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Maritime Engineering Journal

CANADA'S NAVAL TECHNICAL FORUM

Fall 2005

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Canada

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Cover Photo: HMCS *Victoria* (SSK-876) alongside the naval dockyard at Esquimalt, British Columbia. Structural issues affecting the *Victoria*-class submarines have been the subject of extensive study by the Defence Research & Development Canada (Atlantic) agency in Halifax. *(Photo by Brian McCullough)*

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Commodore's Corner

The prelude to action...

By Commodore Richard W. Greenwood, CD
Director General Maritime Equipment Program Management

With my return to Ottawa and to DGMEPM this summer for the third time, I have had occasion to reflect on both the changes and the constants that I am seeing in naval engineering and naval equipment program management relative to my first posting here back in 1988. My first experience in what was then called the Maritime Engineering and Maintenance division (DGMEM) was enlivened by a lot of challenge and volatility in both the world of Canadian naval engineering, and in the world geopolitical situation at large. While much has changed in the intervening 17 years, things really aren't so different today.

Looking back nearly two decades, the naval engineering and support branches were immersed in a tremendous amount of detailed engineering and project management activity associated with bringing the new *Halifax*-class frigates into service, and with modernizing the Tribal-class destroyers under PMO TRUMP. There was also tremendous swirl on the concept formulation/ project definition front as we struggled to reformulate the navy's submarine and future surface ship requirements and options following the cancellation of the SSN project.

On the world stage, the disintegration of the USSR served to throw into high relief the need to reconsider some basic assumptions about Canada's national defence doctrine, and about naval requirements and the associated materiel options. The debate over the termination of the Polar 8 icebreaker project linked considerations of federal fleet renewal to national industrial strategic issues surrounding sustainment of the Canadian shipbuilding industry.

Since 1988, the fleet has undergone an almost wholesale transition from steam-powered, Bailey meter-controlled warships, to a fleet of gas-turbine propelled ships controlled by solid-state integrated machinery control systems. Vertical-launch missiles have largely replaced guns and mortars, and plot tables and ADLIPS have given way to multi-linked, digital command and control systems. Radios and teletype have been replaced by highly interoperable, worldwide satellite communication systems that seem to have an obsolescence half-life barely longer than a single ship deployment. There is no question that the scope and the pace of technological change have been, and continue to be, truly staggering.

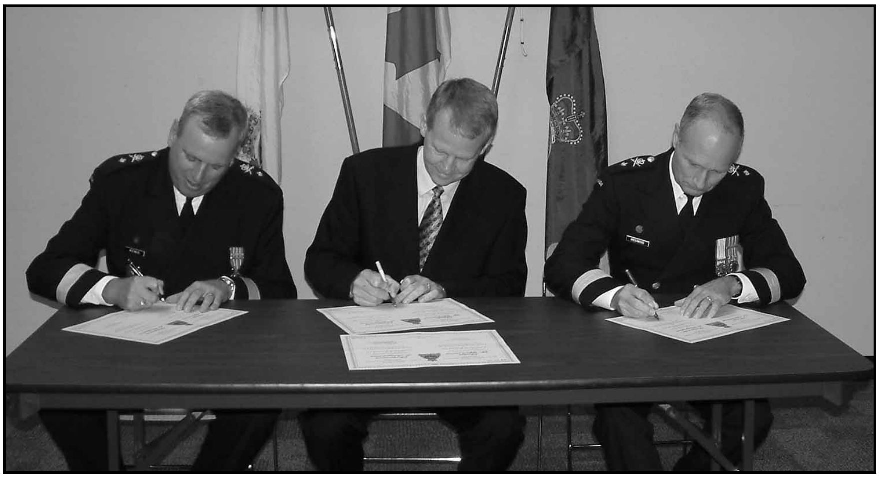
Yet, despite all that has changed, much remains similar in our work today. We are once again heavily engaged in the challenges of introducing a new class of vessels, this time in the form of the *Victoria*-class submarines, are advancing the procurement of a major platform in the joint support ship (JSS), preparing to midlife-update the *Halifax* class under Project FELEX, and are formulating the requirements basis for a future fleet of single-class surface combatants. All the while, of course, we continue with our work of managing a host of project activity surrounding advanced naval equipment and systems. And once again, federal fleet renewal is reanimating discussion and debate on national policy regarding the shipbuilding industry. The world is as dangerous a place as ever (if not more so) and the elusiveness of the threat is motivating a fundamental transformation in the definition of national defence requirements.

Predictably, the operational engineering imperatives of reliability, maintainability and availability continue to be our stable touchstones. They are the operational measure of the success of our efforts, just as the project management trinity of cost, schedule and performance represent the three fundamental degrees of freedom that discipline our common engineering endeavours. We in the naval technical community have an enduring role to play in applying our analytical, systems engineering capabilities to finding solutions to whatever requirements arise in our various posts. In this group I include the entire naval technical support community of naval technical officers, NCMs, DND civilian technical and support staffs, and the galaxy of retired service members and contractors who provide materiel support to the navy.

