Copy No. _____

Defence Research and Development Canada
Recherche et développement pour la défense Canada

DEFENCE R&D DÉFENSE

Maritime Capability Evaluation Laboratory (MCEL)

Concept of Employment

Mark G Hazen

Defence R&D Canada – Atlantic

Technical Memorandum
DRDC Atlantic TM 2012-241
October 2013

Canada

This page intentionally left blank.

Maritime Capability Evaluation Laboratory (MCEL)

Concept of Employment

Mark G Hazen

Defence R&D Canada – Atlantic

Technical Memorandum
DRDC Atlantic TM 2012-241
October 2013

Principal Author

Original signed by Mark G Hazen

Mark G Hazen

Group Leader Maritime Command Team Support

Approved by

Original signed by Francine Desharnais

Francine Desharnais

Head, Maritime Decision Support Section

Approved for release by

Original signed by Leon Cheng

Leon Cheng

Chair, DRDC Atlantic DRP

Abstract

DRDC has proposed a new departmental capability to be known as the Maritime Capability Evaluation Laboratory (MCEL) to jointly serve the Royal Canadian Navy, ADM(MAT) and ADM(S&T). This capability will address the need to support the evolutionary acquisition, development and maintenance of the command and control capabilities aboard naval platforms by enhancing the evaluation of concepts prior to detailed implementation engineering. This document describes the Concept of Employment for the MCEL capability at a high level and provides documentation for the implementation project team. As the project progresses, more detailed Concept of Operation documents will provide the lower level detail of the day to day facility operation and, with this document, will be used to derive the statement of requirements.

Résumé

RDDC a proposé une nouvelle capacité ministérielle connue sous le nom de laboratoire d'évaluation de la capacité maritime (LECM), pour servir la Marine royale canadienne, SMA(Mat) et SMA(S&T). Cette capacité répondra au besoin d'appui en matière d'acquisition évolutive, de développement et de maintenance des capacités de commandement et de contrôle à bord de plateformes navales, en améliorant l'évaluation de concepts avant la mise en oeuvre technique détaillée. Ce document fournit le concept d'emploi de haut niveau pour la capacité du LECM ainsi que la documentation concernant la formation de l'équipe de mise en œuvre du projet. Au fur et à mesure de l'évolution du projet, des documents plus détaillés sur le concept de fonctionnement fourniront les détails liés aux niveaux plus bas du fonctionnement quotidien de l'installation et, avec ce document, ils seront utilisés pour établir l'énoncé des besoins.

This page intentionally left blank.

Executive summary

Maritime Capability Evaluation Laboratory (MCEL): Concept of Employment

Hazen, M.G.; DRDC Atlantic TM 2012-241; Defence R&D Canada – Atlantic; October 2013.

Introduction: DRDC has identified a requirement for the capability to provide evaluation support to the ongoing evolution of shipboard command and control. This evolution can come in a wide variety of forms ranging from changes in doctrine or personnel to major changes in weaponry. DRDC believes that this requirement is applicable across the department and that solutions will be of use to a number of Level 1 organizations.

System engineering experience indicates that early full system evaluation of designs is required in highly complex systems since sub-system evaluation may not be predictive of the overall system effect. It has been shown by both allies and industry that there are significant savings in making changes to systems before implementation in operational units. However, the cost of full system evaluation has often been prohibitive for all but the largest of projects.

Results: The Maritime Capability Evaluation Laboratory (MCEL) is intended to apply best practices from allied nations to provide an enduring capability to support full system evaluation of changes to ship board command and control. The intention is to provide the equivalent of a television stage that can represent current capability and is fully instrumented to support evaluation processes. The facility is envisioned to be jointly managed by the RCN, ADM(Mat) and ADM(S&T) and would be able to conduct two evaluation events simultaneously. Three vignettes are given to illustrate the envisioned usage of MCEL. By maintaining enduring baseline capability measures and platform instantiations the setup/entry cost for a particular project to conduct an evaluation event will be minimized.

Significance: This document provides the high-level concept of employment for the MCEL project. It outlines the expected usage pattern and how it will fit within the departments procedures.

Future plans: As the MCEL project moves toward options analysis and construction this document will provide the high-level context within which the other project documentation will be developed. It is also expected that this document will go through iterations as MCEL, itself, undergoes evolution and development to fit the changing requirements of the department and the Royal Canadian Navy.

Sommaire

Maritime Capability Evaluation Laboratory (MCEL): Concept of Employment

Hazen, M.G. ; DRDC Atlantic TM 2012-241 ; R & D pour la défense Canada – Atlantique; octobre 2013.

Introduction : RDDC a signalé une exigence relative à la capacité de fournir un soutien en matière d'évaluation de l'évolution continue des systèmes embarqués de commandement et de contrôle. Cette évolution peut prendre diverses formes, allant des changements dans la doctrine ou dans le personnel à des changements majeurs dans l'armement. RDDC est d'avis que cette exigence s'applique à l'ensemble du ministère et que les solutions seront utiles à de nombreux organismes de niveau 1.

