field service representatives to Canadian Army locations to install these items post-delivery. This retrofit schedule extends to early 2021.

The Canadian Light Armoured Vehicle program is a global success story going on 20 years. It typifies all of the elements of Canada's defence policy: strong at home, secure in North America and engaged in the world.

Jacques Gobin is from Winnipeg. He retired from the Canadian Armed Forces in 2016, having served 31 years as a RCME officer. He joined the Public Service in 2016 as the Project Manager for the Light Armoured Vehicle Upgrade project.



Modernizing Night Vision in the Canadian Armed Forces

By Roman Kaufman

Strong, Secure, Engaged: Canada's Defence Policy is the driving force behind many projects in Assistant Deputy Minister (Materiel). The Night Vision System Modernization (NVSM) project is one example, initiated to address the availability and quality of night vision equipment for soldiers and sailors. To complete the task, the NVSM project works with the Director of Land Requirements and the Director of Naval Requirements, among other stakeholders, capturing needs from the two Canadian Armed Forces (CAF) elements within one procurement strategy.

The NVSM project will offer a number of fixes and improvements, principally:

- Addressing technical deficiencies in the current night vision capability by matching our allies' capabilities for detecting, recognizing, and identifying targets;
- Ensuring we surpass our adversaries' capabilities;
- Increasing our ability to distinguish friendly, hostile, and neutral forces to improve our situational awareness;
- Increasing our ability to navigate terrain, on land and at sea, in both low light and zero light conditions;
- Reducing weight and bulkiness to decrease the burden on soldiers and sailors; and
- Providing our troops with the ability to communicate information to commanders, near and far, while considering the cognitive burden.

The first major success of the project was the procurement of Monocular Night Vision Devices (MNVD). The contract for these was awarded to CADEX Defence and announced by the Minister of National Defence during CANSEC 2019. The

MNVDs are an improvement on our current in-service PVS-14, with a longer battery life, less weight, less bulkiness, and a white optical viewer. The next step will be to receive 300 kits and distribute them to reserve units.

The project encompasses three types of soldier-borne equipment: Image Intensifiers (I²), thermal imagers, and laser-aiming devices. Requirements for weapon, vehicle, and vessel-mounted devices will be addressed through other projects.

Canada's defence policy provides clear direction on Canadian defence priorities over a 20-year period. The policy acknowledges that the international landscape is marked by the shifting balance of power, the changed nature of conflict, and the rapid evolution of technology. These trends undermine the traditional security once provided by Canada's geographical borders. The NVSM project will address the following priorities identified in SSE:

- Field an agile, highly trained, flexible, diverse, combat-ready military;



- Act as a responsible, indispensable partner with NORAD, NATO, Five-Eyes Partners;
- Field state-of-the-art capabilities to keep pace with allies and to maintain an operational advantage over adversaries; and
- Address the threat stemming from terrorism and actions of violent extremist organization, including those in ungoverned spaces.

The project will provide the Regular Force and Primary Reserve Forces with state-of-the-art equipment. This will offer a vast improvement on the capability offered by our current, obsolete, night vision equipment. The Royal Canadian Navy will also receive this augmented night vision capability. The project is working confidently to deliver in 2025.

Roman Kaufman is Systems Engineering Manager, Night Vision System Modernization.

Progress Being Made on **Soldier Operational Clothing and Equipment Modernization**

By Eric De Lafontaine

Some 600 soldiers at 4th Canadian Division Support Base (4 CDSB) Petawawa are standing out as they help the Canadian Armed Forces test a new Canadian Disruptive Pattern (CADPAT) to help in the selection of a replacement camouflage for the current iconic woodland (green) and arid (tan) CADPAT patterns.

The original distinctive CADPAT, revolutionary for its time, was developed in 1997. Since then, a number of advances have been made in camouflage research – specifically protection from detection by infrared and other night vision systems. The CADPAT pattern is most closely associated with the Canadian Army but Royal Canadian Navy and Royal Canadian Air Force personnel also wear it when they work within Army lines. The MultiCam pattern worn by Canadian Special Operations Forces personnel is not being replaced.

Since the end of September 2019, 3rd Battalion, The Royal Canadian Regiment, has been wearing coats and

trousers, shell fragmentation protective body armour, bush caps, helmet covers, and rank patches in the “Prototype J” mid-spectrum pattern.

This new four-colour pattern falls in the middle of the camouflage spectrum, not overly emphasizing brown or green tones.

While there have been more than a dozen patterns tested, this is the first one to be taken out of a lab and tried out using real soldiers who are undergoing rigorous training for overseas operations. There will likely be adjustments made to the pattern resulting from this trial.

The test period will last until July 2020. During this time, the Human Factors Support Cell from the Soldier Systems Directorate within Director General Land Equipment Program Management will seek user feedback about the “Prototype J” pattern by conducting large-scale questionnaires. The team will also conduct data collection, focus groups, and 3D body scanning to define how the current operational uniform and personal equipment can be improved.

This study will also seek feedback from soldiers of smaller stature, including but not exclusively women, to ensure

that the next generation of clothing and equipment fits the widest variety of soldiers possible.

The Soldier Operational Clothing and Equipment Modernization (SOCEM) project, led by the Canadian Army Director of Land Requirements in cooperation with Assistant Deputy Minister (Materiel) and Defence Research and Development Canada, has been in the works for over two years in an attempt to harness technological advances to improve the functionality of Canadian Armed Forces operational uniforms and equipment.

The goal is to provide operational clothing and equipment that protects and fits better, while lightening the load carried by soldiers.

Transitioning to a single pattern from the current temperate woodland and arid will also create efficiencies in terms of logistics.

Eric De Lafontaine is Manager – Soldier Operational Clothing and Equipment Modernization, Directorate of Soldier Systems Program Management



Data Logging the LAV 6.0 Fleet: **Keeping Armoured Vehicles In The Fight**

By Capt Alvin Tanudjaya

Responsibility for supporting the Light Armoured Vehicle (LAV) 6.0 fleet transferred to the Director Armoured Vehicle Program Management (DAVPM) Wheeled LAV Equipment Management Team (WLAV EMT) as the fleet nears full fielding across Canada. The LAV 6.0 fulfills a wide variety of roles within the Canadian Armed Forces (CAF).

In order to maintain its serviceability up to and beyond its life expectancy, monitoring its sustainability, health, and usage is critical. With this in mind, the WLAV EMT is working in partnership with the manufacturer, General Dynamics Land Systems – Canada (GDLS-C), to implement data logging technology on a specific number of LAV 6.0s, for a set timeframe, in order to characterize operational functions for use as a baseline for analytical purposes.

