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Maritime Engineering Journal

70
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Canada's Naval Technical Forum

Fall 2012

Naval materiel assurance for the fleet —
What the Royal Canadian Navy is doing to guide decision-makers

Also in this Issue:

- The *Journal* at 30 – A professional publication for the 21st Century
- Redesign and shock analysis of the *Halifax*-class gas turbine uptake structure

Canada

Top Naval Engineering Cadet at RMC

Photo courtesy Jim Carruthers

Combat Systems Engineering **NCdt Jeremy S. Hamilton** (left) receives a naval sword from retired CSE Capt(N) Jim Carruthers. This is the first year of an annual award endowed by Capt(N) Carruthers for the top naval cadets in the Naval Technical, Maritime Surface/Sub-surface, and Logistics branches at Royal Military College of Canada. The awards are based on fall term academic marks of final year, and on overall performance in naval training during summer training periods. ***Bravo Zulu, Jeremy!***

Director General
Maritime Equipment Program Management

Commodore Patrick T. Finn
OMM, CD

Maritime Engineering Journal

70

(Established 1982)
Fall 2012

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Photo of HMCS *Regina* by Canadian Forces Combat Camera

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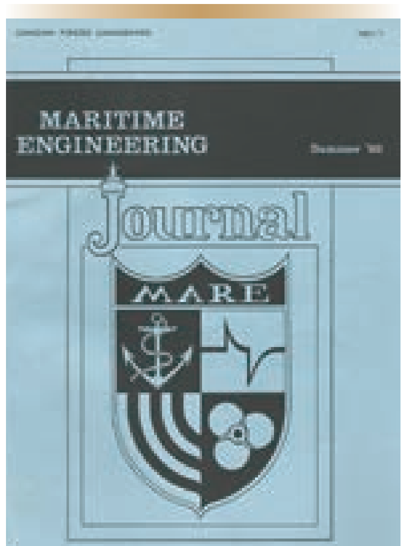
Commodore's Corner

By Commodore Patrick T. Finn, OMM, CD, Director General Maritime Equipment Program Management

The *Maritime Engineering Journal* yesterday, today and tomorrow

This edition of the *Journal* marks the 30th anniversary of a publication that has played an important role in our Branch. Begun under the leadership of Commodore Ernie Ball as Director General Maritime Engineering and Maintenance, and Captain(N) Dennis Reilley (who would go on to be promoted commodore), the *Journal* has striven to educate and generate professional discussion among all members of the Naval Technical Branch. It has presented information on technical changes faced at sea, and the innovative solutions developed in response; has included important historical information on our community, and has been used as a forum for discussing more contentious topics. When the personnel world was examining different methods for managing occupations in the Royal Canadian Navy one option that was discussed was the integration of the combat systems and marine systems streams of our Branch into a single stream. That option was not accepted warmly by everyone, and the *Journal* was used to foster a healthy and professional debate.



As a key component of the Royal Canadian Navy, the technical community continues to need a forum to discuss issues of importance, particularly as we move toward the next fleet that will likely come with concepts for crewing, maintenance, and operational support that will differ from the current approach. These new concepts are but some of the many changes that will affect our community over the coming decade. The pace of change is ever increasing, and with these changes will come our need for greater dialogue.

The *Journal* is one of those items in life that we take for granted, one whose true importance would only perhaps be realized if it were to disappear. Not that the *Maritime Engineering Journal* is under any threat, but ownership of its pages must pass to the next generation – a generation that is drawn to different media forms than those of us approaching retirement have historically used. That will in fact be the challenge of the *Journal* for the coming 30 years: how it will adapt to the changing needs and interests of the members of the Branch. I challenge the youngest members of our community to take an active interest in the *Journal*, and to oversee its evolution as a professional publication for the 21st Century.

I would be remiss if I did not close by highlighting the main factor in the *Journal*'s success over the last three decades, and that is the involvement of Brian McCullough. Most of you know Brian for his ever-present music and storytelling at our mess dinners, and for his quick smile and warmth. Perhaps less known is that Brian has been involved with the *Journal* since its inception in 1982. Brian worked as a copy editor on the first issue, and on all subsequent issues up to today, and was involved in the several redesigns of the publication. After hanging up his uniform in the mid-1990s, Brian established Brightstar Communications to bid successfully on the new Request For Proposals for a production editor for the *Journal*. Brian, with the support of his wife Bridget Madill, has been the driving force behind the *Journal* for the last 30 years, and for that we owe him a great vote of thanks.

Submissions to the *Journal*

The *Journal* welcomes **unclassified submissions** in English or French. To avoid duplication of effort and ensure suitability of subject matter, contributors are asked to first contact the production editor. Contact information may be found on page 1. Letters are always welcome, but only signed correspondence will be considered for publication.

FORUM

A Proposed (interim) Capability for Precision Guided Munitions in *Halifax*-class Ships

By PO1 Bradley Browne

DND photo by Cpl Ron Kinnie, Formation Imaging Services Halifax

The author's proposed site for a precision-guided weapon mount on board some *Halifax*-class frigates is on the starboard mezzanine deck between the hangar and the funnel.

HMCS *Charlottetown*'s deployment to Libyan littoral regions during Operation Mobile in 2011 highlighted the need for naval units to be able to deliver precisely guided munitions against targets capable of threatening civilian populations, and with minimal risk of collateral damage or injury. The inability to effectively minimize this risk was certainly a factor in 'use of force' considerations and weapon selection for engagements.

At this time, ships of the Royal Canadian Navy have no capability for firing 'smart' precision-guided munitions (PGM) and limited capability for conducting naval gunfire support (NGFS). Even after the FELEX frigate life extension upgrades are complete, the 57-mm L/70 Bofors gun system on board the *Halifax*-class ships will not be capable of firing PGMs.

The Navy's next generation of major warship – the Canadian Surface Combatant (CSC) – might well have an integral NGFS capability as part of its design, but before these ships are active there will certainly be more deployments where an NGFS/PGM capability would be highly desirable. Fitting an NGFS/PGM-capable system on board some *Halifax*-class warships would provide an interim solution, allowing doctrine to be formed and operational experience to be gained.

The aim of this paper is to identify a weapon system which could provide both improved NGFS and a PGM capability to the fleet. It is noted that the installation of the Block 2 Advanced Harpoon Weapon Control System (AHWCS) will afford a precision-guided land attack capability to *Halifax*-class ships; however, it is both expensive and has no ability to provide sustained supporting fire without the ship leaving station for reloads.

Discussion

A key element to adding an improved NGFS/PGM capability to a *Halifax*-class warship will be to minimize the impact on the ship's current combat capability. This presents significant limitations both on where an interim weapon can be located and on the type of weapon that can be selected.

The following available locations on board *Halifax*-class warships were considered:

- Forecastle: Removing the 57-mm gun in order to emplace an NGFS-capable system is not a suitable option;
- Bridge Wings and Boat Decks: There is no ability to install a deck-piercing gun mount in these areas;
- Missile Decks: Removing either the vertical launch system (VLS) or the AHWCS would have significant impact on the ship's fighting capability, and there is no way to install a through-deck gun installation on the missile decks;
- Flight Deck: Once again, there is no possibility of installing a through-deck gun mount;
- Quarter Deck: No possibility for a through-deck gun mount, and any system installed in this area would be extremely limited in height due to flight safety requirements; and,
- Mezzanine Decks (Hangar): This area could be considered for a deck-piercing gun installation, but it would affect the torpedo magazine spaces, and would also necessitate removing a .50-calibre heavy machine gun (HMG) mount.

Since the mezzanine decks appear to be the only suitable location available for a new weapon installation, the impact of any potential weapon system must be considered carefully. High-powered systems such as the 155-mm howitzer, for example, would be unsuitable due to weight restrictions and recoil impulse. The proximity of the weapon to the hangar could result in shock or vibration damage to a helicopter stored inside the hangar. Additionally, due to the high recoil impulse of such a gun system, significant stiffening of the ship's structure would be required.