D'après l'expérience acquise en génie des systèmes, tout indique qu'une évaluation précoce des conceptions de tout le système est requise dans les systèmes très complexes, car il se peut que l'évaluation des sous-systèmes ne permette pas de prévoir l'effet global sur le système. Les forces alliées et l'industrie ont démontré qu'apporter des modifications aux systèmes avant leur mise en œuvre au sein d'unités opérationnelles peut se traduire par d'importantes économies. Cependant, le coût de l'évaluation de tout le système a souvent été trop élevé pour tous les projets, sauf les plus gros.

Résultats : Le laboratoire d'évaluation de la capacité maritime (LECM) vise l'application des meilleures pratiques des pays alliés pour fournir une capacité durable, afin d'appuyer l'évaluation des modifications apportées au commandement et au contrôle embarqué de tout le système. L'intention est de fournir l'équivalent d'un échiquier télévisuel pouvant représenter la capacité actuelle et qui est entièrement instrumenté pour appuyer les processus d'évaluation. On s'attend à ce que l'installation soit gérée conjointement par la MRC, le SMA(Mat) et le SMA(S et T), et soit en mesure de procéder simultanément à deux évaluations. On fournit trois scénarios pour illustrer l'utilisation prévue du LECM. En conservant des mesures durables de capacité de base et des instanciations de plateformes, on minimisera le coût de mise en œuvre/saisie d'un projet particulier pour procéder à une évaluation.

Importance : Ce document fournit le concept d'emploi de haut niveau pour le projet du LECM. Il décrit le modèle d'utilisation prévu et la façon dont ce dernier peut s'intégrer aux procédures des ministères.

Perspectives : Au fur et à mesure que le projet du LECM progressera vers l'analyse des options et la construction, ce document fournira le contexte de haut niveau à l'intérieur duquel sera rédigée la documentation sur l'autre projet. On s'attend aussi à ce que ce document subisse des itérations lorsque le LECM, lui-même, subira une évolution et un développement en vue de son adaptation aux exigences changeantes du ministère et de la Marine royale canadienne.

Table of contents

Acknowledgements

The author would like to acknowledge the work of Bradford Dillman and others in developing the ideas embodied in the concept that is MCEL.

INTRODUCTION

DOCUMENT AIM

Concept of Employment (COE)

This document provides the rationale for, and expectations of, the Maritime Capability Evaluation Laboratory (MCEL) in a broad sense. It is designed to achieve a common understanding among all stakeholders of the types of tasks this capability will be expected to support and how it will be employed. The COE is not meant to be prescriptive but rather is intended to inform and guide ongoing staff effort in the development, acquisition and introduction of this departmental capability.

CAPABILITY SUMMARY

The aim of the MCEL project is to decrease the cost and increase the likelihood of successful implementation of (new or replacement) naval command and control capabilities. The aim of the project is to support the CF in being smart customers by providing a capability that enables them to better understand the ramifications of changes to C2 systems. MCEL will do this by providing a cost-effective, enduring capability within which the mission performance of naval command and control capabilities can be evaluated, prior to implementation. In short, "to take it to sea, before going to sea" and provide quantified evidence of performance benefits to decision makers. It is intended that this capability be part of a spectrum of analysis capabilities that include the increasing use of 3D simulation and virtual worlds but in the end require human-in-the-loop experimentation to evaluate the complete human-technical system.

A detailed description of the requirement and proposed concept solution behind the MCEL project is given in Reference 1. Basically, the concept is to provide infrastructure equivalent to a television production facility, but optimized to support the evaluation of naval operations centre systems (where systems are defined as being composed of people, processes and equipment). MCEL as currently formulated will provide two evaluation bays, each large enough to contain a full naval operations centre. In concept, a particular operations centre will be constructed at 1:1 scale from modular walls, consoles and equipment. Particular equipment may be a mock-up, an emulation or actual. When not in use the set for a particular operations centre will either remain in place or be stored for reuse. Particular evaluation events will be similar to an at-sea exercise and each bay will provide space for allied and opposing force inter-actors, white cell exercise control, off-duty crew, and after-action replay. A common synthetic environment and data storage facility will be used to minimize overall cost. The MCEL project, while not providing a particular platform instantiation, will provide some generic modules (floor, walls etc.), and will provide a wide array of data collection capabilities (data, audio, video, simulation truth etc.). In addition, MCEL will provide both red and black network connectivity, thus, allowing connection to fleet or allied distributed exercises.

BACKGROUND

Royal Canadian Navy Context

The following background on the general Royal Canadian Navy (RCN) context is summarized from the Concept of Employment for the Canadian Surface Combatant.