One aspect of the initiative that is currently underway involves installing a full Brigade's worth of LAV 6.0s with data logging systems. Having these systems installed for a period of one year on this sample size will create a baseline that will

enable scalability when comparing data to single or multiple vehicles, or to the entire fleet. The data logger will capture key performance indicators (KPI) from the LAV 6.0 Controller Area Network (CAN) bus. There are approximately 530 parameters available and the EMT will capture and log all KPIs – which will then be detailed and analyzed in the final report.

This initiative is intended only to log vehicle behaviour and characteristics. No effort is being made to monitor or analyze driver behaviours. The data loggers being included in the initiative are independent, read-only devices and have no influence on the overall operation or performance of the vehicle.

While the final analysis of data and implementation of all possible future benefits is expected to begin within the upcoming fiscal year, the data logging of the LAV 6.0 fleet could be the first step toward integrating the LAV 6.0 into the battlespace of the future. The fleet is expected to be the CAF's main fighting force for the next 25 to 30 years.

Looking to the far horizon is necessary when trying to evaluate this landscape; however, for now, we will take this initiative one small step at a time.

The aim of this initiative in the short term, as mentioned previously, is to create a baseline of operational and vetronics performance characteristics for the LAV 6.0 in order to monitor its sustainability, health, and usage. In the long term, this baseline analysis can be used to evaluate future logging



One of the potential data loggers, Kvaser Memorater Pro 2xHS v2



One of the potential data loggers, Vector GL 1000



One of the potential data loggers, IoSiX J1939

efforts to identify trends or other issues of value to the EMT and the Canadian Army. Potentially, this could lead to predictive maintenance and to forecasting expected future equipment failures in specific LAV 6.0 vehicles.

In the future, another initiative is expected to be conducted to capture a 100% data baseline – which will assist in cyber intrusion detection, where significant reductions in baseline performance could potentially be an indication of a cyber-attack.

Capt Tanudjaya is the Chassis Manager for LAV 6.0 in DAVPM. He started his career in the CAF as part of the DEO program as a RCME Officer after getting an Engineering degree at the University of Toronto.

Letter to Maintainers – The Need for Maintenance 2.0

By Nicolas Eldaoud, MGen (Ret), MSC, CD

Dear Maintainer: I hope this letter finds you well. I have decided to write these few words as I strongly believe that, over the years, tactical land maintenance has not been able to evolve to properly support land operations. When looking at it objectively, one must admit that maintenance has not really changed over the last 50 years. We did keep up with technology but have not transformed the ways and means by which maintenance contributes to the operational success of today's land operations. The Corps of RCME and its partners have therefore some catching up to do and you, my fellow maintainers, are invited to contribute to the thinking process and to imagine Maintenance 2.0.

Technology must be looked at, not only from the perspective of how it is made, but equally from the perspective of how it is used. The Canadian Army's capstone document *Close Engagement*, published in 2019, provides clear objectives requiring land operational equipment to become adaptable, modular, self-sufficient, and more durable. It also needs to support rapidly changing situations and therefore be able to be reconfigured quickly.

On the purely technical side, tomorrow's technology will be more integrated and will not care for the current vehicle, weapon, electronic/optronic, and material divisions that exist in RCME. It will be smart to allow physical materials to be one with information systems and the

virtual environment. Weapon systems will hit new levels of integration as more soldier enhancement technologies are introduced. At the same time, technology is moving to become more autonomous. The importance of energy sources and power storage for tomorrow's high-energy-consuming equipment is a serious challenge that has to be considered. Ammunition will become less about the amount of explosive and more toward integrated guidance systems.

Tomorrow's weapon systems will do more but will cost more, limiting the amount being procured and enhancing singular operational importance. The Canadian Army is finding itself in a position similar to the Royal Canadian Navy (RCN) and the Royal Canadian Air Force (RCAF) when it comes to technologies, and it must learn from their maintenance models. For example – contrary to the Army G4 – Navy N4 and Air Force A4 have no business in operational maintenance. Finally, operating as a Combat Service Support (CSS) element has consistently limited the natural evolution of land maintenance operations and this must be challenged.

With the recent publication of *Close Engagement*, the RCME Corps has an opportunity to change course. It is with this in mind that I offer four propositions to help design and build Maintenance 2.0, the new way tactical land maintenance is to be carried out to support land operations. In short, Maintenance 2.0 is the decentralization



of land equipment engineering at the lowest level in order to allow for more flexibility, freedom of action, and adaptability of land equipment – with a view to allowing tactical commanders to exploit the full technological capabilities of their equipment. The propositions are:

- **Modernize the role and responsibilities of land maintenance:** Within the operational objectives of *Close Engagement*, Maintenance 2.0 must be able to provide tactical commanders the agility, flexibility, and ability to effect rapid equipment changes. It must assume responsibilities beyond “fixing the VOR (Vehicle Off Road)”. Maintenance 2.0 adds two new responsibilities: “preparing for battle” – which includes modifications, adjustments, and the customization of equipment to support

rapid changes; and “optimizing for the fight” – which provides real-time monitoring of equipment during combat as well as the ability to adjust equipment directly or remotely. The Navy and Air Force are already well advanced in these areas.

- **Expand the technical skills of RCEME engineers and technicians:** Officers and technicians of all trades must be invested in understanding the fields of electronics, digitalization, automation, and artificial intelligence/augmented intelligence. The Corps must also be involved in the field of energies, including new and emerging concepts such as new fuels and electrical generators and accumulators. These advanced technical aptitudes – and more – will empower RCEME leaders to present novel technical alternatives to their commanders.
- **Allow the evolution of land maintenance toward the Navy and Air Force models:** Maintenance 2.0 must increase the doctrinal

proximity of maintainers to the combat operators while dissociating them from the environment of logistics. It must create a strong vertical alignment between tactical maintenance and the highest technical bodies at the strategic level to enable robust reach-back support and the delegation of technical authorities. Maintenance 2.0 must operate in the exclusive domain of land operational equipment.

- **Extract tactical maintenance from the elements of CSS:** Maintenance 2.0 must exist outside the CSS realm. If a new doctrinal domain is required, create “Combat Equipment Engineering Support (CEES)”. In doing so, Maintenance 2.0 will be able to develop and evolve without the constraint of CSS/logistics practices and assumptions. This will allow honest analysis on how Maintenance 2.0 can be better commanded, structured, planned, and executed to enable enhanced support to land operations.

Beyond the argument for a new Maintenance 2.0, the aim of this short article is to initiate discussion and encourage questions. We have to take advantage of the extraordinary intellect and creative potential of RCEME members and their partners. The opportunity is now. There will never be perfect solutions, so we have to imagine a transformation that allows flexibility, agility, and freedom of action and adaptation. It must enable the decentralization of the decision-making processes to the lowest level and permit trust and acceptance of risk to exist. The Corps of RCEME has demonstrated for over 75 years its ability to take on challenges. Rethinking “how we maintain” is just one of them.