Whether we are working in support of CF transformation, personnel management, current fleet operations or future fleet development, it is our balanced application of a disciplined engineering approach (the art of the solution, if you like) that represents the essential and enduring relevance of our contribution to Canada. The fact that we have members of this community in posts as disparate as Afghanistan and the

Canadian Space Agency suggests that it is the portability and versatility of this fundamental skill set, beyond any platform or system-specific knowledge, which forms the most essential contribution of the naval technical branch to both the navy and to the Canadian Forces as a whole. The ultimate objective of our collective effort in ensuring the navy and the Canadian Forces have the naval equipment they need, when they need it, could be considered the modern equivalent of that essential role Admiral Jellicoe referred to as "the prelude to action."

In pondering these threads of both change and continuity, I am struck by the challenge and the privilege of continuing the legacy of our many esteemed predecessors in this essential role. The requirements and technology may change, but the proud tradition of innovation and commitment in applying "the art of the solution" to important service and national requirements stands fast and is our common heritage to emulate.



Cmdre Roger Westwood (left), Assistant Deputy Minister (Materiel) Dan Ross and newly appointed Cmdre Richard Greenwood sign the DGMEPM handover documents on Aug. 31 in Ottawa. ***(Photo by Brian McCullough)***

A career in retrospect

By Commodore (Ret.) Roger Westwood, CD

Since handing over the reins of the Maritime Equipment Program Management division to Cmdre Richard Greenwood on Aug. 31, and retiring from the navy ten days later, I have had good opportunity to reflect on my 35-year career and put a number of things into perspective.

My first observation concerns the excellence of the undergraduate education I received at the Royal Military College of Canada. Without question, this foundation proved to be the key to all of my future accomplishments. I hate to say it, but it was not until I entered postgraduate training at the Massachusetts Institute of Technology in 1979, five years after leaving RMC, that I fully recognized the quality of my undergraduate program. I was much better prepared than the majority of my U.S. Navy PG counterparts, thanks I am certain to the excellence of my RMC program, and also to the superb naval engineering training I had received in the fleet. While there is no substitute for a continuous learning environment such as that being supported in today's Canadian Forces and Public Service, I cannot emphasize strongly enough the benefits of obtaining a foundation of quality undergraduate education upon which to build. Undergrad degree programs such as those offered by RMC and other top institutions clearly play a key role in underpinning our professional careers and other endeavours.

I must also comment on the outstanding professional opportunities that were given to me over the course of my career. Apart from the time I spent on post-grad, at staff college, and on the National Strategic Studies course, all of my thirty-plus years of commissioned service were in what can be considered "hard" naval engineering positions. The vast majority of these were quality jobs, and I was fortunate to be given such wonderful opportunities to develop my naval profession.

I learned some lessons from these experiences. As a young, brand-new lieutenant-commander posted as Naval Architect Officer on the West Coast — a position with considerable responsibility and latitude — I had to defend my decisions at the admiral level within the formation, and with the design authority in the Maritime Engineering and Maintenance division in Ottawa. This work allowed me to develop an excellent understanding of the overall naval

(Continues next page)

engineering and maintenance picture very early in my career, and was an important step in developing my self-confidence and preparing me for the challenges that lay ahead.

In 1992, then wearing the rank of captain, I was appointed Project Manager for the Maritime Coastal Defence Vessel Project. The project had just entered its implementation phase, and for a naval architect to be given the opportunity to guide a new ship project through preliminary design review, critical design review, construction of first of class, first-of-class trials and transition into service was nothing short of superb. What made it all work was the supportive, familial relationship based on trust that developed between the DND and Public Works and Government Services Canada teams. This formed the basis from which all problems and issues could be resolved, and allowed the project management office to speak with one voice in providing unambiguous, consistent advice and direction to the contractor. There is a good lesson here for project managers in that developing a solid trust relationship and supportive atmosphere within your project teams is a definite key to success.

After eleven years in NDHQ, the chance to return to the West Coast, this time as Commanding Officer of Fleet Maintenance Facility Cape Breton, was just what the doctor ordered. Although I have tried hard never to lose focus on why we are here, this job strongly reinforced the critical role we play in direct support of naval operations. Serving time in both formation and material group environments — the duality of our career paths — is essential to developing our careers and providing the required support to the navy.

I would like to thank all members of the naval technical community, and in particular those of you in the Maritime Equipment Program Management division for your excellent support and friendship during my 27 months as DGMEPM. The support that you gave me, similar to that which I received throughout my career, was simply exceptional and made my job so much easier.

I realize I am leaving the naval technical community at a very challenging time, but I leave knowing there remain many good, talented people who possess all of the necessary skills and abilities to meet current challenges and exploit future opportunities. As a community, we have always exhibited the adaptability, common sense and enthusiasm required to meet the many daunting challenges that have been thrown at us. I see no reason why this should be any different in the future.

Good luck, and best wishes to you all.