Canada's voice in the world must be supported by action, both at home and abroad. The global conditions that continue to reinforce and shape the requirement for multi-purpose, combat-capable naval ships with global reach have been influenced by the Canada First Defence Strategy (CFDS) [3] which provides a detailed roadmap for the modernisation of the CF so as to produce "a first-class, modern military that is well trained, well equipped and ready to take on the challenges of the 21st century." CFDS directs the CF to deliver on this level of ambition by "maintaining its ability to conduct six core missions[1] within Canada, in North America and globally, at times simultaneously." "To deliver on the Government's level of ambition, the Canadian Forces must be a fully integrated, flexible, multi-role, and combat-capable military. They must also contribute as a core element of a whole-of-government approach to addressing both domestic and international security challenges."

Intent CFDS states the Government intends to replace Canada's current destroyers and frigates. In this regard, "…frigate and destroyer variants will be fitted with different weapons, communications, surveillance and other systems. These new ships will ensure that the military can continue to monitor and defend Canadian waters and make significant contributions to international naval operations."

Threat The future maritime threat out to 2030 and even beyond is broadly defined at References 3 and 4. Threats to both Canada and the Canadian Forces (CF) will range from asymmetric attacks launched by terrorists, non-state actors or belligerent states to conventional wars. Weapons will range from small boat attacks to Weapons of Mass Effect (WME). This weaponry may be directed from sea (surface and subsurface), air, land or space against CF units, Canadian merchant shipping or other Canadian interests. The threats reside throughout the maritime region, from alongside through the littoral, and into the open oceans, with each posing its own unique challenges.

Current Fleet Composition The current fleet composition of destroyers and frigates deliver the operational capabilities that the navy has been expected to provide to the Government of Canada. These naval capabilities are embodied in platforms with significant life spans (30-40 years), a situation that is unlikely to change in the immediate future.

[1] The six core missions:
a. Conduct daily domestic & continental operations, including in the Arctic and through NORAD.
b. Support a major international event in Canada, such as the 2010 Olympics.
c. Respond to a major terrorist attack.
d. Support civilian authorities during a crisis in Canada such as a natural disaster.
e. Lead and/or conduct a major international operation for an extended period.
f. Deploy forces in response to crises elsewhere in the world for shorter periods.

Technology Gap

In addition to the above global context that the RCN will be required to operate within, the gap between Canada's capabilities and those of potential adversaries, particularly in complex multi-threat environments such as the littoral is also narrowing. Both the increased wealth of some emerging economies and considerable advances and increased availability of key technology are giving more nations and non-state actors the opportunity to own some very capable and complex modern platforms and weapons. The coupling of this with the expected rapid change of technology implies that the Navy will continue to face the frequent requirement to update/replace/add capability to its platforms. These requirements lead to the need for an evolutionary development/maintenance process rather than a long-period refit process.

While capability maintenance packages are often discussed in terms of new technology, it is well understood that often the actual systems are a complex socio-technological system of systems in which the commander and human operators are critical parts. In particular, the command and control process supported by the combat control system (CCS) is such a system. Thus, any changes to the equipment, personnel, training, tactics, procedures, sensors, algorithms need to be assessed from a systems perspective.

Implementation Costs System engineering best practice indicates that the most costly time to make changes to a system is after implementation and integration in an operational unit. The complex, changing nature of warfare and technology means that it is impossible to understand all possible future requirements of a system, and thus an iterative development/assessment cycle is required. Since the implementation of such a cycle within an operational unit would have negative consequence/costs in terms of the unit's operational readiness, alternative venues for the development cycle are required to minimize the capability maintenance costs.

It is acknowledged that new C2 and combat systems using open architectures and modern software engineering techniques are expected to allow easier integration of new components. However, the requirement to assess whole systems early in development with respect to all PRICIE elements will remain.

Some of this requirement has been achieved in the past through the use of the training system. However, US experience with these processes show that iterative development increases training requirements. Further, the defence reduction strategy calls for the increased use of simulation to offset decreased at sea opportunities for training. At the same time the RCN has begun to increase its requirements for trainer-based collective (vice individual) training. These two trends can be expected to increase the pressure on full system trainer availability, making the current training system less likely to have the resources to support the evaluation requirements of other units.

CAPBILITY GAP

While it is clear that naval capabilities will require an evolutionary maintenance/development cycle, the current governmental procurement system is structured primarily around the acquisition of non-evolutionary systems. Thus, the current process is structured around projects designed to acquire a particular well-defined capability. Once a capability is acquired, a life cycle manager is appointed, and for large projects an in-service support contract put in place. Any changes made by the support process over the lifetime of a capability arise only as a result of supportability

issues or as completely new projects. *Consequently, force developers must rely on separate, somewhat independent, processes to introduce new or changed procedures, tactics or crewing*.