Clearly, a lightweight, relatively low recoil system which can provide a sustainable NGFS capability and the ability to deliver PGMs would be most appropriate for this location. Suitable weapon systems do exist, one of which is the 120-mm NEMO New Mortar system from Patria Hägglunds. The naval version has the following characteristics:

- Weight 1,500 kg;
- -3 to + 85-degree elevation capability;
- Unmanned turret;
- Semi-automatic 120-mm smoothbore mortar with hydro-pneumatic recoil system;
- Maximum rate of fire 10 rounds per minute (rpm) and a sustained rate of fire of six rpm;
- Range greater than 10 km;
- Suitable for all standard 120-mm smoothbore mortar ammunition and smart PGMs;
- Stabilized system;
- Low recoil forces;
- The Patria NEMO 120-mm system fits in a standard 1.9-metre turret ring (as found on the LAV-III armoured vehicle);
- Nuclear, biological, chemical (NBC) protection integrated with the turret; and,
- Direct and indirect fire capability.

It is proposed that the best option to provide a *Halifax*-class warship with NGFS/PGM capability would be the installation of a 120-mm NEMO turret emplaced on the starboard mezzanine deck, with through-deck piercing into the starboard torpedo magazine. The starboard side is recommended so as to enable the best Phalanx Close-In Weapon System (CIWS) engagement sector to be presented landward during NGFS missions. Such an installation will have the following impacts:

- Loss of one .50-calibre HMG mount;
- Reconfiguration of the starboard torpedo magazine to allow palletized storage of 120-mm mortar ammunition instead of torpedoes (deck mountings could be retained for torpedo brackets should an anti-submarine warfare priority mission be assigned). This would result in a reduction of torpedo capacity to a maximum of 12 torpedoes when configured for NGFS missions;

- The starboard torpedo tubes and hoist would be retained, allowing weapons still to be loaded and fired on the starboard side;
- Installation of a 120-mm NEMO turret with below-deck access for loading, maintenance and manning through the torpedo magazine;
- Palletized ammunition storage space for 120-mm mortar ammunition allowing for fast ammunitioning, including at-sea replenishment via helicopter or heavy jackstay;
- Due to the remote-control nature of the NEMO turret, the fire-control system for it could be emplaced in the operations room; and,
- The weapons veto system (WVS) would require a modification to include a veto capability for the NEMO turret.

The NEMO is capable of firing guided rounds including the Strix 120-mm mortar bomb, an infrared-seeking round capable of engaging armoured fighting vehicles, providing it with a PGM capability. Other Global Positioning System-guided PGMs might also be compatible, such as the M395 120-mm PGMM which is now in service with US Forces in Afghanistan.

This installation would not be necessary on all *Halifax*-class warships. Having two to three ships per coast modified with the NEMO mortar would suffice to provide this operational capability with sufficient redundancy for ships unavailable due to maintenance.

Conclusion

It is recognized that the relatively short range (10+ km) of the NEMO weapon system is not an ideal solution; however, littoral operations such as those encountered by *Charlottetown* during Operation Mobile may see Canadian warships operating within three to five miles of shore – well within the effective range of the NEMO and its PGM capability.

Establishing an improved naval gunfire support capability and developing the ability to deliver precision-guided munitions is a goal that the Royal Canadian Navy has had an interest in progressing for many years. Installation of the 120-mm NEMO system would allow the fleet to both establish doctrine and gain experience with this interim capability, while providing a significant additional littoral combat capability for the fleet.

Petty Officer First Class Bradley Browne was Senior Weapons Engineering Sonar Technician on board HMCS Charlottetown *(FFH-339) during Operation Mobile. He is now a Weapons Engineering Manager and Senior Weapons Engineering Sonar Instructor at Canadian Forces Naval Engineering School Halifax.*

Naval Materiel Assurance — Prelude to Action for the Royal Canadian Navy

By Lt(N) Scott Koshman, Cdr David Peer, Cdr Russell Green

"The prelude to action is the work of the engine-room department." – Admiral Sir John Jellicoe, RN, Battle of Jutland, 1916

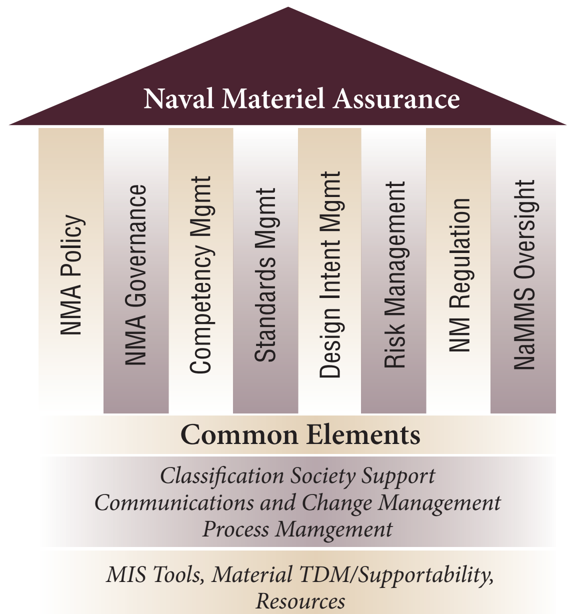
The Case for Action

Director General Maritime Equipment Program Management (DGMEPM) introduced Naval Materiel Assurance (NMA) in the 2011 revision to the Naval Materiel Management System to guide our future materiel support decisions (*see MEJ no. 68*). NMA is important for naval technical officers and non-commissioned members to understand because, quite simply, the concepts it embraces undergird all processes for the materiel support of our fleet.

We are living in challenging times with limited engineering resources but increasing engineering demands. It is a given that the Royal Canadian Navy (RCN) and the Department of National Defence (DND) have insufficient in-house technical expertise and capacity to completely design or maintain a ship. NMA will provide the structure to ensure that appropriate technical support resources, including industrial capacity, are dedicated to a ship's design and to its maintenance through-life.

Today's materiel support environment is shaped by key factors that, when combined, exceed our engineering capacity. The RCN is faced with evolving and increasing legislative and regulatory requirements, and ADM(Mat) is adjusting its materiel acquisition and support strategies to take advantage of private sector capabilities that are transforming fleet support. We are embarking on a critical period of sustained fleet renewal with fewer resources for standards development, independent review, and design validation than ever before, and yet, compounding the situation, the roles, responsibilities, and accountabilities of the organizations and authorities involved are sometimes unclear.

Without denying the significant challenge this creates, the collective aim must be to make the most effective use of all available resources to support the naval mission with an acceptable level of materiel risk. It starts with requirements and the correct alignment of design decisions. An hour of effort in early design and design review could save hundreds of hours of re-work afterward correcting initial design errors which, in some cases, might ultimately prove impossible to fix.



Success of naval materiel assurance (NMA) requires the execution of work in a number of key areas and common elements that highlight both existing and new areas of focus. The development of NMA requires reinforcement and expansion of governance, oversight, policy, and risk management. New, or sometimes historically overlooked, pillars include competency management, management of engineering standards, management of a ship's design intent, and naval materiel regulation of safety/environment.

Underpinning these areas are common enablers such as the support of classification societies, management information systems and tools, technical documentation and materiel supportability, and capacity of resources. As part of the comprehensive view of the Naval Materiel Management System, NMA represents an updated approach to the business of assuring that navy materiel satisfies its intended use through life.

Figure 1.

Lack of proper materiel assurance can have grave consequences, and in this respect the deadly gearbox explosion on board HMCS *Kootenay* in 1969 (*MEJ 34, 48*) was a watershed event for our navy. Since then we have been fortunate in avoiding major disaster due to materiel failure, but two very recent examples from allied forces are worth reviewing as these failures in technical support weighed significantly in the development of Naval Materiel Assurance.

RAF Nimrod Aircraft Crash

On 2 September 2006, a Royal Air Force Nimrod maritime patrol aircraft crashed after experiencing a fuel leak and fire during in-flight refuelling operations over Afghanistan. All 14 service members on board were killed. Of particular interest to the RCN is that an independent review accused the UK Ministry of Defence (MoD) of sacrificing safety to cut costs. The report, "A Failure of Leadership, Culture and Priorities,"[1] identified three design flaws and a number of previous incidents that should have provided ample warning of design problems. In the words of the report's author, consideration of Nimrod safety "missed the key dangers" and was "a story of incompetence, complacency, and cynicism."[1]

The report cited a lack of appreciation of the specific needs of older equipment, a poor relationship with industry, an ineffective and wasteful safety system that was not fit for purpose, and a culture that sacrificed basic safety in the interest of cost savings. In response to legal action, the UK MoD admitted responsibility for the deaths of the 14 service members in March 2009.