Letters to the Editor

Sir:

After having received and appreciated the *Maritime Engineering Journal* for a great many years, I now would like you to remove my name from your mailing list...Time and age have come where interest in naval engineering and associated business is gradually fading away.

I have very much enjoyed and valued my contacts with the Royal Canadian Navy, both during my active service as a weapons-electrical officer in the Royal Netherlands Navy during the late 1950s and 1960s, as well as during my career as program manager, commercial director and president of Hollandse Signaal Apparaten in the '70s and '80s.

I do wish you and your editorial staff lots of success with your most interesting journal.

With kind regards,

— Jan. H. Bosma
Goor, The Netherlands

Dear Sir:

I take much pleasure in receiving the latest issue of the *Maritime Engineering Journal*, and my profound thanks for all previous issues. The timing also coincides with the admission that old age is here and for that reason I have enclosed my new address to commemorate the occasion....

I admire what you do, and my best regards for the future.

Yours sincerely,

— Kenneth Inglis
St. Catharines, Ontario

[P.S. Do not forget me when the next issue is due.]

Branch Adviser

Enhanced flexibility in NCM technical occupations of key importance in environment of "progressive change"

By Captain(N) Martin Adamson

Of all the issues that are most important to the Naval Technical branch, the ongoing MOSART review of all occupations within the Canadian Forces remains first and foremost. While this initiative emanates from the Assistant Deputy Minister for Human Resources (Military), the navy is highly engaged and provides team members as well as oversight through a sponsor advisory group.

The MOSART teams were encouraged to explore all options and have been charged by the Chief of the Maritime Staff to "challenge the status quo and ensure that we are ready for the years ahead." Determining the future with certainty is always problematic, but there are clear trends — e.g. the shift toward smaller crew sizes and even greater application of technology — that point to the need for significant change. More certain, however, is one factor that will not change — the need for technical expertise at sea. The MOSART teams have taken their guidance to heart and have developed numerous "way ahead" options for the navy and the naval technical branch. The options considered feasible for further study are being discussed in a number of focus groups and other arenas where they are provoking considerable debate. As the various proposals continue to take shape, discussion and consultation will become even more widespread in preparation for seeking approval in principle for a definitive course of action.

So where are we? For naval technical officers, this review will likely not result in major change given that their occupation was recently restructured under MOSART. With respect to the combat systems and marine systems career fields for non-commissioned members, however, we will likely see new occupational structures. The models under development for the two career fields share similar themes regarding common entry-level training, recognition of common leadership and management skills for senior NCMs, and revised employment that focuses on broadening skills and instilling greater flexibility within the NCM technical ranks. The concept of enhanced flexibility will take on key importance in an environment of "progressive change" as the navy continues to operate the current fleet of ships through mid-life modernization and beyond, while preparing for the next generation of warships to follow.

Not surprisingly, response to the proposed career models has varied considerably. Some people think we are going too far, while others believe we are being far too conservative and cautious. It is for this reason that I strongly encourage all members of the branch to take an active interest in MOSART. The pace of change within this project will continue to accelerate, and receiving input from the branch will be a vital factor in ensuring things move in the right direction.

In closing, I would like to express thanks on behalf of the branch to Capt(N) Pat Finn for his commitment to the betterment of the naval technical branch during his tenure as our branch adviser.

Capt(N) Adamson is the Naval Technical Branch Adviser and the Director of Maritime Ship Support in National Defence Headquarters in Ottawa.

Maritime Engineering Journal Objectives

- To promote professionalism among maritime engineers and technicians.
- To provide an open forum where topics of interest to the maritime engineering community can be presented and discussed, even if they might be controversial.
- To present practical maritime engineering articles.
- To present historical perspectives on current programs, situations and events.
- To provide announcements of programs concerning maritime engineering personnel.
- To provide personnel news not covered by official publications.

Forum

Canadian vs. UK ship technical readiness

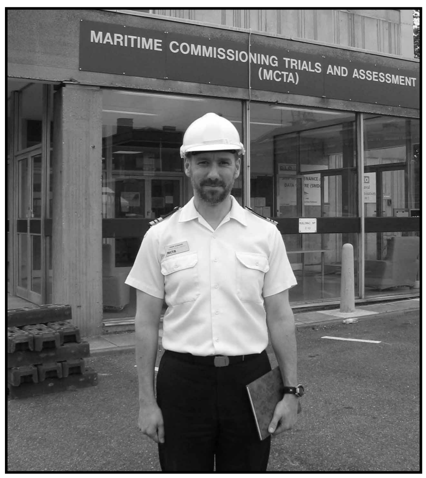
Article by LCdr André Godmaire

How many times have we had technical problems with our shipboard systems only a couple days after completing a maintenance period? How many times have you heard, “The ship needs to go to sea to iron out the technical problems?” How many extra hours do our technicians have to work on the weekend prior to a deployment to get a ship ready for sea? How much are we spending in additional expenses to ship spare parts and/or fly in technicians to repair equipment after a maintenance period?