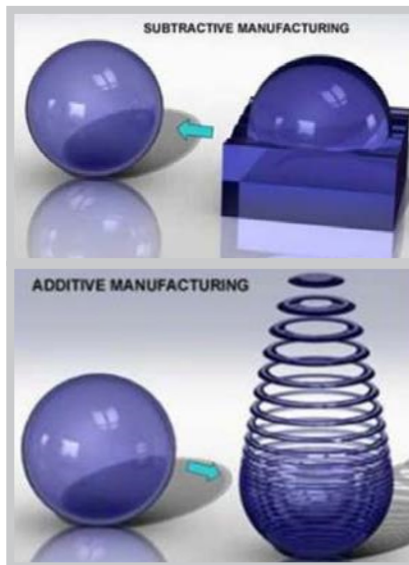
Major-General Nicolas Eldaoud retired from the Corps of RCEME in 2019. He now enjoys supporting his wife's career in Washington and cooking, travelling, photography, and staying in touch with RCEME.



Additive Manufacturing, LEMS and the RCME Corps

By René Provencher

Ever heard of Additive Manufacturing (AM)? How about 3D Printing? This relatively new method of manufacturing involves adding or bonding thin layers of a material to build an item layer-by-layer as opposed to conventional technology that largely focused on iterative removal of material from a block of raw material (subtractive manufacturing). Additive manufacturing has seen exponential growth within the last five years.



This is due mainly to today's availability of inexpensive and powerful digital control and computing tools. The advent of metallic printed components now brings AM into the realm of producing useful production parts for systems. Even more exciting is the possibility of producing optimized parts that can mimic organic structures, saving both material and weight as seen in this example:

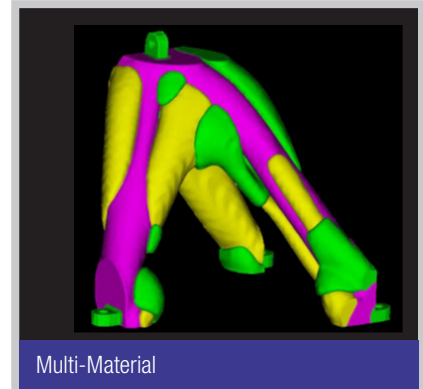


There is also the possibility of creating small “mesoscale” (from 0.1 mm to 5 mm) structures that can form the building blocks of the following organic structures saving even more weight.

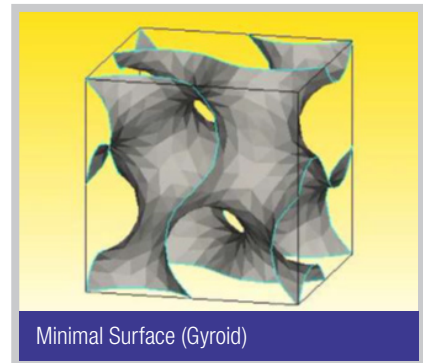
But what does this mean for LEMS and the RCME Corps? Should we jump right into using this new technology and, if we do, how will it affect the support of current and future military equipment?

The commandant of 202 Workshop Depot (WD) has been given the responsibility to lead AM implementation within the Director General Land Equipment Program Management (DGLPEM) Division and has also been asked to help guide the Canadian Army (CA) on how to best address these questions.

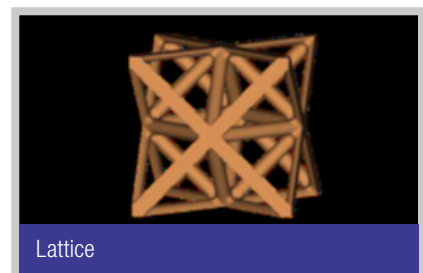
To date, 202 WD has used polymer AM machines to produce prototypes, jigs, and fixtures – and to aid the development of in-house designs – but what about using it to make in-service parts? To better understand this, personnel from 202 WD visited US and German defence establishments to see what kind of equipment they are using, which parts they are producing using which material, and also to discuss their AM policies.



Multi-Material



Minimal Surface (Gyroid)



Lattice

This review of the current state of AM technology has revealed that it is still emerging and many challenges remain to be solved before it can be utilized to replace conventionally

manufactured parts. For example, predicting the resistance to stress, strain, fatigue, and so on of organic designs is not practical – and in some cases not yet possible. Also, current metal AM methods require both a huge amount of care with the storage and handling of raw materials, and extensive quality control measures to ensure material properties are repeatable and consistent.

Based on the above findings, the 202 WD commandant has concluded that the latest polymer AM machines offer the most reliable, practical, and easy-to-use technology while also producing the most consistent parts for use within the CA. Currently, 202 WD is building a deployable AM capability that will be part of Maple Resolve 2020 (MR20). The use of this capability during MR20 will inform options about its employment and will help determine

its usefulness, ability to perform within this environment, and the development of guidance/policies for its use. Below are photos of the MSVS shelter, which will be used as the system under test, and the AM system. The AM system being deployed consists of a laptop, a hand-held 3D scanner and a 3D printer.

Although there are currently a few polymer AM systems out at some units, there remains a lack of clear policies and guidance regarding their use: 202 WD's Land Material Assurance section will be working with Maj Brent Wagner and his team at the CA G4 Maintenance organization to develop these documents.

Along with the Quality Engineering and Test Establishment (QETE), 202 WD has been chairing annual DND-wide AM forums, the second of which was held on November 7 and 8, 2019, to ensure coordination of effort within all of DND.

Finally, 202 WD and QETE will be examining a number of polymer AM machines in order to determine which would be suitable for use within the CA and make recommendations... stay tuned!

René Provencher is Land Engineering Support Centre (LESC) Leader.

With the collaboration of:

Kevin Wright – Land Material Assurance (LMA) Program Manager; Major Fernando Echavarria-Hidalgo – Lead for Innovation and Technology Group at LESC; and Major Ali Alibhai – Manufacturing, Components and Electronics Production Program Leader at 202 Workshop Depot (202 WD).



Deployable Additive Manufacturing system consisting of an MSVS shelter, laptop, hand-held 3d scanner and 3d printer.

Advanced Sub-Unit Water Purification System: Water – An Essential Combat Supply

By James Buell

Water, as we all know, is essential to sustain human life. Under various field conditions, a single soldier can require up to 45 litres of water per day for drinking, cooking rations, and basic hygiene. On a camp, this requirement increases to 150 litres per day.