When a potential capability change is proposed, either to address a capability deficiency or a maintenance deficiency, the appropriate management has to make an assessment of the cost/benefit of the change. These evaluations are currently supported via a variety of instruments: operational evaluations (OPVAL), technical evaluations (TECHVAL), operations research studies, engineering studies, subject matter expert evaluation, or, insertion in trainers or training exercises. Which instruments are used depends on availability of resources, cost etc. *In general due to the cost of platform modification and at-sea exercises the evaluations are done at a sub-system level and with a small number of iterations or samples.* These processes are capable of generating reasonable estimates of the engineering costs of technological implementation.

It is much more difficult to *assess/estimate the mission performance* benefit due to a change; although, engagement modelling can provide estimates in some cases. The human factors costs of particular changes are also difficult to ascertain. In general, *the generation of quantified baseline mission performance is a difficult problem*, understanding the ramification of a change to one part of a complex system on the other parts is even more difficult. Yet, these are essential tasks, and ones we expect to be increasingly called upon to conduct.

Efficient and economical capability updates or insertions demand a capability to conduct consistent, low-cost performance evaluations of changes to complex systems; in the case of MCEL to elements of a naval command and control support system (combat management system, machinery control, and bridge systems).

INTENT FOR THE MCEL CAPABILITY

The Maritime Capability Evaluation Laboratory (MCEL) is proposed to address these gaps by enabling the testing of ship combat management systems at the full-system (platform) level. Here ship combat management systems include the sensor-to-shooter chain as well as damage control and platform defence systems. In particular to address the capability gaps identified above, MCEL will:

1. Provide a common evaluation infrastructure for all platform based C2 evolution (all PRICIE elements);

2. Reduce the cost of evaluations, by allowing testing at a full system level and/or increased sample sizes within tests;

3. Enable mission performance testing which includes human factors issues; and

4. Provide a consistent test environment allowing the development and reuse of baseline performance data.

The laboratory will support the full-scale implementation of the C2 systems for controlling ship capabilities, while utilizing modelling and simulation to implement sensors and weapon effects. The level of environmental fidelity will depend upon the requirements of the capability being tested, but it is expected that MCEL will make use of RCN standard models whenever possible.

System components fidelity will also depend upon requirements and are expected to range from plywood mock-ups of consoles through to actual equipment. The wide range of development means that the facility should not be a single agency capability but a joint CRCN/DRDC/ADM(Mat) land-based test facility. The proposal is that the facility would support the deployment of improved platform capabilities, including but not limited to: demonstrating and evaluating new subsystems, testing new architectures and combat management system functionalities, and evaluating new operations room human systems integration (HSI) and process concepts. The laboratory would also include instrumentation to evaluate the effectiveness of human operators in the loop, and networking capabilities to allow it to be linked with other simulation and training facilities, including ships alongside. Integral to this concept is the ability to baseline current capability so that the effects of new concepts and processes can be fully evaluated.

A major function of the facility would be to conduct experimentation and studies to develop and maintain baseline warfare capability performance metrics for current configurations. It is also intended that the facility will be used to support the capability development process by hosting conceptual system integration trials against baseline systems. This will allow enhanced concept integration testing before going to the expense of attempting to integrate the new capabilities in a live platform. This is particularly significant if existing capabilities need to be removed from operational units before installing the new capability (such as removing an existing radar console or software before installing the new technology).

It is intended that MCEL will be a critical supporting facility to all aspects of the naval capability acquisition process. It should be noted, however, that MCEL is aimed at usability and team performance evaluation not detailed technical engineering evaluation. The questions to be answered are of the type: does this capability concept increase the overall mission performance of the platform.

GENERAL CONCEPT OF EMPLOYMENT

The operational business model is to provide a facility that facilitates capability development in naval platform command and control (combat and maritime systems) at the full system level. It will maintain full implementations of current fleet combat and ship management systems that are instrumented for experimentation purposes. This may require the ability to represent a variety of capability levels as other nations have found it difficult to maintain fleet wide system consistency due to the rate of change of evolutionary systems and the need for special mission fits when working with coalition forces. The system implementations will be contained within full-size, re-configurable, physical mock-ups of the operations centres (and other spaces).

The operational model assumes that a developer of some C2/operations room concept or capability will conduct sub-system development in their own facilities. These capabilities will then be brought to MCEL to conduct experimentation within a whole of platform (or with networking, task group) environment. When concept capability testing is complete, the MCEL system will be returned to the current operational configuration. As changes are made to operational units the MCEL systems will be modified to reflect those changes. The facility will, in general, not undertake subsystem development on its own or take ownership of capabilities that are not part of a current operational capability – although some storage of equipment and configuration knowledge may be maintained.