RAN Amphibious Fleet Failure

In February 2011, the Royal Australian Navy (RAN) was called upon to provide amphibious support to disaster relief following Cyclone Yasi, whereupon the RAN revealed to the Australian defence minister that wholesale materiel support failures had been affecting the availability and sustainability of the RAN amphibious fleet for over a decade. Failure to keep the fleet seaworthy and ready for action left Australia unable to respond effectively to a national emergency.

Rizzo Report Conclusions for Canada

- Organizational complexity and blurred accountabilities create risk
- Failure to manage materiel leads to deviations from design intent and poor materiel performance
- Resource shortages over a sustained period create a bow wave of materiel problems
- Organizational culture that places the short-term operational mission above all else compromises the sustainability and technical readiness of the fleet
- A 'hollowing out' of naval engineering capability has significant negative impact on materiel support organizations and fleet readiness.

The subsequent Rizzo report[2] highlighted a number of critical issues for the RAN and its Defence Materiel Organisation. The report made 24 recommendations, the most significant of which was to "rebuild navy engineering;" a rather serious indictment of the RAN and DMO. The impact of hollowing out the engineering capability of the navy was by far the most troubling finding in the Rizzo report.

NMA and Key Concepts

These two reports highlight issues pertinent to the RCN and its materiel support organizations since we have similar fleets, organizational structures, processes and resource challenges. Assuring the ability to provide naval materiel support is a key enabler of the naval mission. Risk to the RCN and DND due to systemic failures in materiel management ultimately impacts the naval mission and cannot be ignored.

NMA is founded on certain pillars and common elements (see Figure 1), and has three key objectives:

- Assure the materiel state of naval systems and equipment;
- Avoid severe accidents through selected regulation in key safety areas; and
- Balance effectiveness and efficiency.

Naval Materiel Assurance begins at concept design and continues until disposal. Knowledge of the state of the systems and equipment allows identification and management of risk to personnel safety, the environment, and materiel performance and capability. The risk of severe accidents is reduced first through competent engineering design, then through diligent conduct of maintenance, and finally by pragmatic risk-based decisions when dealing with departures from the design intent of the materiel. Short- and long-term operational effectiveness of naval materiel is balanced with efficient resource usage.

Control of a ship's design intent through-life to assure a defined naval capability is the essence of materiel assurance. It is a fundamental principle of systems engineering. NMA will be applied to surface ships, submarines, and naval auxiliary vessels so that they will meet their design intent, and thus comply with applicable legislative requirements and regulations, and meet intended performance standards. NMA will also provide guidance and direction on the management of technical risk throughout the life cycle of naval materiel when departures from design intent occur. The goal is to facilitate sound, informed risk decisions on a wide range of technical and materiel issues.

NMA depends on the correct application of a few key concepts, especially now as the assurance framework is being established. For example:

- Limited resources must be prioritized and applied to the most critical naval materiel issues; thus, structured **risk management** is a critical concept of NMA. Effective organizational decision-making can only occur when clarity of roles, responsibility, authority, and accountability exist;
- Separate consideration of **safety and performance** will help naval authorities and DND materiel support organizations deal with the department's organizational construct, policy framework, and legal responsibilities for safety;
- The use of appropriate commercially available naval **materiel technical standards** and practices will contribute to a more effective use of the navy's scarce technical resources;
- The materiel management system (**NaMMS**) needs to be overseen to ensure its effective implementation and execution; and finally,
- **Classification societies** are now providing support to Western navies in ship safety and assurance. They can provide support that will help DND leverage commercial and civil expertise in support of NMA.

Each of these concepts is central to how NMA will work, and, as key concepts, deserve further explanation.

NMA Implementation Timeline

2009-2013 Initial policy development
NaMMS
Naval Materiel Regulation CFTO
Risk Management CFTO
Ship Classification CFTO

2010-2015 NMA information and guidance
Naval technical seminars
Maritime Engineering Journal Articles
Training and education events

2012-2022 Naval regulation implementation
Develop ship or class certification plans
Apply materiel regulation to major projects
Apply materiel regulation to existing fleet

2012-2022 Classification Society Engagement
Contract with classification society(ies)
Build and maintain new ships in class
Develop internal tools, templates and processes
Phased implementation of class in fleet

Risk Management and Effective Decision-making

A critical part of the naval mission is the collective ability to manage risk while respecting the primacy of operations. Managing risk and establishing clear lines of responsibility and control should be considered together for the understanding of the challenges and opportunities the RCN faces, and how appropriate decisions are made. For effective materiel management in an organization as large as DND, decisions must be made in a consistent, structured manner by those in the best position to weigh and accept the risk.

Consideration of risk underpins all decisions affecting naval materiel. Insufficient resources necessitate the setting of priorities, and the conscientious balancing of compromises. Five key risk principles underpin all decisions affecting naval materiel:

- Accepting no unnecessary risk;
- Making risk decisions at the appropriate level;
- Accepting risk when the benefits outweigh the costs;
- Anticipating and managing risk by planning; and
- Documenting key risk-based decisions.

Decision-makers must understand the likelihood and consequences of risks due to changes of the materiel state or changes to ship roles that lead to departures from the design intent. They need clear guidance on roles, responsibilities, authorities, and the accountability for decisions, and they need to plan for known risks. DGMEPM is producing naval materiel policy guidance on risk management for typical through-life materiel support.

Safety and Performance

Government legislative and policy decisions necessitate separate consideration of safety and performance. Comparable civil processes, upon which safety assurance models are based, are not applicable to military performance issues. The separate consideration of safety allows the navy to compare safety-related risks against a civil baseline and assists in making structured, informed decisions.

DGMEPM is taking great strides in managing ship safety as a core capability of the fleet and as a key responsibility for the department. A major initiative is now underway to introduce self-regulation for ship safety. In April 2012, DGMEPM established the Naval Materiel Regulatory Authority (NMRA) that has embarked on an ambitious program to define policy for risk management, to introduce safety-based self-regulation on surface ships, and the engagement of classification societies. These NMRA initiatives will help the RCN achieve greater effectiveness within its support capacity and ensure that DND will be able to demonstrate effective management of ship and environmental materiel safety.

Naval Materiel Technical Standards Management

Another key NMA concept is the use of commercial standards and practice where practicable. Since writing and maintaining RCN standards when appropriate commercial standards are available is not a prudent nor effective use of resources, NMA has encouraged the decision to adopt classification society rules to support the design and build of future ships. NMA has also based DND's self-regulation of ships on international standards – the International Naval Safety Association's Naval Ship Code and the International Maritime Organization's Safety of Life at Sea (SOLAS) convention, selected for each class by rationalizing against military roles. These decisions will significantly reduce the effort necessary to ensure that appropriate and relevant technical standards are available for our ships.

NaMMS Oversight

Oversight of the Naval Materiel Management System (NaMMS) is required to assess both the effectiveness of the materiel support processes that are delivered and the adherence by the naval technical community to the policies. Oversight is also necessary in identifying root causes of NaMMS problems and prioritizing improvement efforts.

NaMMS is intended to be the performance management framework to assess and report on materiel support to the RCN mission. The Defence Resource Management Information System (DRMIS) tool will be used to improve our ability to implement such a framework and ensure the desired NMA outcomes occur.

Classification Society Support

DGMEPM has adopted classification society rules for all future ship designs, following the lead of the United Kingdom and many other allied navies. The support possible from classification societies extends far beyond their rules. For example, Lloyd's Register provides a naval ship assurance service for the UK Ministry of Defence, and is also involved in ship safety and naval regulation activities. Classification societies could provide this support to Canada, and also provide valuable independent assurance of in-service support contracts. Classification societies would bring experienced, qualified personnel into the Canadian naval materiel support toolbox – a key enabler for NMA.

Conclusion

The navy of the future will need innovative ideas to make the most effective use of available resources, thus maximizing the operational effect for Canada's naval mission. NMA – naval materiel assurance – is an important step forward and will chart new ways and means to ensure the RCN continues to sail the world's oceans in support of national objectives and the defence of Canada. In this sense, NMA is poised to become the RCN's prelude to action.