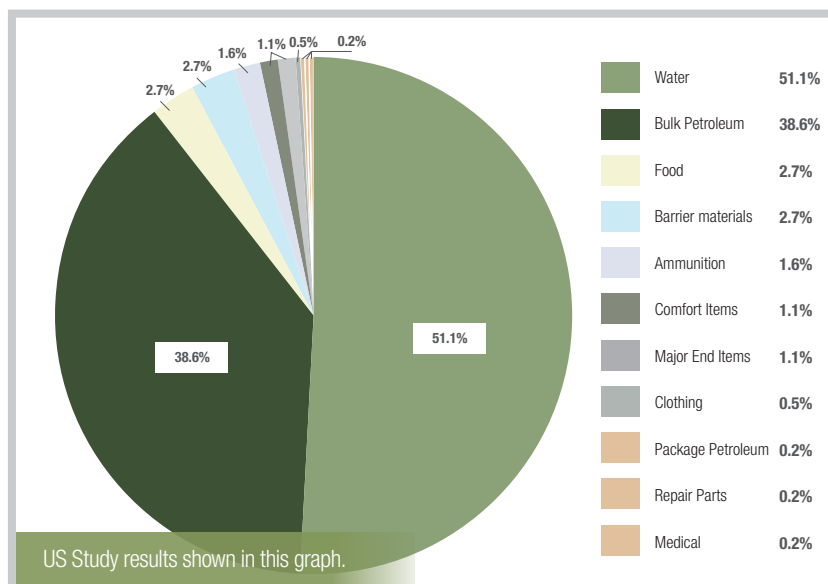
The Reverse Osmosis Water Purification Unit (ROWPU) has been the workhorse of water production since it entered into service in the mid-1990s. The size of a sea container, a single unit is intended to provide clean, potable water for approximately 5000 soldiers deployed for an indefinite period of time. With dispersed operations increasingly becoming the new norm, there is a need to augment the ROWPU with a smaller system. This need has been reinforced by lessons learned during several Disaster Assistance Response Team (DART) deployments such as Haiti.

In Kandahar Province, troops were dispersed across a wide area of operations, and drinking water was supplied predominantly as bottled water. This placed a considerable burden on strategic and tactical supply lines but also exposed resupply convoys to high risks. An American study on operations in Afghanistan and Iraq shows that slightly greater than 50% of all convoy tonnage was for transporting water. Clearly, a new way of doing business is needed.

The Advanced Sub-Unit Water Purification System (ASUWPS) project



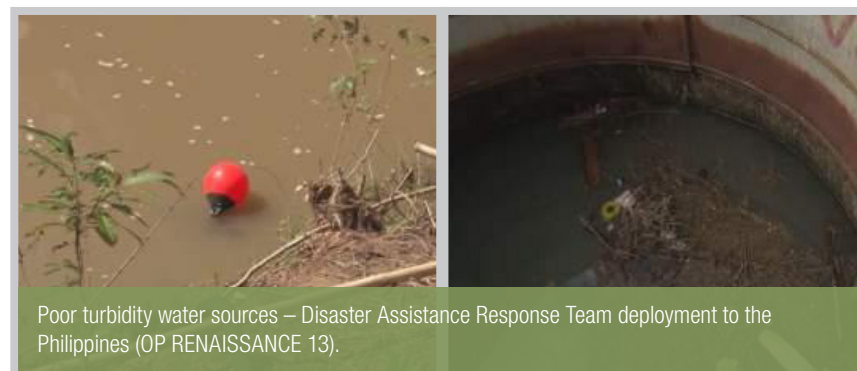
Reverse Osmosis Water Purification Unit (ROWPU) deployed to Haiti (OP HESTIA 2010).



will address these deficiencies through the delivery of a sub-unit (up to 250 personnel) water treatment system to both the regular and reserve forces, for whom this is an entirely new capability. The project also intends to replace the aging Water Buffalos with a much larger (3000-litre) water tank trailer.

The advanced water treatment system when delivered will be capable of treating virtually any water source, including seawater, chemical and biological contaminants, and high turbidity water. The system will be fully automated – including self-diagnostics of any faults and backwashing of filters to prevent fouling – thus enabling minimal intervention from the operator. Transported on a trailer, the system will include a cold weather sustainment kit to enable operations in environments with temperatures as low as -40 degrees Celsius.

The sustainment of the water treatment system will build on lessons learned from the in-service ROWPU. Operators and maintainers alike often suffer from skill fade. These challenges are compounded by the fact that reserve engineer regiments do not



have inherent maintainers. For these reasons, an in-service support contract will be awarded for the acquisition contract.

The structure of the sustainment contract will provide maximum flexibility to augment first line technicians when necessary, but also to conduct scheduled inspections, fault finding and major repairs, additional training of operators and maintainers as well as Repair & Overhaul (R&O). Industry will also provide deployable spare kits to sustain deployed operations such as the DART.

The project team is working diligently to move the project into implementation by June 2020 and subsequently into

contract. Although fielding of the equipment is still well in the future, the capabilities that the ASUWPS project will deliver will ensure the provision and distribution of safe drinking water to both the Canadian Armed Forces (CAF) and on humanitarian assistance operations for years to come. Moreover, the sustainment solution that has been developed offers a unique resolution of the supply and maintenance challenges presented by the fielding of a small, specialized fleet.

James Buell is the project manager for the ASUWPS project and section head for Combat Engineer capital equipment projects.



Adaptability: The Key to Success in Operations

By René Provencher

What is this new organization called the Land Engineering Support Centre (LESC)?

What does it do and why do we need it?

To show you the *why* of LESC, let me tell you about an incident that took place during the Second World War.

During the Normandy Campaign in 1944, the Canadian Army (CA) launched a number of major armoured offensives on prepared German Army positions defended by heavy Panzer battalions. During one of these assaults, within the lines of Les Fusiliers de Sherbrooke, a

vehicle technician noticed an armoured officer working on a Sherman tank. On closer inspection, he saw that the officer was tack welding a section of German Tiger track onto a Sherman, overloading the vehicle.



Major Radley-Walters receives the Military Cross from General Bernard Law Montgomery in Ghent, Belgium, October 1944.

The corporal took one look at the Sherman's suspension and said: "You're adding a lot of weight onto that suspension. You'll be lucky to get 500 miles out of this tank." The officer replied: "If this tank can get me over this hill, it will have paid for itself eight times over," explaining that during that day he had driven a number of Sherman tanks up to the German Army position, and each time his tank had either been hit or otherwise disabled. In some cases, the officer had barely managed to jump out of his tank before it burst into flames, and then he had walked back to his lines, climbed into another tank, and repeated the process all over again.

By now, the officer had noticed a weakness in the design of the Panther tank and was preparing to exploit it. The Panther's turret had a curved mantlet. The officer knew that if he could get within 600 yards of the Panther tank, his gunner could hit the lower portion of the mantlet and the anti-tank round would ricochet downwards into the relatively thin roof of the chassis, effectively destroying the Panther. The problem was getting within 600 yards.