The MCEL project will provide the infrastructure for the capability but is not currently envisioned to provide any particular platform mock-up out of project funds. MCEL is envisioned as providing the equivalent of a television production facility; it provides the tools – synthetic environment, stage, data collection, storage etc. but not the production specifics. One departure from this analogy is that once a platform has been constructed and baseline performance is measured, MCEL will store the physical construct and performance data so that this work does not need to be done a second time. This means that the start-up costs for platform specific mock-ups are expected to be covered by projects other than MCEL. However, it is expected that the VICTORIA class submarine control room mock-up (vVictoria) developed for submarine C2 research and as an MCEL technology prototype will be hosted within MCEL.

It is expected that evaluation tests conducted in the facility will utilize fully trained operational CF combat teams. It is vital that evaluations be based upon usage by trained operators and, thus, access to operational personnel is a critical element of the concept. It is expected that work within the facility, while not training, will provide a realistic enough environment to provide a positive benefit to participants. It is also hoped that early exposure to new concepts will spur positive feedback into the advancement of the art and science of naval warfare.

The optimal long-term operation of such a facility is dependent upon the adoption of the evolutionary development model for ship system capability by naval capital projects. Given system costs, both the acquisition of the initial platform system instantiation and ongoing system capability maintenance will require project/LCMM (Life Cycle Material Manager) support. However, it is expected that by using common infrastructure, the costs would be minimized, and that projects would be limited to supporting the installation and maintenance of their own platform's systems. The use of technology developed for platform specific training is expected to further reduce implementation and maintenance costs. As an example of potential costing, DRDC

has invested approximately $750,000 in developing the vVictoria prototype which includes both the mock-up and simulation infrastructure. It is expected that since MCEL will provide the infrastructure and general physical framework that instantiating a new platform will be substantially less than this amount.

Facility usage is expected to come from at least the following sources (roughly in order of priority):

1. Major platform acquisition project programs: options analysis, requirement definition, bidder evaluation, acceptance trials, and SOPS/TTP development.

2. System development generated by major platform evolutionary capability development programs operating on a known 2-3 year periodic update cycle. Essentially, DNR and DMEPM driven with CFMWC, DRDC and industry support.

3. System maintenance development programs (essentially LCMM support).

4. System operations changes (DNR, DNTE, CFMWC). For example, evaluation of changes in watch schedules, team configurations, equipment, or environmental conditions such as lighting conditions.

5. DRDC research program final demonstration and technology transition. It is expected that the majority of these programs would be transitioning into the platform evolution process, however, some research programs could be longer range and lower TRL level, but need the fuller system implementation for proper experimentation.

6. Canadian industry developed systems requiring demonstration or development experimentation in a full system context in order to meet Canadian or international TRL standards.

7. International industry developed systems of interest to Canada or whose developer wishes to buy time for development in a full naval system context.

SPECIFIC EMPLOYMENT

This section assumes that a mock-up of the platform compartments has been developed and that baseline mission performance data is available, either from previous MCEL projects or from at-sea trials.

If the particular platform compartment(s) is not available, then part of the inputs would be the funding to develop the mock-up. Similarly, lack of baseline performance would require funding to develop them. This concept of employment assumes that the most efficient method would be for the platform acquisition project to develop the initial test platform and baseline performance measures.

It is also assumed that each user will fund the cost of developing their project specific changes to the baseline platform compartment mock-up, and the cost of conducting the experimental runs for the investigation: crew time, analysis of data etc.

DGNFD Usage Case

Integration of Unmanned Aerial Vehicles (UAV) into naval platforms.

Amongst the issues relating to ship board use of UAVs are the question of where the control stations will be located in the ship and how command of the operators will be exercised.

Staff generate two concepts of operation; one where the UAV controller is located in the hanger area and the other where the controller is located in the operations room. Initial sub-system level work is conducted looking at expected information flow and operations room layout to revise the concepts.

MCEL is configured to represent both cases and used to evaluate and explore issues for each case using operational ship crews, but not requiring any ship alternations or changes to combat system certification. The evaluation team is composed of a combination of DGNFD staff and Sea Training thus providing operational input and early review of proposed doctrine.

CRCN/DGNFD - DNR/CFMWC

Usage:

1. Investigation of potential changes that might be implemented in a maritime platform operations or control room; e.g., outcome of a possible change to Tactics Techniques and Procedures (TTPs), manning or equipment configuration.

2. Investigation of a perceived SOCD that has been reported from the field.

    a. Support to OPVAL investigations of possible solutions.

    b. Verify details of SOCD and develop understanding of requirements.

3. Development or validation of operator-performance related parameters required for engagement-level modelling (timings etc.) for situations not covered by at-sea trials.

Outputs:

1. Test report providing qualitative and quantitative measures related to the question, based upon full socio-technical system performance. Reports would also give feedback on positive

and negative aspects of the changes and potential avenues for further development.