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Cdr David Peer is the Defence Fellow at Dalhousie University in Halifax and was the Ship Systems Section Head in DGMEPM. He is a key author of the upcoming NMA Canadian Forces Technical Orders.

Cdr Russell Green is the Section Head responsible for the NaMM System, including the policy, implementation and oversight of NMA and Naval Materiel Regulation in DMSS in Ottawa. He is also the MEPM Strategic Initiative (MSI) Thrust Leader for NMA.

Redesign and Shock Analysis of the *Halifax*-class Gas Turbine Uptake Structure[1]

By Lt(N) Simon Summers [Illustrations and photos courtesy the author, except where noted]

Since early in their life, the gas turbine uptakes of *Halifax*-class patrol frigates have experienced thermally-induced cracking (Figure 1). The two contributing factors are that the thin shell plating is supported by a stiff external structure to resist shock loads, and the interior of the shell is washed directly with hot exhaust gases. The shell is subjected to thermal expansion, but is constrained by the stiff structure thus leading to a fatigue cycle for every flash-up of a gas turbine. Consequently, any solution must address the thermal cycling while ensuring that shock requirements are met.

In this work, an attempt was made to redesign the uptakes to meet both requirements, but addressing only shock requirements explicitly. First, a review was conducted of previous work on this problem to determine features anticipated to reduce thermal constraint. Then, a model of the uptake was modified and assessed against shock loading, and further modifications were applied iteratively until the best possible design was achieved within the given constraints.

Photo by Brian McCullough

The clean exterior of this funnel of a *Halifax*-class frigate shows no evidence of the situation going on inside the gas-turbine uptake structure.

Problem

The cracking occurs at the welds between the shell and the circumferential flanges, and between the shell and vertical stiffeners. Paradoxically, the heavy stiffening structure designed to withstand shock loads is the direct cause of the cracking, which reduces resistance to shock. Since heavier structure also increases inertial loads in shock events, a lighter structure should have a compounded positive effect.

This problem should be addressed in the *Halifax*-class (and avoided in future ships) because:

- cracking reduces the structural strength of the uptakes to the point where they could potentially fail in a shock event;
- escaping exhaust gases pose a hazard to personnel; and
- time and resources spent on repairs could be committed to other maintenance or to operations.

Prior Work

Soon after cracking was discovered in *Halifax*-class vessels, a study recommended either reducing the constraint on thermal expansion, or insulating the interior surface with a liner 38-mm (1.5 inch) thick along the full height of the uptake. The first option was rejected as requiring excessive modification. A variation of the second option was implemented, but only using 13-mm-thick (0.5 inch) liners at each of the three circumferential flanges. Unfortunately, this merely delayed the onset of cracking.

Another study investigated potential modifications, assessing the effect on thermal stresses of reducing dimensions of the stiffening structure. Stresses were found to be still well above yield, showing that any solution would need to eliminate constraints to be successful. Encouragingly, however, shock stresses were reduced by lightening the structure.

Figure 1a. It will take more than a cosmetic repair to close this thermally induced crack along a forward main vertical stiffener in HMCS *Montreal*'s starboard gas turbine uptake.

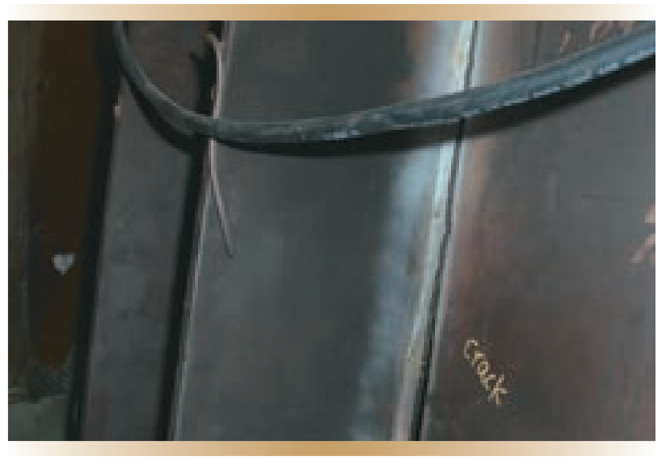

Figure 1b. One word says it all. Fatigue failure is the result when the shell of the intake is subjected to thermal expansion, but is constrained by the external stiffener.

The United States Navy addressed the problem in the *Oliver Hazard Perry* (FFG-7), *Avenger* (MCM-1) and *Arleigh Burke* (DDG-51) classes. Measures shown to reduce constraint included:

- reducing or eliminating stiffener lengths;
- detaching stiffeners from the shell in areas of high constraint;
- intermittent rather than continuous welds;
- mounting arrangements that permit thermal expansion;
- avoiding geometric constraints such as corners;
- uptakes consisting of separate sections connected by flexible joints;
- internal insulation; and
- reducing or eliminating external insulation.

European navies have used other measures such as installing shock mounts which reduce acceleration of the structure during shock events, thereby requiring less stiffening and constraint, and using trunnion-mounted uptakes supported by A-frames to eliminate bending stresses and allow thermal expansion. The trunnion procedure was developed to reduce damaging heat transfer in glass fibre ships, ensuring dissipation of heat before it can be conducted to ship structure. (This was implemented in the Danish StanFlex ships, and a design was produced for the Royal Navy's Type 23 frigates.)

Shock Assessment

Other than physical testing, the analysis methods surrounding surface ship shock requirements[2] are the ***design response spectrum*** method – which is given as the preferred method – and the ***base acceleration*** and ***time-history*** methods. For all methods, the design criterion is the 0.2-percent offset yield stress.

Design response spectrum method – This is the basis for the other methods, and is essentially an application of the seismic design method for static structures to shock rather than seismic events. A concern with shock design is the lack of a single, unique event that can be used to represent a worst case. Different shock events can excite different frequencies, leading to different failure mechanisms. The DRS method addresses this anomaly through requirements originally created using a representative set of shock events, then applied in the frequency domain.

Requirements are given as displacement curves to be applied to the equipment mode shapes as a function of natural frequency. The curves were developed by recording the displacements of a range of single-degree-of-freedom systems to a number of shock events, then creating an envelope that captured the greatest displacement over all events at each frequency.

In applying the method, the natural frequencies and mode shapes are determined, then displacements from the curves are applied to find the maximum deformation at each node in each frequency. These must then be related in time, which is achieved by using an empirical summation to conservatively account for phase differences between responses across the frequency range. The result is the maximum displacement at each node, used to calculate parameters such as stress, section force and reaction force. This method is only strictly valid in the elastic stress range, because plastic deformation will change the modal responses.

Base acceleration method – This is essentially a less-rigorous application of the DRS parameters. It assumes constant acceleration, treating the model as a single-degree-of-freedom system moving stiffly with the base motion.

Time-history method – This is the modelling of the actual response to a displacement time-history that meets the DRS envelope. Since this action shows only that the model would survive the specific event, it is possible that the model would fail in a different event if different modes were excited. However, this method can accommodate damping, which tends to reduce displacement and thus stress, and may reduce excessive conservativeness in a design.

The Model

Figure 2 shows the model of the original uptake in its current configuration in *Halifax*-class ships. It is approximately a cylinder 10 metres tall by two metres in diameter, with the DRES Ball air-eductor mounted on the upper end. The boundary conditions consist of the feet at no. 1 deck and four 'snubbers' at the upper ends. The material is AISI 316 stainless steel, and is subjected to temperatures of up to 500° C. A stress-strain curve was developed for the material at this temperature, giving the failure criterion as 199 MPa, the 0.2-percent offset yield stress. The model accounted for the weight of insulation, and dynamic modelling used Rayleigh damping parameters from other work on shock modelling in ships.