Is this acceptable for our ships? After more than a year in the United Kingdom on exchange with the Maritime Commissioning, Trials and Assessment (MCTA) organization, I believe there are many things we can do to improve the technical readiness of our ships. As the Royal Navy has already done, the Canadian navy can start by putting more focus on quality as part of the maintenance period process to ensure that the products being delivered by shipyards and contractors are meeting our technical specifications and satisfying all stakeholders’ expectations.

Reasoning that it is cheaper to do it right than do it over, the Canadian navy could adopt more of a business sector approach to managing ships’ maintenance periods. Emphasizing accepted quality management concepts of customer satisfaction, prevention versus inspection, and management responsibility for quality, the navy could mitigate post-maintenance-period “quick fixes,” frenzied predeployment repairs, and expensive deployment of technician teams and parts.

The Royal Navy has adopted these quality concepts by introducing close relations between their various fleet and headquarters stakeholders, and by standing up an independent trial agency — the Maritime Commissioning, Trials and Assessment organization — to ensure the full technical readiness of the RN’s platforms. MCTA is an ISO-9000 certified organization that provides support to class desks and life-cycle materiel managers (LCMMs). It proves the performance of both existing and future marine and combat engineering systems through objective installation inspections and setting-to-work trials. MCTA then provides impartial assessment reports of these system trials, which evaluate installations or repairs made by various private shipyards and/or companies. MCTA trials are conducted both alongside and at sea on all Royal Navy platforms including ships, submarines and shore bases, on ships under construction/refit, and even on vessels for overseas customers. All items of interest and trial results are recorded and inserted into a database maintained by MCTA, which can be viewed and accessed by various agencies.



LCdr André Godmaire

Would quality processes such as the ones used by the Royal Navy be beneficial to the Canadian navy? An independent Canadian organization such as MCTA would be ideal for conducting impartial assessments and improving the quality standards of our ships, but this would be very costly and would tax our already stretched technical trades. Therefore, instead of creating a new agency, I believe the Canadian navy could achieve similar levels of quality by strengthening and combining the efforts of the various stakeholders. This would mean better co-ordination between the coastal engineering authorities and all other players including ships, LCMMs, Sea Training staffs, coastal readiness support program trial offices, fleet maintenance facility quality assurance teams, weapons assessment personnel with the Maritime Warfare Centre, operational readiness personnel, and the navy’s logistics branch.

There are four major areas of improvement I believe could be harnessed by these stakeholders to improve the navy’s state of technical readiness. First, unlike our Canadian trials program which is mainly conducted after a major refit period as part of the readiness support program, the Royal Navy performs trials and assessments of shipyard engineering standards throughout a maintenance period. The Canadian trials program leaves it to the discretion of ships’ engineering officers to organize any required or desired trials within a rigid time frame, but a more formal independent trial process could be scheduled by coastal authorities (based on upcoming missions), inserted within the maintenance period, and conducted by non-crew technicians. This approach would lessen the number of technical problems a ship would likely encounter after leaving harbour, and reduce the overwhelming post-maintenance period workload now carried by ships' technical staffs.

Second, we do not check the standard of the product delivered to our ships by our maintenance facilities. It is again left to ship's staff to comment and report on any installation problems, and on deficiencies of spare parts and publications. However, I know from my Sea Training and MCTA experience that crews have neither the time nor always the specific knowledge to verify that a shipyard has delivered the engineering standards they are expected to meet. This is a function that should be fulfilled by an independent organization to ensure that quality standards are being consistently met. I suggest that additional quality assurance inspections could be performed with the help of the Sea Training engineering departments which already possess a high level of technical knowledge. They have the advantage of continuous contact with all ships, and are well positioned to track deficiencies identified through "jazzogram" deficiency messages.

Third, Royal Navy LCMMs are closely involved with their equipment being trialed. They often show up for MCTA inspections, which is a logical solution given that MCTA is performing these trials on their behalf. This makes it easy to report problems and efficiently address engineering changes on the spot. A closer liaison between Canadian ships and life-cycle materiel managers should be established to alleviate equipment problems and create better responsiveness to engineering changes.

Finally, it is essential that the health performance of major ship systems be reported and monitored. Data accumulated and analyzed under such a program would help technicians identify equipment performance trends, predict and prevent potential equipment failures, achieve timely solutions, save costs, and in the case of combat systems provide operators with accurate (rather than generic) input for acoustic and atmospheric prediction tools. Trend prediction and preventive action would maximize the overall combat efficiency and capability of the fleet.

On the whole, strengthening and combining the efforts of the various stakeholders — i.e. putting in place a more formal trials program, conducting more quality assurance inspections, increasing the visibility of LCMMs aboard ship, and analyzing ship system performance through a centrally controlled information system would paint a more accurate picture of the technical readiness of each ship. Quality improvement action could then be taken to reduce both the number of equipment defects and the overall corrective maintenance costs. This would increase ship systems availability and reliability, improve configuration management, decrease the risks of defects, and result in better technical readiness of Canadian warships.