The Panther could engage and kill his Sherman while it was still two kilometres away, so the officer's solution was to apply "add-on-armour" (AoA) to the front glacis of the Sherman's chassis and turret by tack welding a combination of Panther track and Tiger track to the front of his vehicle. The Panther round would wedge itself into the AoA and both would fly off the glacis of his Sherman without penetrating it. Then, before the Panther had time to shoot again, his Sherman could get within 600 yards and shoot to kill.

This armoured officer was none other than Sydney Valpy Radley-Walters, known as "Rad", who was awarded the Military Cross, the Distinguished Service Order and was the western Allies' ace of aces in WWII.

When Rad told me this story, it hit close to home since my great-uncle was a Sherbrooke Fusilier who was killed while driving a Sherman on D-Day + 1.

This story illustrates the adaptability that the CA needs today. Rad knew the strengths and weaknesses of his own equipment and that of the enemy's so he could quickly apply new information to improve survivability. At LESC, we specialize in improving equipment survivability, lethality, mobility, and sustainability, and we have the in-house capability and expertise to help you develop these vital skills.

What else can LESC and the RCME Corps do to help you succeed?
More to follow...

René Provencher is Land Engineering Support Centre (LESC) Leader.

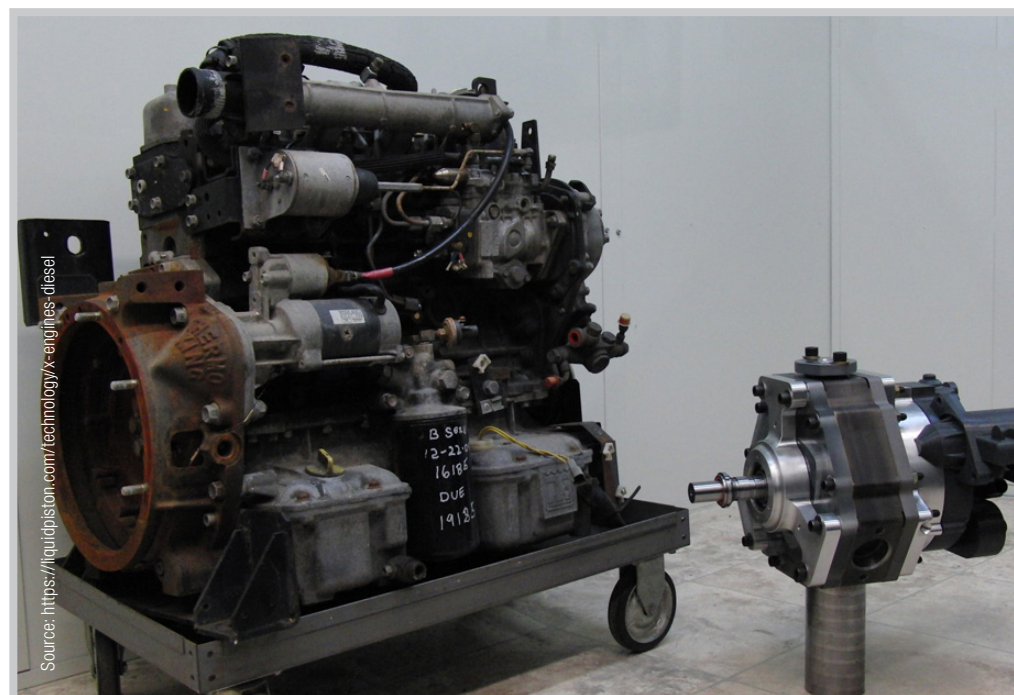
Innovation in Defence: Insight Gained Through Liaison With Our American Colleagues

By Maj Jason Das

As the Canadian Armed Forces (CAF) Liaison Officer (LO) with US Army Tank-automotive and Armaments Command (TACOM) at Detroit Arsenal, I've had several unique opportunities to learn more about the collaborative nature of the American defence industry. As a RCEME officer, I'm constantly on the lookout for possible opportunities for LEMS to learn from American innovation and experience.

While I have observed that the US defence industry as a whole is more intricately connected to the US Army than Canadian industry is to the Canadian Army, the US Army is still pursuing innovative ideas and products from small businesses. Chasing innovation is critical to technological superiority, but requires a fine balance between flexibility and risk. Canadian and American approaches to innovation are subtly different, but both provide excellent opportunities for our respective armies to benefit.

The Department of National Defence (DND) has initiated the Innovation for Defence Excellence and Security program (IDEaS) as a way to network with the Canadian innovator community and identify to them opportunities for investment from the defence community. IDEaS regularly releases Calls for Proposal (CFPs) on defence and security challenges to which a variety of innovators respond. As of July 2019, more than \$26 million has



A standard 35 HP diesel engine (left) next to LiquidPiston's 40HP diesel engine (right). LiquidPiston is one of the 12 xTechSearch 3.0 finalists scheduled to compete for the grand prize in the spring of 2020.

been awarded to innovators to develop solutions to these challenges. In the long term, the expected annual investment will level out at approximately \$80 million.¹

Over its first year, IDEaS has issued 27 challenges focused on a variety of themes including: Operating in Austere Environments; Defending Space Missions; Building Cyber Capability; Accelerating Next-Generation Technologies; Enhancing Command, Control, Communications, Computers,

Intelligence, Surveillance and Reconnaissance (C4ISR); Putting Our People First; and Protecting Our Forces. Future CFPs will include themes of Increasing Combat Power; Sustaining Operations; and Greening Defence. The division of proposals submitted from innovators to IDEaS was approximately 20% from academia, 60% from small-to-medium industry (<500 employees), 10% from large industry, and 5% from non-governmental organizations (NGOs).

1. IDEaS website: <https://www.canada.ca/en/department-national-defence/programs/defence-ideas.html>

As an LO, I have witnessed the American innovation efforts, specifically a US Army project run by the Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT)) called the Expeditionary Technology Search (xTechSearch). This competition is now starting its fourth cycle of evaluating proposals based on nine focus areas identified by the Army: Long Range Precision Fires; Next Generation Combat Vehicle; Future Vertical Lift; Network with Hardware, Software and Infrastructure; Air and Missile Defense; Soldier Lethality; Medical Technologies; Military Engineering Technologies; and Manufacturing and Manufacturability Technologies.²

Each cycle of xTechSearch consists of four phases spanning a full year. Phase 1 is the proposal review and acceptance of 48 entrants with a \$5000 award. Phase 2 has each entrant present the product in a Dragon's Den fashion to a panel of military, industry, and technical experts with an award of \$10,000 for the 24 accepted proposals. Phase 3 is a more detailed presentation at an Association of the United States Army (AUSA) tradeshow with an award of \$120,000 for the 12 selected products. Phase 4, after a further six months of development, has each participant demonstrate a proof-of-concept and transition plan on how the product will be commercialized at the AUSA annual meeting. The winning participant receives \$250,000 and the other 11 receive \$10,000. This program awards a total of \$2.28 million per cycle, with a new cycle started every six months, exclusively focused on US Army priorities.