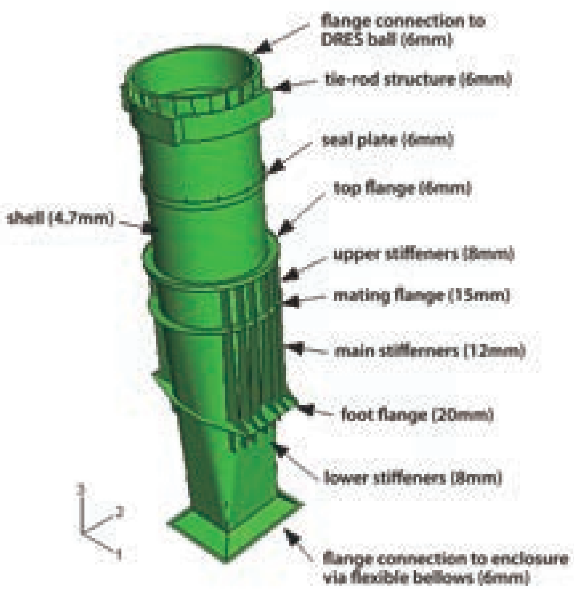

Figure 2. Original design of the original (existing) uptake with boundary conditions.

Evaluation

The iterative design process entailed assessing the original model and the 'minimum' model, which had all stiffening structure removed. Then, features were incorporated to reduce thermal fatigue. Further modifications were based on each previous model, strengthening where required and reducing constraint where possible. This process was used to converge on the best possible design within the constraint of the existing mounting arrangements.

It was intended that, as the preferred method, only the DRS method would be used. However, all models – the original, the minimum and the final – failed the design criterion using this method. Due to the elastic nature of the model, stresses were artificially extremely high. To get an idea of realistic stresses with plastic deformation, they were mapped to the plastic curve at the same strains. Though stresses still exceeded the design criterion, all strain values were less than two percent, thus the uptake might survive a shock event with some deformation while continuing to function.

Because all models failed the DRS method, the base acceleration method was used instead, which had also been used for the original design. This allowed modelling of geometric and material non-linearity with the plastic stress-strain curve. Plastic deformation allowed dissipation of the unrealistically high stresses from the elastic model, while geometric non-linearity allowed a localized buckling check. The model was also assessed using global cylinder buckling criteria. This method was successful in determining a model that met the design criterion.

The original and final models were also checked using the time-history method. This showed the original model exceeding the design criterion in only a few localized areas with high stress and with strain of approximately two percent. As this was in non-critical areas, the uptake would likely survive with minor plastic deformation. The final model, however, experienced high stresses and was stopped when stress exceeded the design criterion by 50 percent. However, the time-history event used was constructed based on the DRS envelope, was very conservative, and did not represent an actual shock event. Thus, this does not indicate certain failure. Further analysis could be conducted using actual shock time-histories, which was not possible here due to the classification of this information.

Final Design

The final design (Figure 3) had a 25-mm gap where the main and upper stiffeners are currently welded to the uptake, and had flanges of 12 mm x 50 mm attached to the inward sides of the main stiffener outer edges. This design was selected because maximum shock stresses were well below the design criterion and susceptibility to buckling was similar to that of the original uptake.

This was the termination of this work. However, before potential implementation, the model would require assessment in thermal loading, then iteration between design for shock and for thermal loading.

Previous reports on the *Halifax*-class uptakes showed high stresses developing due to thermal gradients, particularly at the circumferential flanges. Unfortunately, implementing the potential solutions to thermal cycling found in the review of previous work would require major modification to address these flanges, which was outside the scope of this work. Given this, the final design here is unlikely to reduce thermal stresses to an acceptable level.

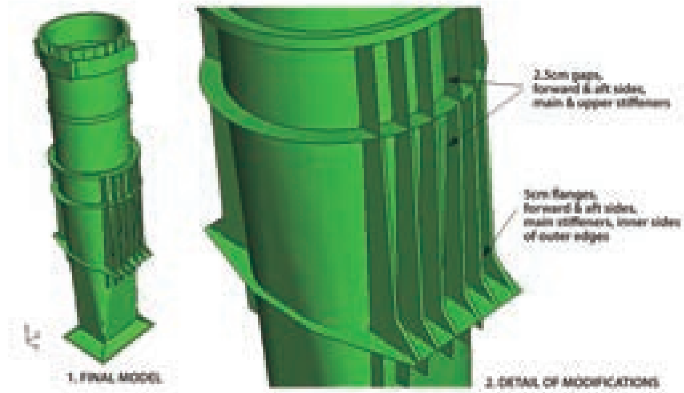

Figure 3. Model of the final uptake design with detail.

Recommendations

The main results here are to assess the inadequacy of the current design, to describe potential modifications, and to underscore the importance of considering both thermal fatigue and shock loading in future designs. The following are design features that can reduce thermal constraint while meeting shock requirements:

- Fit internal insulation to reduce shell temperature, heat transfer rate, and thus the temperature gradient;
- Employ exhaust gas cooling, such as with a heat-exchanger or water injection;
- Minimize or eliminate stiffening, flanges, and other constraints attached directly to the shell;
- Use multiple, individually-mounted sections connected by flexible bellows, reducing weight and thus minimizing shock loads and the required stiffening;
- Use shock mounting to reduce shock loading and the required stiffening;
- Use A-frame trunnion mounting to eliminate bending stresses, allow for thermal expansion, and reduce heat conduction to ship structure; and/or
- Situate mounting points as near as possible to the uptake centre of gravity, thereby minimizing inertial loads above and below the mounting points.

Other insights were gained from this work, particularly regarding shock design. The DRS method, which uses the relevant mode shapes, is given as the preferred method. Though the models here failed the DRS method, this was much the result of being constrained by the existing design, and it was still seen why this is the preferred method. In a new design the DRS method would ensure that all mode shapes are addressed, which the time-history method cannot do, and would tailor the structure by considering likely response in shock, rather than leading to the uniformly stiff structure generated using the base acceleration method. It was seen that a relatively small number of modes contribute significantly to the stress, making this detailed refining of the model feasible.

Also, though all design methods are technically acceptable, it is important to note that they can lead to very different designs. Base acceleration, though simpler, is not actually representative, and tends to give stiff, heavy designs that do not consider the effect of inertia on dynamic response. Conversely, if the time-history method were used alone, it would result in a model tailored to one or a few specific shock events, and would likely be too light and would fail in other shock events. The DRS method considers all modes in a realistic manner, resulting in a relatively light design that should survive expected shock events. Models designed using this method then provide the benefit of minimized stiffening, reducing constraint to thermal expansion, and also minimizing weight, thus increasing the margin available for other systems.

Lt(N) Summers is the Marine Systems Engineering Officer on board HMCS Preserver.

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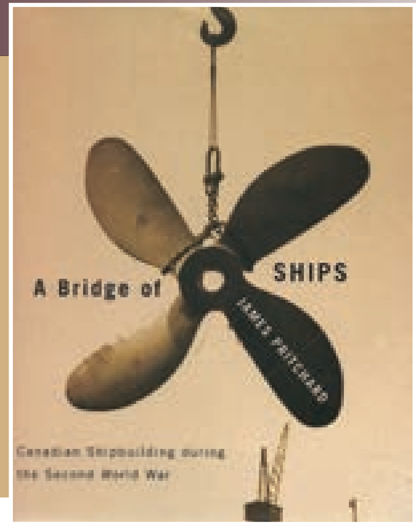
Book Review

A Bridge of Ships

Reviewed by Captain(N) ret. Jim Dean
and Captain(N) ret. Don Wilson

A Bridge of Ships – Canadian Shipbuilding during the Second World War
James S. Pritchard
© 2011
McGill-Queen's University Press (Montreal)
ISBN 978-0-77353-824-5
464 pages; Illustrated; Select bibliography; Index; $59.95