LCdr Godmaire is the Command and Control Systems Leader with the Maritime Commissioning, Trials and Assessment organization in Portsmouth, England. He previously served as the combat systems engineering officer with Sea Training Pacific and in HMCS Winnipeg.

Materiel Acquisition and Support Information System:

MASIS business process control in DGMEPM — a work in progress

Article by Gary Marshall

So, we have MASIS — the project management tool of the 21st century.

Now what?

Some people believe that buying the best project management tool will automatically take care of the project management. This couldn't be farther from the truth. One of the main cornerstones of good project management is to understand, document and make available to the entire organization standard processes for managing projects. Which is where the DGMEPM business process control office comes in.

When the Materiel Acquisition and Support Information System was rolled out to the navy on December 15, 2003 (MEJ: Summer 2004), we understood there would be shortcomings. Although the people directly involved in designing and im-

(Continues next page)

plementing MASIS did their absolute best, we just didn't have an in-depth understanding of the overall system and its internal workings. This was exacerbated by a lack of definitive divisional business processes and a clear concept of operations for the new MASIS functionality. Unfortunately, this led to the development of generic rather than navy-specific project systems training.

The result of all this was that DGMEPM matrix staff had to explain our business processes as best we could so that MASIS Project personnel could write them up as business process scripts and design the system accordingly. Basically, we had to deconstruct our current practice and have the project team reconstruct it in MASIS. With our limited understanding of what had to be done to produce business scripts, this didn't always work exactly according to plan. At rollout some of the transactions still didn't work, documentation hadn't been written or updated, training was too generic and a large number of processes were still under review. We have come a long way in the past two years, but there is still a long way to go, particularly with regard to documentation. It was understood at rollout that documentation would be lacking, but the intent was to create a forum for collecting, validating, updating and distributing documentation to relieve users' collective pain.

MASIS hit us like a giant wave with no "real" documented processes in place to help us manage the system and the projects within it. Sure, we had hundreds of business process scripts, many of them cut and pasted from SAP Corporation's standard delivered system modules, but who had the time to read them? Who even understood what they were reading? Although we are now beginning to better understand this new Material Acquisition and Support Information System, it will likely take another two to three years before all of the ripples fade away and people are entirely comfortable using MASIS. In the meanwhile, it is our intention within DGMEPM to begin making the business processes available in a clearer, easier-to-follow format for the people who need them the most — the ones using MASIS on a daily basis to manage their work.

Some of the major business processes that DGMEPM will be addressing first include: Managing Engineering Change, Managing Task Acceptance and Agreement (TAAG) Notification, Managing Procurement, Managing Repair & Overhaul, and Managing Projects. Even though most of the processes are currently under review, an on-line "dashboard" of quick-buttons has been created to provide DGMEPM MASIS users with easy-to-navigate instructions on the various business processes (see link below). The dashboard leads to simplified descriptions of the processes, tells who is responsible for each aspect of a process, and explains how to execute the work in MASIS. The dashboard will be updated on an ongoing basis as new processes are refined with user feedback and finalized over the next two years. It is our intention to engage all of the subject matter experts and personnel using the tool in helping define and refine the processes as we develop them.

Most people understood from the outset that MASIS would not decrease our workload. In fact we knew it would create *more* work in the short term, but that once all of the business processes were in place MASIS would allow us to manage our work and our workforce much more efficiently. It would also permit significantly more insight into the work being performed at every level within the department.

Discipline is the key to success with the MASIS business processes. At the end of the day it won't matter how good the processes are if they aren't being followed, because the result will be poor, or non-existent project management. MASIS is here to stay. While we have yet to figure out how to instill the discipline, the best we can do in the meanwhile is provide users with the tool and the processes they need to succeed with the Materiel Acquisition and Support Information System.

If you have any questions or concerns, or have process changes you would like reviewed for possible implementation in DGMEPM, please do not hesitate to contact me. I would also be pleased to discuss our initiatives with MASIS users in other areas.