When I attended the AUSA conference in Washington, DC, I took advantage of the xTechSearch "Innovator's

Corner" at the conference to talk to many of the participants in Phase 3 of the third cycle. The variety of products and potential applications was eye-opening. Medical technology such as briefcase-sized X-ray machines and pocket-sized pathogen diagnosis tools were lined up next to advanced power systems and radars that could see through walls.

While each approach is different, the IDEaS program in DND has significant potential to influence future CAF equipment procurement. However, there are a few key opportunities where I think early investment from LEMS would make a significant impact later.

First, from publicly available information, the US Army innovation endeavour places significantly more attention on the commercial viability of each proposal. The program even has an "accelerator" program to help xTechSearch winners be successful so they can transition technologies to the warfighter and commercial markets. This connection to commercial success encourages longer-term relationships between these fledgling industries and the Army, or wider Department of Defense (DoD) – creating a greater pool of creative potential for future procurements.

Second, the phased approach encourages continual feedback between the innovators and the consumers. Not only does this provide ongoing incentive for each phase of development, but it provides opportunities to refine a product with input from panels of experts – including military users, maintainers, and logisticians. It helps focus defence investment where the intersection between sound business decisions and military applications meet. This

reduces the likelihood of investment in technological cul-de-sacs or orphan equipment.

Finally, rapid innovation is useless without rapid acquisition. I have yet to see evidence from either the Canadian or American programs that includes procurement mechanisms whereby fledgling developers can be issued a contract for their actual products (whether from the Army or from senior industry partners ("Primes")) rather than awards from the innovation competition process.

LEMS is a system that develops, procures, manages, maintains, sustains, and, finally, disposes of equipment. Innovation efforts must not neglect the stages following "develops". While IDEaS is still growing as both a network of innovation and channel for investment, LEMS must get involved. Not only is this an opportunity to create our own challenges to find Canadian innovators who could improve LEMS, it is also critical to ensure that solutions proposed for Canadian Army equipment challenges are grounded in core LEMS tenets that have been battle-proven through more than a century of experience.

Maj Jason Das is currently the Liaison Officer at the US Army Tank-automotive and Armaments Command at Detroit Arsenal in Michigan. His past LEMS experience includes technical services officer positions, an engineer position at Director of Ammunition and Explosives Management and Engineering, and sustainment business case analysis for the Logistic Vehicle Modernization Project.

2. xTechSearch website: <https://www.arl.army.mil/xtechsearch/index.html>

An Outside Canada Posting Can Be a Dream Come True!

By LCol Martin Bedard

So you have managed to secure an outside Canada (OUTCAN) posting? How lucky you are! Against all beliefs, finding volunteers for RCEME OUTCAN positions is a significant challenge. I am currently serving on my third OUTCAN posting with my family and want to reflect about these foreign work environments and offer a professional and family perspective to fellow RCEME officers who may be considering a similar experience.

There are currently eight RCEME officers – one captain, five majors, one lieutenant-colonel and one colonel – deployed OUTCAN with their families. These positions are not randomly established but carefully selected by the Vice Chief of the Defence Staff (VCDS) to ensure they achieve a deliberate strategic effect. These positions provide the RCEME Corps and the Canadian Armed Forces (CAF) with access to technical facilities and expertise as well as a means to influence and keep up with issues that affect our ability to operate seamlessly with our allies.

In this article, I want to reflect on professional and family considerations when contemplating an OUTCAN posting. The first aspect I will discuss is career advancement. You must have heard that when you accept a position abroad, your career will take a hit. Yes and no! An OUTCAN posting is a hard commitment

of three years – and one could argue that after two years, it is time to move on and learn something new. On the other hand, upon returning with new experience, you will be able to challenge what everyone else takes for granted and be able to present new views and concepts on systemic problems.

From a family perspective, your children will likely experience an international school curriculum, which will usually be turned into an opportunity. Children normally reintegrate seamlessly into the Canadian school system with the added bonus of an extra language and an international perspective picked up along the way. While your spouse's professional career will likely be placed on hold, OUTCAN financial benefits will offset some of that pressure. In addition, Canadian employment opportunities do exist for spouses while abroad.

Our members returning from OUTCAN have acquired unique experiences. In a perfect world, the RCEME Corps would capitalize on the knowledge and perspective gained by those deploying abroad and actively plan their next employment in Canada. As an example, the officer returning from a posting as the Staff Officer 2 Combat Service Support - Equipment Support - Availability Manager in the United Kingdom (UK) – could be advantageously employed within Director Land Equipment Staff 3 (DLEPS 3)

where newly acquired experience and knowledge about the UK REME systems could be leveraged to enhance the RCEME Land Equipment Management System (LEMS). The RCEME Corps has successfully selected capable candidates who performed well in the international arena and upheld Canada's high reputation among our allies; however, we have to improve the way we employ those officers to capitalize on our investment when they return.

Overall, I strongly believe that accepting an OUTCAN posting and serving Canada's interests abroad can be an extremely rewarding experience from a professional and family perspective. However, a word of caution – this is not a one-size-fits-all experience.

LCol Martin Bedard is currently serving on his third OUTCAN posting as the Canadian Liaison Officer at the NATO Support and Procurement Agency in Luxembourg. Previously, he enjoyed challenging OUTCAN postings in JFC Naples (IT) and 1 UK Armd Div HQ in Herford (GE).

RCEME in York: A Golden Opportunity to See How Others Do It!

By Maj Grant Pudlowski

There is a gem of a posting in York, United Kingdom (UK) with the 1st (UK) Division. This formation is made up of eight brigades: four infantry, two logistics, one medical, and one engineer. The brigades span from Northern Scotland to Southern England. There has been an RCEME position in the division since at least 1997, when it was an armoured division headquartered in Germany.

York is about halfway between London and the Scottish border, an hour from the east coast and two hours from the west coast. It is an historic place, having existed continuously since its founding as a fort by the Romans in 71 CE.

The position I hold is Availability Management in the Equipment Support (ES) branch of the HQ. It is roughly equivalent to a G4 Maintenance position in Canada. My duties include being the Divisional Joint Asset Management and Engineering Solutions (JAMES) officer. JAMES is an enterprise software system like the Defence Resource Management Information System (DRMIS), but easier to use.

The Brits are big on contracting, much more so than in Canada. For example:

- Your truck needs a windscreen?
No problem. Call a civilian company and they'll come out and replace it.
- Flat tyre? Don't go to the Light Aid Detachment (LAD) (British version of a maintenance platoon). Go to the quartermaster and exchange it, because LADs don't have tyre machines.

- Need an alternator? Your supply guys will get you one from downtown.
- Going on a small road move?
No worries. There is a national recovery service like the Canadian Automobile Association (CAA) that you can call if you break down.