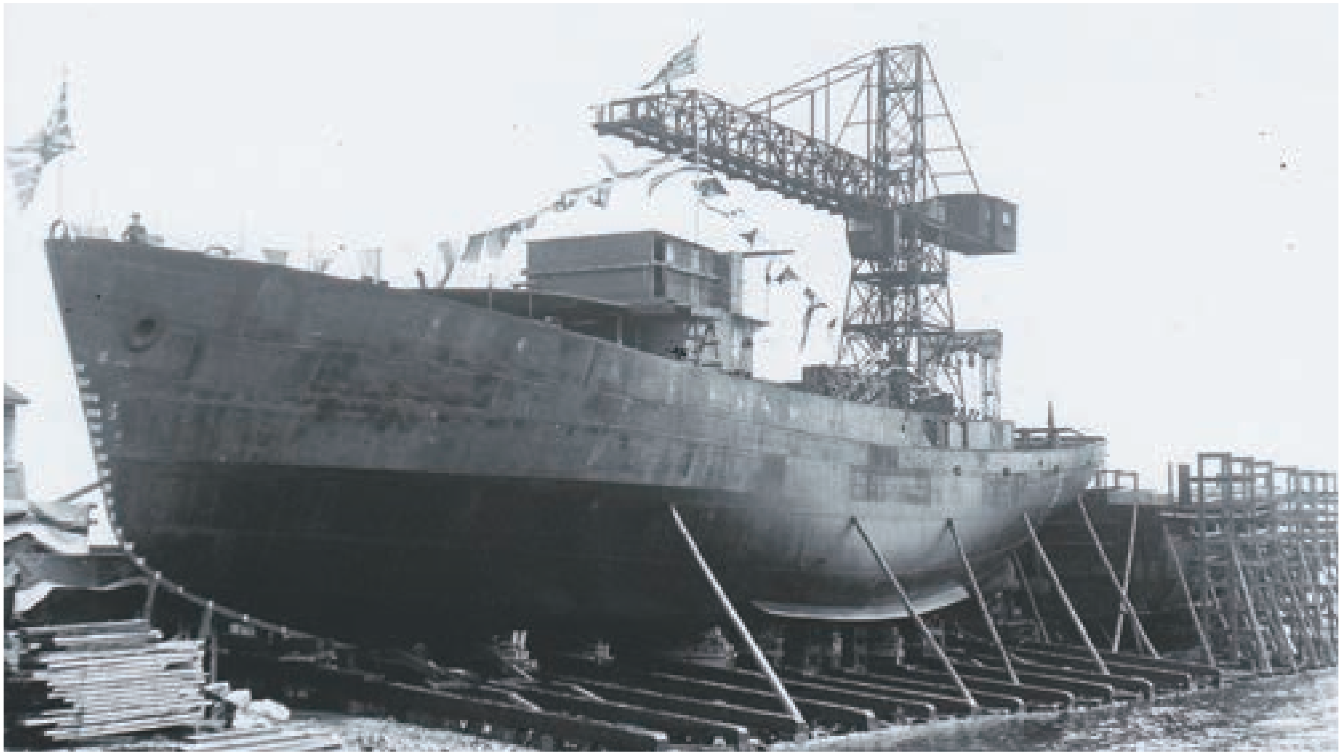
This meticulously researched book is a fascinating overview of the many facets of the rise, success and subsequent fall of Canadian shipbuilding and repair, specifically during the Second World War. It is always a pleasure to find that someone has taken the time to research and put together a book that most successfully fills a knowledge gap. While the role of the Royal Canadian Navy (RCN) in the Second World War is well-documented, until the publication of this book this had not been the case in terms of the Canadian defence industrial base that grew to meet Canada's need for naval and commercial ships at the beginning of the war.

It was apparent from the start that the federal government could not manage the building and repair of ships without a major contribution from industry and from all those Canadians who worked in shipbuilding and repair. There were also major challenges based on the sheer magnitude of the requirement, and the geographical breadth of the country. Demographics defined the likely geographical location for shipbuilding and ship repair yards, but it was the fact that government and industry found a common goal that provided such remarkable results.

The book's title derives from a wartime poster that proclaimed, "The Road to Victory is a Bridge of Ships." Canada, as most of us know, made a significant contribution to shipbuilding between 1939 and 1945, especially in the construction of corvettes. What most readers likely will not know is the story of the resurrection and expansion of Canada's almost moribund shipyards, the organization that evolved for wartime shipbuilding and repair, the development of the industries needed to supply engines and other equipment for ships, and the problems and impact on wartime labour. This book examines in detail all these factors as well as the interactions among the involved politicians, public servants and industrialists, which in themselves provide a fascinating insight into the struggle for power and the resources to meet wartime commitments. Anyone who was associated closely with the construction of the DDH-280 Tribal-class destroyers or *Halifax*-class patrol frigates in the 1970s and 1980s will find that the book provides historical background that explains much about the problems and attitudes experienced on these projects.

Author James Pritchard, professor emeritus of history at Queen's University in Kingston, shows a thorough understanding of what is involved in ship design, construction and repair, and of the industrial infrastructure and resources that support them. He sets the scene for his review by outlining Canada's limited shipbuilding effort in the First World War, which was constrained by the hostile efforts of the British shipbuilding industry and preferential tariffs for British steel. The Canadian government had little interest in shipbuilding, and neither did the RCN which, until the start of the Second World War, basically relied on the Royal Navy for technical expertise. By 1939 the few Canadian shipyards remaining did little construction, limping along with repair work and whatever manufacturing jobs they could obtain.

At the outbreak of war the shipyards had to expand quickly, and this required government investment. An organization was needed to meet shipbuilding construction and conversion targets, while providing for ship repair (which often conflicted with ship construction). Pritchard describes the organization and expansion that was achieved, how it varied through the war, and how it was affected by changing government policies and by the personalities of the politicians, public servants and industrialists who were involved. He provides some interesting perspectives on the main players, such as the iconic Minister of Munitions and



Marine Museum of the Great Lakes at Kingston, Francis McLachlan Collection

The revised Flower-class corvette HMCS *Belleville* (K-332) under construction at Kingston Shipbuilding Co. (Kingston, Ontario) in 1944. The ship was sold to the Dominican Republic in 1947.

Supply, the Hon. C.D. Howe, who is described as disliking civil servants, preferring businessmen, obsessed with control, and a poor planner.

Howe's name is prominent in this book as the individual who stick-handled his way through government meetings and was able to recruit officials from industry to help him manage the tremendous task of creating an infrastructure to construct and repair both naval and commercial ships. Not only was it important to have facilities to build the ships, there was also the need to manufacture the main and auxiliary machinery – boilers, engines, pumps, generators and a raft of other items – frequently under licence from British or American companies.

The book offers a number of surprises. For instance, those who believed that many warships were built in the Maritimes during the war will find it interesting to learn that only three steel-hulled warships – three corvettes built by Saint John Shipbuilding and Drydock – were completed. The four Tribal-class destroyers built in Halifax were started, but not completed until after the war because the priorities for labour and steel in the Maritimes were for cargo vessels and ship repairs. Another interesting fact pertains to the national distribution of warship and cargo ship construction. Cargo ship construction predominated on the West Coast and is a story in itself. In addition to building 252 cargo ships of 10,000 tons, and many smaller ones, West Coast yards converted 19 American-built CVEs (Carrier Vessel Escorts) for the Royal Navy.

Britain's interest in ship construction in Canada is a very important facet that runs throughout the book. While the British interests might be construed as selfish and as "exploiting the colonies," the technical support and liaison of the British Admiralty Technical Mission (BATM) that was established in Canada by the Admiralty at the outset of the war proved crucial for both the shipbuilding industry and the RCN. Unfortunately, the reasons are mentioned only briefly, and the reader is left feeling that more information about the BATM's interaction and contribution with both industry and the RCN would have been useful. Indeed, the Navy does not shine in the story of shipbuilding and repair, being characterized as lacking such things as foresight, planning and ship acquisition project management skills. It is criticized for slow recognition of the importance and problems of ship repair, but there is no detailed examination of the reasons. Admittedly, the book is about the structure and organization for shipbuilding, but whereas both the initial shortcomings and the development of industry are exposed in detail, naval personnel may well feel that the RCN has been treated too lightly and somewhat unfairly.