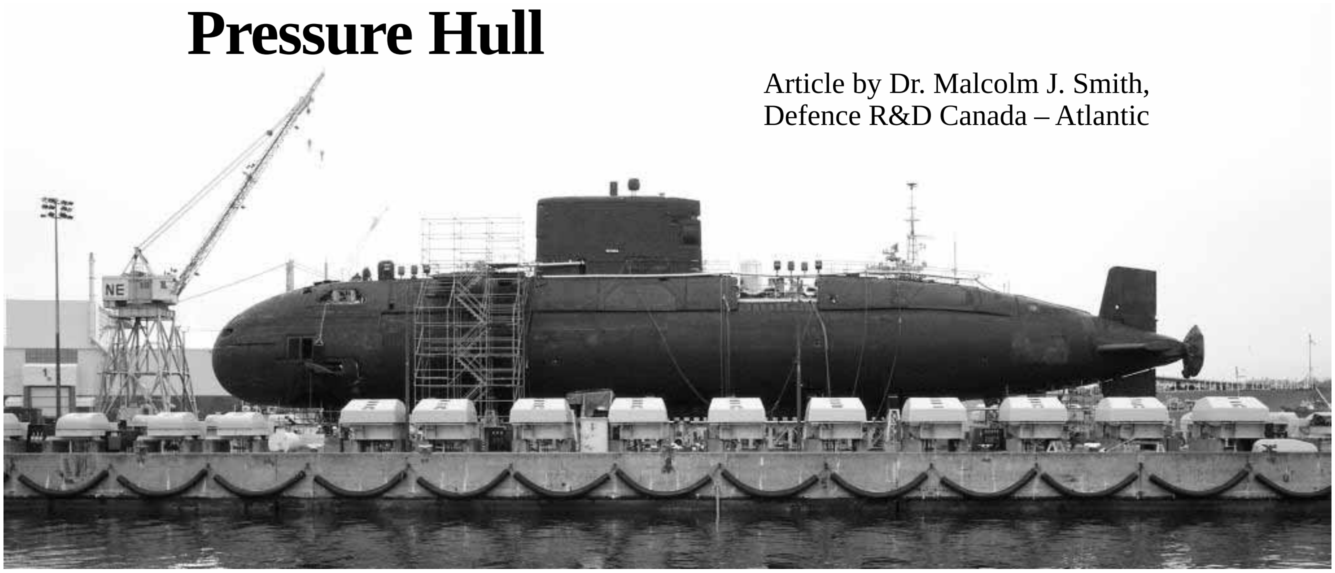
Gary Marshall is the DMMS 3-5 manager for Business Process Control in DGMEPM. He may be contacted at (819) 994-8881, and at Marshall.GW@forces.gc.ca

The DGMEPM business process "dashboard" may be viewed at the following site:

http://masis-trg.ottawa-hull.mil.ca/left_menu/03/04/01/MASIS%20EPD%20Dashboard_files/frame.htm

Structural Modelling and Strength Assessment of the *Victoria*-class Submarine Pressure Hull

Article by Dr. Malcolm J. Smith,
Defence R&D Canada – Atlantic



(Formation Halifax Imaging Services)

HMCS *Victoria* docked in Halifax in 2002.

In recent years DRDC Atlantic has been tasked by the Directorate of Maritime Ship Support to investigate the structural integrity of the *Victoria*-class pressure hull. Two particular problems have been the subjects of extensive study: (1) the effect of indentation damage in the forward compartment of HMCS *Victoria*, and (2) the effect of corrosion damage in the aft compartment of HMCS *Chicoutimi*.

The purpose of this article is to provide an outline of the structural modelling and analysis work that was performed for these two problems, and to provide insight into how structural damage affects pressure hull performance. Operational implications are not discussed in detail.

Assessments of submarine pressure hulls generally involve considerable complexity and pose a number of unique challenges to the engineer. Before addressing the two *Victoria*-class damage cases, a general discussion is provided on submarine pressure hull collapse behaviour and the methods used to predict it.

Predicting Pressure Hull Collapse

A submarine pressure hull is comprised of a ring-stiffened cylindrical/conical structure which is divided into compartments by watertight bulkheads and capped by unstiffened dome structures at the fore and aft ends (*Fig. 1*). This is usually all of the structure that is considered when determining the collapse pressure of the hull.

Since watertight bulkheads are effectively rigid under external pressure, compartments collapse more or less independently of one another as pressure increases. Hull compartments can therefore be considered in isolation, with the failure pressure of the weakest compartment determining that of the submarine as a whole.

In its simplest form a submarine compartment is a ring-stiffened cylinder with rigid ends. The collapse behaviour of this configuration has been studied extensively, and is dominated by overall or interframe collapse mode types, as illustrated in *Fig. 2*. Both types of modes can also be categorized by their n-value, which refers to the number of lobes around the circumference of the collapsed shape.

The critical mode, i.e., the one that occurs with the lowest collapse pressure, is a function of the dimensions and material properties of the structure. It also depends on two very important strength-reducing factors that must be considered when evaluating collapse pressures. One of these is the out-of-circularity (OOC) of the pressure hull. Although this is usually small (maximum excursion from circularity is less than the thickness of the shell plate), the