2. Expected change in mission performance relative to the current baseline.

3. Development of new procedures and tactics.

Benefits

1. Reproduction of full human in the loop situations reported from the field (e.g., capability deficiencies) so that they can be better understood before generating possible solutions.

2. Options analyses of possible changes to equipment, SOPs, etc. with qualitative and possible quantitative results from team interactions.

3. Reduced risk by validating new requirements for SOPs or equipment by testing team interaction.

4. Opportunity to verify engagement level modelling parameters in a fully configurable and instrumented environment.

5. Optimization of Operations Room layout, processes and manning.

ADM(MAT)/LCMMs

Usage

1. A request to investigate the impact of a possible system change required for system sustainability that will affect the physical and human-systems interface environment of a team in a maritime platform operations or control room.

2. Investigation of options for minor equipment project changes that might be implemented in a maritime platform operations or control room.

Outputs

1. Test report providing qualitative and quantitative measures related to the question, based upon full socio-technical system performance. Reports would also give feedback on positive and negative aspects of the changes and potential avenues for further development.

ADM(MAT) Project Usage Case

Support of ANZAC upgrade by ANZAC combat System Integration Lab (DSTO, AS).

The Project office for the ANZAC frigate upgrade worked extremely closely with DSTO Maritime Operations Division and utilized a wide variety of modelling and simulation to reduce risk and verify proposed designs.

Amongst the tools they used was a full scale mock-up of the proposed operations centre which was instantiated in a DSTO lab. This lab was used to conduct preliminary OT&E on systems prior to sea trials and saved the project on the order of four weeks of sea time by developing and evaluating TTPs prior to the at-sea phase, discovering simple to fix interface issues before production and providing a location for crew familiarization and training.

In addition, the lab provided the ability to independently verify simulation results provided by the contractor which allowed the reduction in the number of at-sea tests.

The project office also used the lab to assess alternate designs with operational staff thus decreasing the risk of designs not meeting requirements

2. Expected change in mission performance relative to the current baseline.

3. Proposed adjustments to the TTPs supported by the proposed equipment changes.

Benefits

1. Options analyses of possible upgrades and/or replacements for aging equipment with qualitative and possible quantitative results from team interactions without the need for sea going engineering.

2. Reduced risk by validating potential changes to capabilities earlier in the engineering process.

ADM(MAT)/DGMEPM/Individual PMOs

Usage

1. Development of functional requirements for new equipment or changes to existing equipment.

2. Investigation during options analysis phase of acquisition.

3. Evaluation of technical/operational feasibility of bid packages.

4. Evaluation of deliverables.

5. Development of non-technical PRICIE elements such as SOPS, TTPs etc.

Outputs

1. Test report providing qualitative and quantitative measures related to the question, based upon full socio-technical system performance. Reports would also give feedback on positive and negative aspects of the changes and potential avenues for further development.

2. Expected change in mission performance relative to the current baseline.

Benefits

1. Reducing project risk by validating potential requirements.

2. Reduced change cost and/or increased system performance from early identification of operator and team performance issues.

3. Consistent evaluation environment through project life.

Defence R&D Canada / ADM(S&T)

Usage

1. Investigation of full and partial team performance related to the use of new S&T concepts.

2. Demonstration to full and partial naval teams of the potential benefits from the use of new S&T concepts (venue for research program product demonstration).

Outputs

1. Test report providing qualitative and quantitative measures related to the question, based upon full socio-technical system performance. Reports would also give feedback on positive and negative aspects of the changes and potential avenues for further development.

2. Expected change in mission performance relative to the current baseline.

3. Operator feedback on the practicality/usability of S&T solutions to CF problems.

Benefits

1. Early validation of the potential impact of S&T concepts.

2. Development of understanding of naval C2 problem areas.

3. Access to quality data on naval team C2 performance.

4. Increased visibility for new S&T concepts to a wide range of naval personnel.

Industry

Usage

1. Demonstration and evaluation of the potential of prototypes and other equipment not reflected in the real platform under consideration.

Outputs

1. Test report providing qualitative and quantitative measures

DRDC Usage Case

Technology Demonstration

Incommands anti-air warfare technology demonstrator. The project developed and tested a system to coordinate hard and softkill systems for single ships. The testing was conducted at the sub-system level in a synthetic environment at DRDC Valcartier and was demonstrated at sea.

However, the demonstration could not be allowed full access to the combat system and the equipment was located in a separate compartment.

While the project was extremely successful, it was limited in exposure and was not able to explore how the equipment should be integrated into the full operations centre system.

With MCEL the system would be instantiated in a full operations centre and could be exposed to multiple ship crews. Further, by comparison to baseline capability data numeric results on improvement to system capability could be obtained thus providing hard evidence to support the further development and transition from lab to operations.

related to the question, based upon full socio-technical system performance. Reports would also give feedback on positive and negative aspects of the changes and potential avenues for further development.