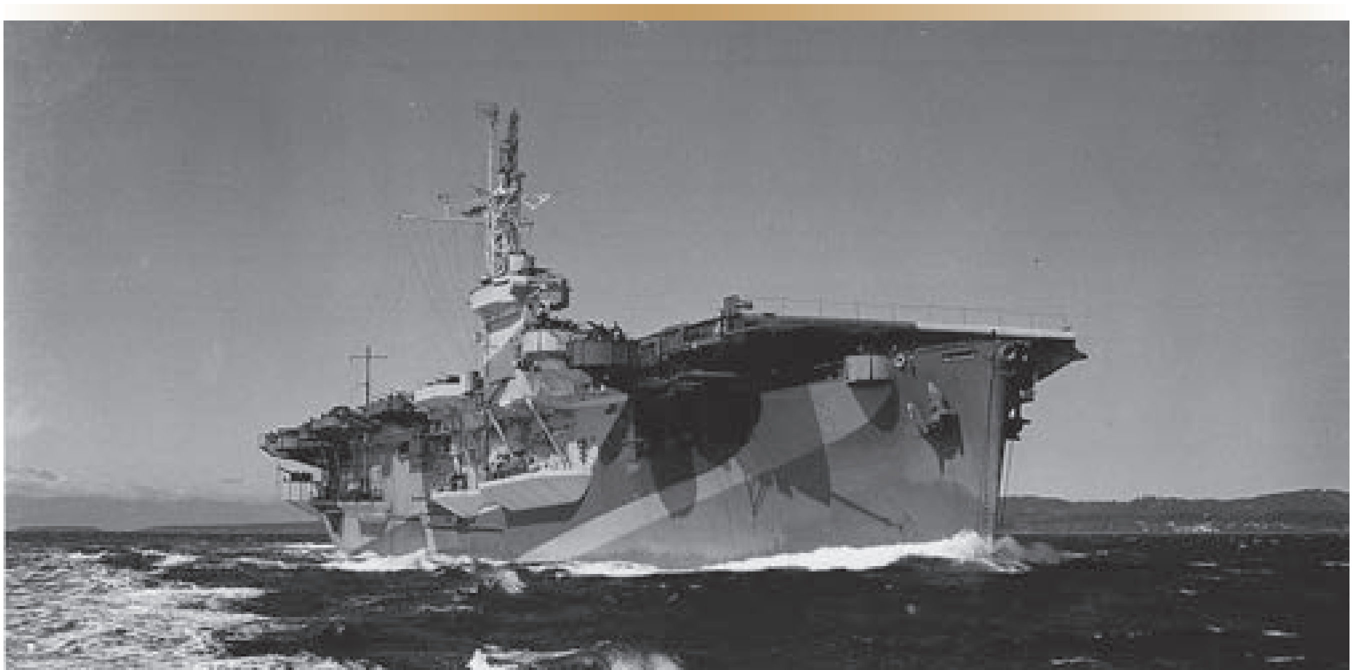
No examination of wartime shipbuilding would be complete without a thorough discussion of shipyard labour, and this is particularly well executed in Pritchard's book. The mistrust between management and labour resulted in many strikes and much unrest that affected production. Wages, working conditions, incomprehensible policies and lack of suitable housing – all of these affected the labour force. What emerges is that British shipbuilding and conversion programs were necessary to maintaining a stable shipyard labour force in Canada. At its peak in 1943, shipbuilding and repair employed about 126,000 men and women, or about 15 percent of the wartime labour effort, making Canada third among Allied shipbuilding countries. Canadian yards built more than 1,000 merchant and warships, some 3,300 landing craft and more than 5,000 other vessels of varying sizes, and carried out in excess of 36,000 repairs to naval vessels and merchantmen. Indeed, the speed with which vessels were constructed demonstrates the resourcefulness of Canada's shipbuilding organizations. United Shipyards in Montreal set a speed record for construction of North Sands freighters in 1943, "…delivering the last of the first six ships on 31 May. Sixteen more North Sands freighters followed during the next twenty-eight weeks before freeze-up. One of them, SS Fort Romaine, [was] delivered on 8 September, fifty-eight days after the laying of her keel….Twenty-eight days later, she arrived in the United Kingdom with a full cargo."

For many reasons, these magnificent achievements left no lasting legacy for future shipbuilding. Wartime shipbuilding in Canada was 'build-to-print' of British designs and specifications, and there was no development of a Canadian engineering design capability. What did remain was a rejuvenated steel-production industry and a cadre of skilled workers for other post-war employment.

The book is loaded with statistics but the story is an easy read. It is highly recommended for anyone interested in Canadian shipbuilding, particularly as we begin new ship construction under our National Shipbuilding Procurement Strategy (NSPS). *A Bridge of Ships* would be perfect 'required reading' for all those involved in the NSPS from both government and industry.

Capt(N) Jim Dean was involved in systems acquisition for the DDH-280 class destroyers, commissioned HMCS Iroquois *as the Combat Systems Engineer, and was Deputy Project Manager (Ship) for the Canadian Patrol Frigate Project, responsible for engineering.*

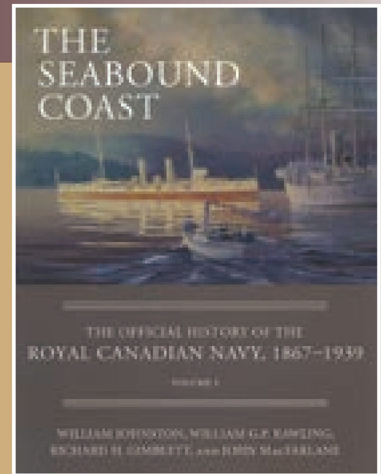
Capt(N) Don Wilson served as engineering naval overseer for the DDH-280 building program in Sorel, Quebec, commissioned HMCS Huron *as the Engineering Officer, and served as Planning Officer of Ship Repair Unit (Atlantic). Both retired officers are active with the Canadian Naval Technical History Association in Ottawa.*



Library and Archives Canada, PA-13818

HMS *Rajah* was one of 19 carrier vessel escorts converted for the Royal Navy on Canada's West Coast.

Book Review



The Seabound Coast

Reviewed by Captain(N) Hugues Létourneau

The Seabound Coast – The Official History of the Royal Canadian Navy, 1867-1939, Vol. 1
William Johnston, William G.P. Rawling, Richard H. Gimblett and John MacFarlane

Dundurn Press (Toronto)
ISBN 978-1-55488-907-5
1,014 pages; Illustrated; Select bibliography; Index; $70

In the early 1950s, the Royal Canadian Navy (RCN) published Volumes 1 and 2 of *The Naval Service of Canada* by naval historian Gilbert N. Tucker. Volume 1 covered the period prior to the Second World War, and Volume 2 described the RCN's shore-based operations in that war. Volume 3 was to have covered the operational – i.e., the seagoing – aspects of the Second World War, but was never published. Tucker was seen by naval authorities at the time as being somewhat too frank about the RCN's lack of proper equipment during the war (described very well by naval historian Richard Mayne in his 2007 book, *Betrayed*), and his third tome never saw the light of day. Instead, historian Joseph Schull was commissioned to produce *The Far Distant Ships*, which, while relatively entertaining, was rather short on serious historical content and analysis.

In theory, today's group of Canadian naval historians should have produced a 'pumped-up' Volume 3, but in the past six decades much new information has come to light suggesting that Canada's naval participation in the 1914-1918 war was considerably greater than what Tucker presented. Despite the vast small-ship fleet that defined the Navy in the 1940s, the RCN of the early 1950s put considerable emphasis on a big-ship navy, and tended to minimize the importance of small-ship operations in the First World War – which might help explain why small-ship operations before the Second World War received little attention from Tucker.

Today's generation of naval historians therefore resolved to provide a more balanced view of Canada's official naval history, and this is reflected in *The Seabound Coast*, published in 2010. Considered the official history of the RCN for the pre-World War II period, it is the 'new' Volume I. The new Volume II, published in two books as *No Higher Purpose* and *A Blue Water Navy*, respectively, was released some years ago.

Historians William Johnston, William Rawling, Richard Gimblett and John MacFarlane have succeeded in providing the more balanced approach they were striving for, helped in part by the passage of time and the availability of a considerable amount of new material since Tucker's histories appeared in 1952. At over a thousand pages it is a bulky reference text – and quite readable. The whole naval defence question since the Canadian federation was created in 1867, including the issues leading up to the RCN's creation in 1910, is presented in a new, far more complete light. As well, for the first time, the book provides a thorough and complete account of the RCN's not-so-minor role in the First World War. It also shines a light on the drought years between 1918 and 1927, when the RCN practically ceased to exist. The snail's pace growth, starting around 1930, would help preserve a core of expertise, however small.

The 1980s saw the development of a long-overdue 'core' – a critical mass – of naval historians in this country. The generation led by Alec Douglas, James Boutilier and Michael Hadley would be augmented by Rawling, Gimblett, Mayne and others who would give the final push to ensure that Canadian naval history would remain an ongoing concern. *No Higher Purpose*, *A Blue Water Navy*, and now *The Seabound Coast*, mark the arrival of a professional, clear account of the relevant aspects of our naval history and heritage.