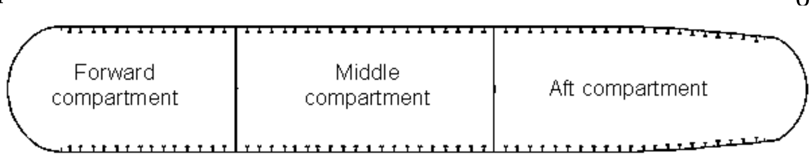


Fig. 1. *Victoria*-class pressure hull

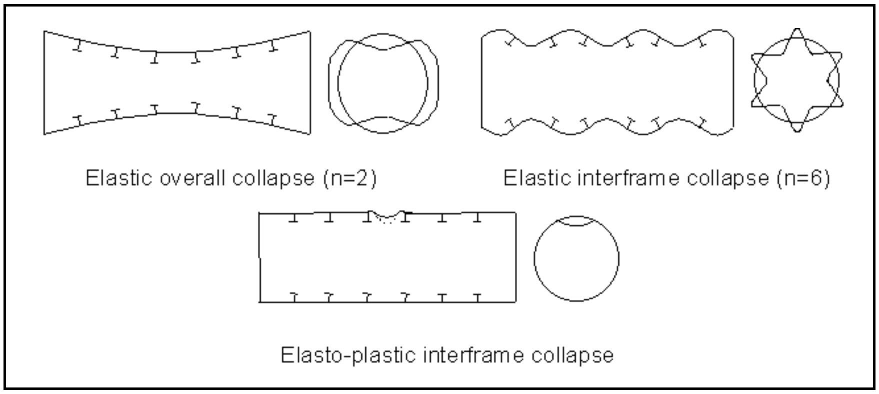


Fig. 2. Collapse modes of ring-stiffened cylinders.

resulting increase in deflections and reduction in collapse pressure can be quite large (*Fig. 3*). This high degree of sensitivity is a result of localized bending of the plating and stiffeners that occurs when imperfections are present. This effect tends to magnify the shape imperfections and promote early localized yielding of the structure. Therefore, real pressure hulls tend to collapse elasto-plastically, i.e., collapse occurs subsequent to initial yielding.

The second important strength-reducing factor is fabrication-induced residual stresses. *Figure 4* illustrates the distribution of circumferential residual stress in a plating-stiffener cross-section resulting from "cold bending" the steel into a circular shape. This process is performed on the shell plating and stiffeners separately prior to assembly. Research has shown that although residual stresses introduced by welding have little impact on pressure hull strength, cold bending stresses can reduce the collapse pressure by as much as 20-30 percent.

These two factors make it very difficult to predict collapse pressures accurately by purely analytical means. Submarine structural design standards therefore make use of a combination of analytical formulae and empirical design curves developed from collapse tests on models of ring-stiffened cylinders. An example of this use of empirical curves is the BS5500 standard for external pressure vessels.

Non-linear finite element analysis (FEA) offers some advantages over the traditional design approach in that the actual geometry can be modelled (as opposed to assuming a ring-stiffened cylinder). Also, in-service damage such as corrosion and deformations can be more readily incorporated into FE models, as can measured shape imperfections and residual stresses. Internal structure, penetrations and other details can also be modelled if necessary. On the down side, FEA has yet to be incorporated into a submarine design standard, and no safety factors are currently available that can be directly applied to FE results owing to the limited data available for validating FE predictions.

DRDC Atlantic's experience has shown that submarine structures are best analyzed using a combination of design methods and FEA. To this end DRDC Atlantic has jointly funded, with the UK Ministry of Defence, the development of SubSAS (Submarine Structural Analysis Suite), a specialized software tool for both

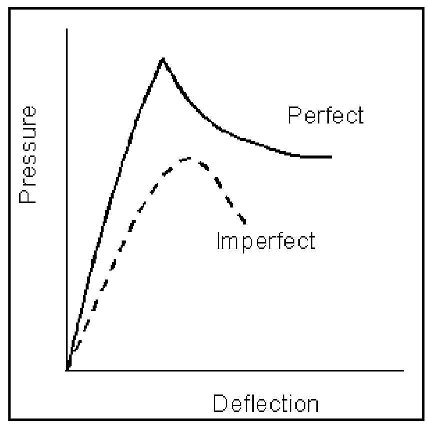


Fig. 3. Collapse behaviour of perfect and imperfect cylinders.