Benefits

1. Demonstration of new capabilities in a team setting with impartial scientific reporting.

2. Increased visibility of capabilities to a wide range of naval personnel.

3. Increased credibility of product with customer base.

HOW DOES IT INTEGRATE?

Since CRCN and ADM(MAT) currently sponsor a wide range of R&D, in industry and DRDC, aimed at developing and understanding new technological and process capabilities, a portion of the ongoing facility usage would not be new program. The MCEL concept is proposed to provide the required capability more cost effectively with less impact on the conduct of operations. The capability is unique in many instances but in some applications may be required to duplicate existing capabilities (for example to check industry claims for contract verification).

The MCEL facility's full-scale maritime platform experimentation capability is expected to complement and support current and projected DRDC and DND/CF experimentation facilities. At the moment these include:

1. Canadian Forces Warfare Centre (CFWC) at Shirley's Bay: Joint Battlelab (JBL) (Full size joint headquarters) which provides the ability to conduct experimentation on new technologies for strategic and operational joint headquarters.

2. Canadian Forces Maritime Warfare Centre (CFMWC) at Halifax: Battlelab which provides a secure visualization lab for data analysis and C2 concept development, and a team/task group (TG) simulation facility. Neither of these facilities is currently configurable for platform-level system evaluation studies.

3. Canadian Forces Air Warfare Centre (CFAWC) at Shirley's Bay: air related simulators mainly for training purposes, and an extended distributed simulation capability linking CAF trainers and units for distributed mission operations (DMO).

4. Canadian Forces Naval Operations School (CFNOS) simulator facilities in Halifax and Esquimalt which, while providing full and part-task trainers, are limited due to configuration control and increasing dry-land training requirements. CFNOS is currently extending its facilities to provide distributed mission operations for collective and joint training.

5. Combat Systems Training Centre (CSTC) has, as part of the original Halifax class acquisition, a fully-configured full-scale Halifax Class operations room. However, the facility is tightly configuration controlled and used for training and CCS 330 technical development. This could be a location for the MCEL capability but would need to be in addition to current tasking.

6. DRDC Valcartier; System Integration Lab (SIL/LIDS) provides infrastructure for conceptual studies of advanced strategic and operational C2, as well as facilities for sub-system level technology for experimentation and demonstration. It was not intended for tactical/platform level research, lacks easy access to operational personnel, and has space to support a single platform.

7. DRDC Toronto: Provides space for single person and small team experimentation and technology demonstration. Currently contains F18 simulator, helo-deck landing simulator etc. Full scale ergonomic mock-ups have been done in the past of ship bridge physical spaces but there is a lack the space to maintain full size operations room mock-ups and lacks easy access to operational personnel.

8. Industry facilities such as Lockheed Martin's Technology Collaboration Centre (TCC). These facilities are typically normal information technology labs that limit the ability to instantiate platform spaces to scale and are meant for limited duration projects. There is also the question of maintaining intellectual property rights if equipment to be tested comes from a third party.

9. 3D world technology can provide a level of realism and is likely to be an important tool in the development of new concepts. At this point the technology is still developing, and DRDC is working within TTCP to evaluate its usefulness in different types of experimentation. It currently is deficient in the area of human movement around objects, human communication, and ability to reproduce full combat system interfaces. The latter is an area of active research in the United States.

Summary

The RCN has a requirement for a capability to conduct operational performance evaluation of proposed changes to the C2/combat management systems on-board its platforms. These are complex socio-technical systems that require human-in-the-loop testing that is not currently available in software simulation. As platforms move to a more iterative and evolutionary process of capability maintenance, and secondary task access to current RCN facilities decreases (due to primary task usage) this requirement will need its own primary support facility.

The Maritime Capability Evaluation Laboratory (MCEL) will provide this facility and support CRCN/ADM(MAT)/ADM(S&T) and Canadian industry. MCEL is envisioned as a land based facility, akin to a television set, with the capability to support two platform development programs simultaneously using a common synthetic environment and data collection infrastructure. By instantiating a platform's system once, and then evolving it as required, the cost of entry to conduct an evaluation is minimized and the RCN will have improved information to support capability acquisition/development decisions.

MCEL will provide both the stage and infrastructure to support through life evaluation of expected performance due to changes in platform command systems. By enabling full system evaluation earlier in the development cycle, MCEL will improve both the cost-effectiveness of solutions and the overall capability of the RCN. The aim of MCEL is to provide an essential part of the spectrum of tools required for DND/CF to be "smart customers".

References

[1] Hazen, M.G., *Ship System Development Laboratory (SSDevL): A Maritime Systems Development* Facility. (DRDC Atlantic TM 2008-213), Defence R&D Canada – Atlantic, October 2009.

[2] Concept of Employment for Canadian Surface Combatant, Draft, dated Oct 2011.