Because of the extent to which the Brits use contracting, another work strand I am involved in is dealing with the Army's main contractor for

maintenance, Babcock Defence Services Group (BDSG). It is a huge company with multiple responsibilities, but I deal with Maintenance, Repair and Overhaul (MRO) levels 1-3.

They have several workshops scattered around the UK. When LADs are overtasked, units will send all types of work from oil changes and inspections to engine replacements to a BDSG workshop. Many units take advantage



Maj Grant Pudlowski

of these facilities, particularly reserve units, which, with the rare exception, do not have any integral maintenance support. Routine, predictable work such as inspections must be forecasted four months in advance.

Recently the BDSG contract expanded to include several Field Mobile Support Teams (FMST) – think Mobile Repair Teams (MRT). The division has access to vehicle mechanics, armourers (weapons technicians), and recovery mechanic teams (recovery is a trade here – a bad idea in my humble opinion). These civilian teams back up LADs and can even be used as non-tactical support on exercises, both domestically and overseas.

The idea of this “whole force approach” – using civilians to supplement the guys in green – is growing. Many

units that have used the FMSTs have commented that they would have been lost without them, especially when the equipment availability targets are so high. Units on high-readiness must maintain 85% equipment availability, while those units not on high-readiness have a target of 75%. The idea of using civilian contractors to augment RCME tradespeople is probably something that should be explored in Canada.

Like us, the Brits have their own language when it comes to acronyms. I am getting the hang of them, but it doesn't help that some of the accents here are so thick you could cut them with a knife. The Brits tend to be in shape, and the division does physical training twice a week – and it is tough! Circuit training is unfortunately very popular, as is running shuttles or laps in combat boots.

But an exchange posting is a great opportunity to be exposed to other armies, other ways of doing things, and other priorities. Not to mention the opportunity to live in Europe. And even better, I don't have to pay for parking like I did in Ottawa!

Maj Grant Pudlowski is currently on his first OUTCAN and is learning the local language. Previously, he worked in DGLEPM with the LAV and TAPV EMTs. He is a graduate of the Land Force Technical Staff Program in Kingston and holds a Master's Degree in Public Administration from RMC. He also has an Automotive Mechanics Licence, although he really doesn't like getting his hands dirty.



The Royal New Zealand Electrical and Mechanical Engineering Corps: **Our Closest Relatives?**

By Maj Stéphane Payant

December 8, 1996 – to paraphrase US President Franklin D. Roosevelt’s comment about the attack on Pearl Harbor on December 7, 1941 – is a day that shall live in infamy for our brethren of the Royal New Zealand Electrical and Mechanical Engineering (RNZEME) Corps. With the stroke of a pen, they were absorbed into the newly formed Royal New Zealand Army Logistic Regiment (RNZALR). So, how did this affect the Kiwi Land Equipment Management System (LEMS)?

For starters, the Corps may no longer exist, but the craftsman still thrives. Indeed, the Maintenance Support (MS) trades survived the amalgamation, and the flame is still very much alive. The RNZEME crest and colours fly high in every workshop around the country, and it is common to see technicians and officers wearing their old RNZEME regimental belt under their tunics.

Basically, there is not much that is different. We share very similar doctrine and structure. Maintenance of the equipment is separated into four grades of repairs: operator, light, medium, and heavy grades. Those are mainly based on the engineering capacity required in terms of skills and knowledge, infrastructure, and tooling – ranging from replacement of minor parts conducted by the operators to component-level repairs that require extensive tooling and specialized

facilities. The four grades of repairs are conducted at each level of the support structure: integral, close, general, and national.

The NZ Army’s operational forces are grouped under 1st NZ Brigade. Major units – the two infantry battalions, the cavalry regiment, the artillery regiment, and the engineer regiment – which have their own integral support that conducts light-grade and sometimes medium-grade repairs. Their Technical Support Sub Units (TSSU) employ Forward Repair Teams (FRT) to conduct repairs as forward as possible.

The brigade also has two Combat Service Support (CSS) battalions that are regionally based on North and South Islands. These battalions are the Close Support organization and they conduct light-grade repairs to units without their own integral support, and medium-grade repairs for the entire brigade. The CSS battalions can also form the basis of a General Support organization when deployed on a prolonged operation.

The MS trades perform light- and medium-grade repairs in the brigade. Armourers are their weapons technicians, maintenance fitters are their materiel technicians, automotive are their vehicle technicians, electronic technicians are their electronic-optronic as well as their communication

system technologist, and their electrical fitters are electrical and refrigeration technicians.

If for any reason the equipment is deemed beyond local repair, it gets back-loaded to the national workshop, the RNZALR version of 202 Workshop Depot. This workshop is staffed with contractors from Lockheed Martin New Zealand, which enables the limited number of military technicians to be employed in the field. The national workshop offers medium-grade repairs for units outside of 1st NZ Brigade, such as reserve units and training establishments as well as heavy-grade repairs for all.

A key aspect that allows units to maintain their equipment availability is the replacement of items deemed beyond local repair from the national Repair & Maintenance pool controlled by the Defence Equipment Management Organisation (DEMO), their “Director General Land Equipment Program Management” (DGLEPM). This organization is responsible for the through-life support of all NZDF non-platform equipment.

DEMO is responsible for keeping the equipment fit for purpose and overseeing the supply chain. The former is accomplished through such things as monitoring the reliability, investigating failure modes, and trends, researching

and implementing design changes, and adjusting the maintenance regimes. Overseeing the supply chain is accomplished through monitoring the national scaling of parts and their procurements through original equipment manufacturers or other suppliers, when alternative sources are required.

DEMO is also heavily involved with Capability Branch, which, as the name implies, has the responsibility of managing the various capabilities. This organization is responsible for developing the requirements in a similar fashion to Director Land Requirements. Capability Branch is also responsible for delivering the various

capabilities through projects. DEMO is involved by informing the capability managers when equipment requires upgrades to remain technologically relevant, and when the equipment needs to be replaced because it is becoming unsupportable. DEMO is also involved from the earliest stages of capability definition and acquisition, assisting the capability managers and project managers through early capability thinking, requirements setting, and support solution development.

All in all, there are so many more commonalities with the Canadian LEMS and the RCME Corps than there are

differences. Couple that with a similar culture, the versatility that comes from being a small army and the “go getter” attitude, and it can be said that the craftsmen and officers from the RNZALR are probably our closest cousins.

I am proud to serve with them.

Major Stéphane Payant is Canadian exchange officer in New Zealand Equipment Management Group Leader Combat Systems – Defence Equipment Management Organisation.



Patience, Ingenuity and Basic Kiwi Do-It-Yourself-Itis: A History of the RNZEME Corps

By Colin Andrews and Kelvin Hawley

With the advent of mounted warfare – first on horseback and then on wheels – the need arose to mobilize those who made and repaired harnesses, wheels and vehicles. As farriers, forgers, strikers, and blacksmiths used their tools to keep the equine engines happy and shod, wheelwrights, mechanics, and coachbuilders tended the vehicles.