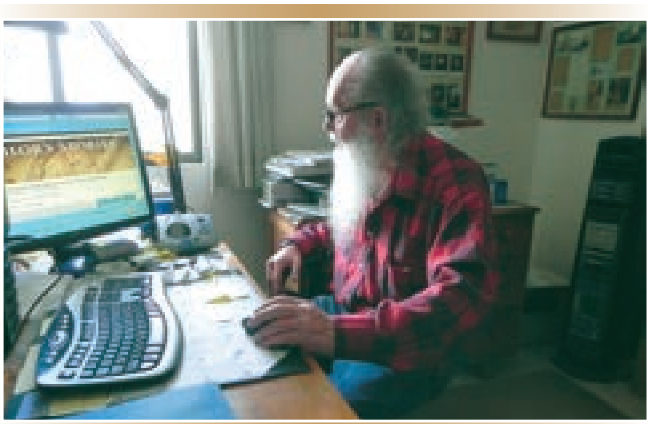
Capt(N) Hugues Létourneau lives in Québec City and is Regional Liaison Officer (Québec) for the Canadian Forces Liaison Council.

Book Review

A Sailor's Stories

Reviewed by Brian McCullough

A Sailor's Stories
Arlo M. Moen
© 2009 Arlo Moen
P.O. Box 34074, Scotia Square RPO
Halifax, NS B3J 3S1
ISBN 978-1-896496-64-1
205 pages; Illustrated; Author's notes; $20 + $3 S&H
(www.arlommoen.com)



Arlo M. Moen

It's not too many books that come with a warning label. In the case of *A Sailor's Stories*, the tag line on the title page reads: *WARNING – It is difficult to tell from a distance where fiction ends and fact begins. (Did it happen, really, or was it all a dream?)*

Blow me down if this wasn't all the invitation I needed to dive into this extraordinary book. As I was to discover later when I met up with the author in his crow's nest overlooking Halifax Harbour, the book is the man is the book. And what a story they have to tell.

Meet Arlo Moen – the boy from Saskatchewan, navy veteran, professional actor, author, and commentator on practically everything. He is a polite and attentive host, but don't let the perfect manners fool you. He is irreverent and suffers fools badly. Did I mention that he is 92 years old?

A Sailor's Stories is like nothing I have read before. Shock. Surprise. Delight. Awkwardness. Embarrassment. I felt each of these as I immersed myself in the vignettes that Moen has chosen to share from the sea bag of his life's journey. To tell you the truth, I wasn't always sure where he was headed.

The book opens with a seminal event for Moen, the torpedoing of HMCS *Saguenay* on 1 December 1940. As a young sparker he was ordered to send the ship's distress signal over the wireless, amid the screams of the injured and dying that would stay inside his headset to haunt him for more than seven decades.

His brief account of his service as a telegraphist on board HMS *Rodney* during the hunt for the *Bismarck* is remarkably evocative, as is his leisurely and partly fictional reminiscence of his peacetime experiences years later as an Electrical Officer on shore leave in Havana. Moen delivers his salty yarns in the confident voice of a mess deck raconteur, and the two pieces are brilliant for entirely different reasons.

The book goes decidedly non-linear after this, with a lurching foray into childhood memories (some disturbing), a few self-indulgent rants, and some insightful poetry – "*Men and minds, discipline held, on steely springs,*" (from *Stanchion*). When I asked him about some of the rough language and indelicate passages in the book, he replied simply, "That's the way it was."

I didn't know quite what to make of all this. *A Sailor's Stories* struck me as something of an odd stewpot of stories and essays at first, but then a light went on and I finally 'got it'. Arlo Moen plays by his own rules. Where I had been looking for a highly structured memoir, I was missing the journey of ideas that was being offered by this most amazing, free-thinking writer.

"It always paid to have a good story," Moen writes. The reader is well-paid with the good stories dished up in this remarkable book.

News Briefs

Journal associate editor receives Veterans Affairs commendation

by Brian McCullough

Tom Douglas, Associate Editor of the *Maritime Engineering Journal*, has received a Minister of Veterans Affairs Commendation for his extensive contributions to the remembrance of the sacrifices and achievements of Canadians in armed conflict.

Douglas, who joined the *Journal* editorial team earlier this year, is an author and historian who has written extensively on Canadian military heritage subjects, including four best-selling books: *Canadian Spies, D Day, Great Canadian War Heroes*, and *Valour at Vimy Ridge*. His latest book, *To Wawa with Love*, a collection of short stories about his family's life in the Northern Ontario mining town of Wawa after his father returned from serving overseas during the Second World War, was recently published by James Lorimer and Company.

Photo courtesy Veterans Affairs Canada

Tom Douglas (right) receives a commendation from Veterans Affairs Minister Steven Blaney in July.

Prior to joining the *Journal*, Douglas was English copy editor for the *Canadian Military Journal*, and also served as Communications Assistant to former Veterans Affairs Minister Bennett Campbell. In 2005 he was part of the Veterans Affairs media delegation that travelled overseas to report on the 60th anniversary of Holland's liberation. (For more on Tom Douglas's career see **www.veterans.gc.ca/eng/department/mincom/commendation**)

London radar museum looking for naval material


Photo by Brian McCullough

London, Ontario's **The Secrets of RADAR Museum** is looking for material to establish a display on naval radar, and is interested in hearing from anyone who can contribute relevant information, publications or artifacts. This not-for-profit museum in London's south end is dedicated to preserving the history of radar in Canada and around the world. Contact naval coordinator Lawrence Petch at **info@secretsofradar.com**, and visit **www.secretsofradar.com** for more information.

PRESERVING CANADA'S NAVAL TECHNICAL HERITAGE

NEWS

Canadian Naval Technical History Association

CNTHA News *Est. 1997*

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Preserving our Naval Technical Record

The CNTHA is very pleased to have had a close association with the *Maritime Engineering Journal* for the past 14 years. The *Journal* records today's naval technical accomplishments, along with the issues and problems of the day and how they were solved. To help preserve this historical record, the CNTHA is completing a scanning project (see below) so that the entire 30-year *Journal* collection can be accessed through our website **www.cntha.ca**.

Today's technical issues quickly become yesterday's news and tomorrow's historical events. Recording these events, and remaining cognizant of why they occurred and the lessons they offer, is an important aspect of avoiding similar challenges as we move our technology forward.

Canada has a rich history of innovative naval R&D. As early as 1948, the Royal Canadian Navy's electrical laboratories had originated the idea of DATAR, a digital system for acquiring, processing, transmitting and displaying naval battle space information. Later advancements included variable depth sonar, the RAST (Recovery Assist, Secure and Traverse) system to support shipborne helicopter operations, and a triad of shipboard integrated systems for processing and display, machinery control, and interior communications. Navies around the world continue to rely on some of these technologies to this day.

The CNTHA believes it is important that the naval technical support community, both serving and retired, safeguard and learn from this rich naval technical heritage. We sincerely hope that the close relationship between the *Maritime Engineering Journal* and the CNTHA will continue for many years to come.
– ***Tony Thatcher, CNTHA Executive Director***

Photo by Brian McCullough

CNTHA webmaster Don Wilson has been scanning back issues to complete an online PDF archive of the *Maritime Engineering Journal*'s full 30-year catalogue.

Journal Scanning Project

Since 1998, the *Maritime Engineering Journal* has been delivered in electronic PDF format from **d2k Marketing Communications**, the magazine's production services provider. Previous electronic files are unavailable, so in July the CNTHA's webmaster undertook the task of creating a PDF archive of all editions of the *Journal* going right back to issue no. 1 in 1982.

In a delightfully surprising twist we discovered that, due to an indexing error made many years ago, what had been identified as issue No. 3/1983 just did not exist. Rather than upset the now-established numbering sequence, we simply identify the phantom issue in the archive as 'not published.'

The scanning project should be complete by December. With a full online archive of the *Maritime Engineering Journal* now available via the Internet, the lessons of our navy's technical past can continue to serve interested researchers everywhere. We are pleased to have helped make this happen.
– ***Don Wilson, CNTHA Webmaster***

Canada