[3] *Canada First Defence Strategy (CFDS)* (2008)

[4] *The Future Security Environment 2008-2030 Part 1: Current and Emerging Trends* (January 2009)

List of symbols/abbreviations/acronyms/initialisms

ADM(MAT)	Assistant Deputy Minister - Material
ADM(S&T)	Assistant Deputy Minister - Science and Technology
C2	Command and Control
CCS/CMS	Combat Control System / Combat Management System
CF	Canadian Forces
CFDS	Canada First Defence Strategy
CFWC	Canadian Forces Warfare Centre
CFAWC	Canadian Forces Air Warfare Centre
CFMWC	Canadian Forces Maritime Warfare Centre
CFNOS	Canadian Forces Naval Operations School
CRCN	Commander Royal Canadian Navy
CSTC	Combat System Training Centre
DGMEPM	Director General Maritime Engineering Project Management
DGNFD	Director General Naval Force Development
DNCS	Director Naval Combat Systems
DNR	Directorate of Naval Requirements
DNTE	Directorate of Naval Training and Evaluation
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
HSI	Human System Integration
JBL	Joint Battle Lab
LCMM	Life cycle material manager
MCEL	Maritime Capability Evaluation Laboratory
OT&E	Operational Test and Evaluation
OPVAL	Operational Evaluation
PRICIE	Personnel, Research, Infrastructure, Concepts, Information tech, Equipment
PMO	Project Management Office
R&D	Research & Development

RCN	Royal Canadian Navy
SIL	System Integration Lab (also LIDS)
SOCD	Statement of Capability Deficiency
SOPS	Standard Operating Procedures
TCC	Technical Collaboration Centre
TECHVAL	Technology Evaluation
TG	Task Group
TTCP	The Technical Cooperation Program
TTP	Tactics, Techniques and Procedures
WME	Weapons of Mass Effect

This page intentionally left blank.

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g., Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.)

Defence R&D Canada – Atlantic
9 Grove Street
P.O. Box 1012
Dartmouth, Nova Scotia B2Y 3Z7

2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.)

UNCLASSIFIED
(NON-CONTROLLED GOODS)
DMC A
REVIEW: GCEC APRIL 2011

3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)

Maritime Capability Evaluation Laboratory (MCEL): Concept of Employment

4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used)

Hazen, M.G.

5. DATE OF PUBLICATION (Month and year of publication of document.)	6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.)	6b. NO. OF REFS (Total cited in document.)
October 2013	28	4

7. DESCRIPTIVE NOTES (The category of the document, e.g., technical report, technical note or memorandum. If appropriate, enter the type of report, e.g., interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Technical Memorandum

8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)

Defence R&D Canada – Atlantic
9 Grove Street
P.O. Box 1012
Dartmouth, Nova Scotia B2Y 3Z7

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)	9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)
41AP	

10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.)	10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)
DRDC Atlantic TM 2012-241	

11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)

Unlimited

12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.))

Unlimited

13. ABSTRACT (A brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual.)

DRDC has proposed a new departmental capability to be known as the Maritime Capability Evaluation Laboratory (MCEL) to jointly serve the Royal Canadian Navy, ADM(MAT) and ADM(S&T). This capability will address the need to support the evolutionary acquisition, development and maintenance of the command and control capabilities aboard naval platforms by enhancing the evaluation of concepts prior to detailed implementation engineering. This document describes the Concept of Employment for the MCEL capability at a high level and provides documentation for the implementation project team. As the project progresses, more detailed Concept of Operation documents will provide the lower level detail of the day to day facility operation and, with this document, will be used to derive the statement of requirements.

RDDC a proposé une nouvelle capacité ministérielle connue sous le nom de laboratoire d'évaluation de la capacité maritime (LECM), pour servir la Marine royale canadienne, SMA(Mat) et SMA(S&T). Cette capacité répondra au besoin d'appui en matière d'acquisition évolutive, de développement et de maintenance des capacités de commandement et de contrôle à bord de plateformes navales, en améliorant l'évaluation de concepts avant la mise en oeuvre technique détaillée. Ce document fournit le concept d'emploi de haut niveau pour la capacité du LECM ainsi que la documentation concernant la formation de l'équipe de mise en œuvre du projet. Au fur et à mesure de l'évolution du projet, des documents plus détaillés sur le concept de fonctionnement fourniront les détails liés aux niveaux plus bas du fonctionnement quotidien de l'installation et, avec ce document, ils seront utilisés pour établir l'énoncé des besoins.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g., Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Capability; Evaluation; Test facility; Navy; C2

This page intentionally left blank.

Defence R&D Canada

Canada's leader in defence
and National Security
Science and Technology

R & D pour la défense Canada

Chef de file au Canada en matière
de science et de technologie pour
la défense et la sécurité nationale

DEFENCE DÉFENSE

www.drdc-rddc.gc.ca