Cutlers and masters of ordnance forged the striking and throwing weapons used by soldiers. From the smithies' work, the term hammer and tongs became synonymous with going hard at something. Brigadier Steve Weir, (later Major-General Sir Stephen Weir) chose these words to describe the taxing Operation Crusader battles in 1941 during the Second World War. The symbol of a crossed hammer and tongs (or pincers) came to symbolize the achievement awarded to men passing exacting technical exams as artificers.

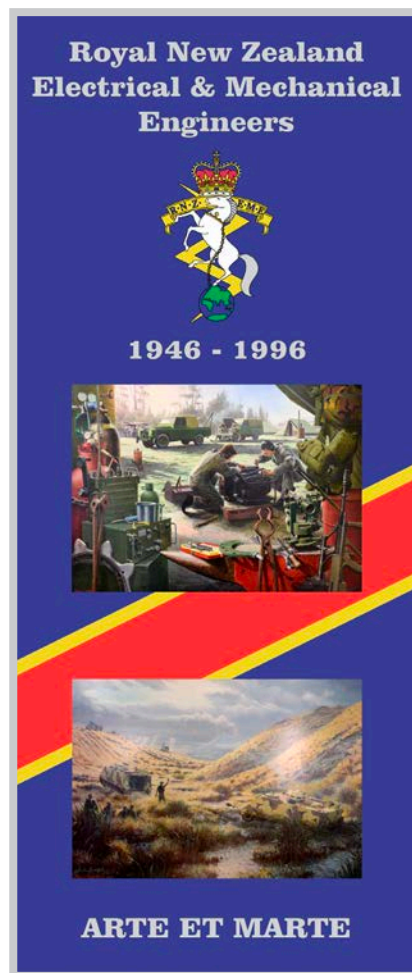
The proud wartime reputation established by the New Zealand Ordnance Mechanical units (NZOM) founded in 1917 during the First World War carried through to the NZOM units of the Second New Zealand Expeditionary Force (2NZEF) in the second world conflict. Serious shortages of spare parts and supplies in the North African campaign fueled the Kiwi tradesmen's inventiveness, which is often characterized as the "Number 8 Wire" philosophy. This heavy-gauge fencing strand has long been used to cobble together mechanical solutions on the farm back home or at the factory

and for over a century this knack for improvisation has flowed to every front line where Kiwis have fought.

The NZOM units in North Africa formed part of the greater New Zealand Ordnance Corps and it is from this organization that the Corps of New Zealand Electrical and Mechanical Engineers (NZEME) was born, reflecting the organization of the British Army it was supporting. Significantly, NZEME came into existence on the feast day of its patron, Saint Eligius, on December 1, 1942. St Eligius is the patron saint of not only the NZEME but also goldsmiths, metalworkers, veterinarians, and – most notably – horses and those who work with them. Throughout the remainder of the Second World War NZEME earned high praise for its ability to keep equipment in the fight despite the challenges. Its success was attributed to "patience, ingenuity and basic Kiwi do-it-yourself-itis".

Forming the NZ Electrical & Mechanical Engineers as part of the temporary 2NZEF overseas had set a precedent, and arguments were brought forward in New Zealand for establishing a permanent electrical and mechanical engineering branch of the army. Nothing would happen, however, until after the Expeditionary Force was demobilized.

When members of the NZEME returned home from war service, they reverted to being NZ Army Ordnance Corps (NZAOC). Those who went on to serve in Japan with Jay Force, which was formed from 2NZEF in Italy, took with



them the reputation and traditions of the wartime NZEME Corps. The postwar NZAOC comprised of a Headquarters and Inspectors Group in Wellington, and the main ordnance and ammunition depots at Trentham, as was the case with each military district.

The case for establishing a permanent branch progressed, and official notification establishing the New Zealand Electrical

& Mechanical Engineers came in August 1946. On August 23, an Army Department, Wellington notice stated: "His Excellency the Governor-General has been pleased to approve under Section 6(a) Defence Act, 1909, of the NZ Permanent Forces, with effect from the 1st Sept 1946 – Corps of the Electrical and Mechanical Engineers", signed by Frederick Jones, Minister of Defence.

Royal assent followed in July 1947 when, along with other NZ Army Corps, the NZEME gained the royal prefix. This honour was recognition by King George VI of the fine service rendered by NZ Forces in the recent global war. The NZEME Corps had become the Royal New Zealand Electrical & Mechanical Engineers (RNZEME). The badge of the Corps is described heraldically as: "A horse forcene (enraged) gorged with a coronet of four fleur-de-lys, with a chain reflexed over its back, standing on a terrestrial globe superimposed on a lightning flash and surmounted by the Royal Crown upon a scroll bearing the letters RNZEME."

The year 1948 saw the establishment of the Regular Force (RF) Cadet School in Trentham Camp that included an RNZEME School of Trade Training.

The RF Cadet School relocated to Waiouru in 1952, where it remained throughout its existence. The RF Cadet School was the main source of apprentice tradesmen (craftsmen) to RNZEME workshops through to its disbandment in 1991, and was pivotal to achieving the 'By Skill and By Fighting' ethos of RNZEME.

The Vietnam conflict was the last in which RNZEME went to war. Individuals from the Corps have gone to war zones since then, but in a peacekeeping capacity. The post-Vietnam period became one where the Corps responded to changes in the structure of the NZ Army toward this peacekeeping role, and reorienting the country's defence focus from Southeast Asia to the Pacific and away from Cold War operations. For the Corps the process meant a steady downsizing until it was disestablished in 1996. At no time throughout this process did the Corps of RNZEME lose its focus on professional standards in its work for the NZ Army – and the esprit de corps of RNZEME continues today among former members

His Royal Highness Prince Philip, as RNZEME Colonel-in-Chief, shared the following sentiments at the time RNZEME was disbanded: "Armies have

always been leaders in technological advance. RNZEME can be proud to have been the technological leader within the NZ Army. Its service and loyalty to the country is beyond reproach".

On December 8, 1996, RNZEME was disbanded and amalgamated with the Royal New Zealand Ordnance Corps (RNZAOC) and Royal New Zealand Corps of Transport (RNZCT) on December 9, 1996 to form the Royal New Zealand Logistic Regiment (RNZALR).

Colin Andrews is a retired RNZEME sign writer. Colin joined the NZ Army as a Regular force Cadet in 1959 and graduated into RNZEME in 1960 as the first indentured sign writer apprentice. A keen military historian, Colin is a long-time member of the New Zealand Military Historical Society and has written and published several works of military history.

Kelvin Hawley is a Systems Engineer working on the New Zealand Light Armoured Vehicle project.