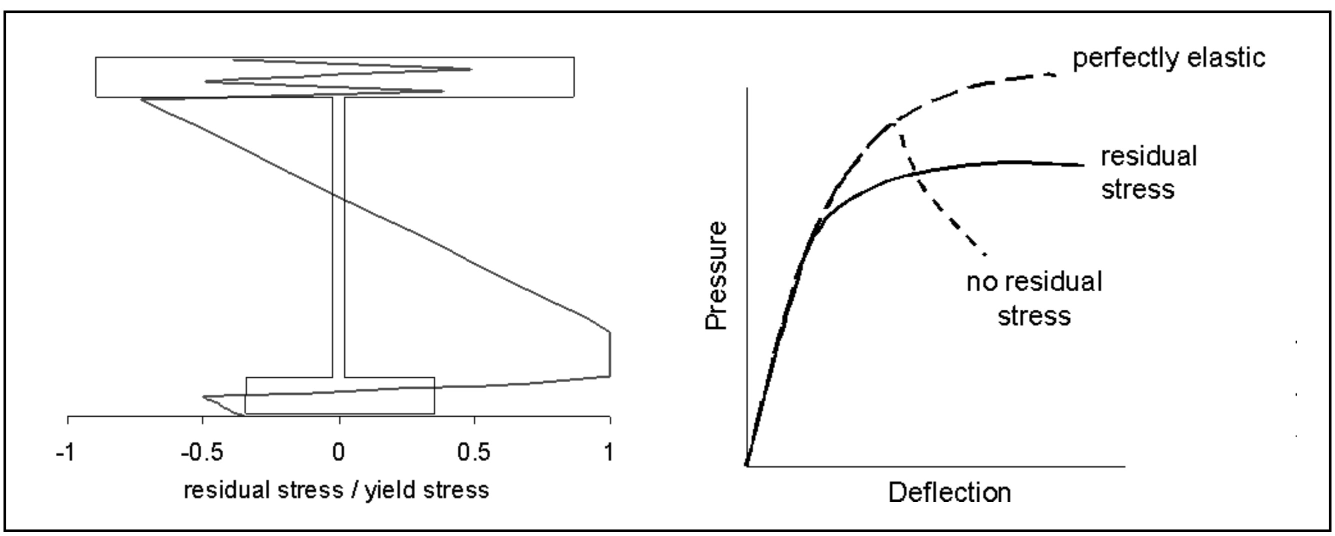


Fig. 4. Circumferential residual stress in a plating/stiffener section (left); effect on pressure-deflection curve (right).

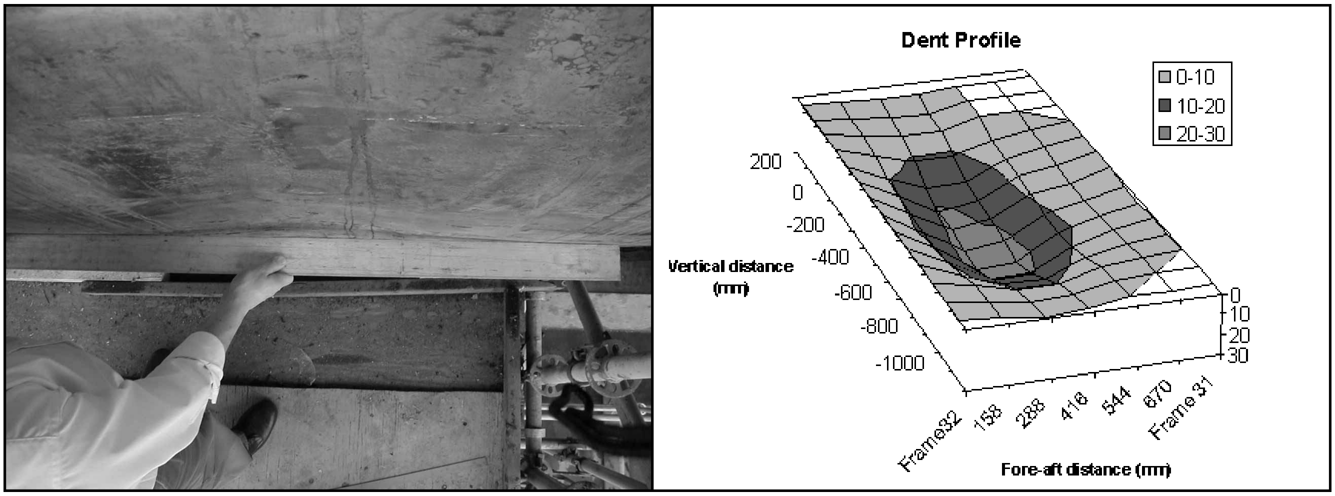


Fig. 5. Indentation damage, HMCS *Victoria*.

design-level and FE analysis of submarine pressure hull structure. This tool has already proven to be effective in reducing the time required for pressure hull collapse analysis, and has been used extensively in recent assessments of the *Victoria*-class pressure hull.

Indentation Damage Assessment

A dent was discovered in the pressure hull of HMCS *Victoria* upon its arrival in Canada (*Fig. 5*). The damage was located in the shell structure between frames 31 and 32 on the starboard beam of the forward compartment. Measurements indicated the damage to extend over a 1.5 × 0.75 m area, with a maximum radial deformation of 25 mm.

Concerned that ring-stiffeners at frames 31 and 32 were also damaged, Fleet Maintenance Facility *Cape Scott* measured the pressure hull exterior shape using a laser theodolite system. Although only a portion of the circumference was exposed for measurement, the data indicated that the circularity of the hull at these two frames was within the build tolerance of ±0.2 percent of radius. Furthermore, no damage to the ring stiffeners could be observed from inside the pressure hull.

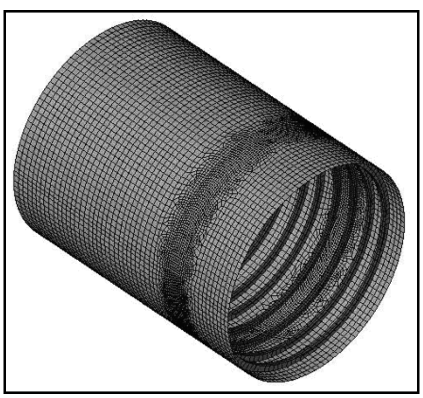


Fig. 6. Finite element model of the forward compartment.

The subsequent analysis therefore focused on predicting the effect of the deformed plating on the structural capability of the hull. *Figure 6* shows one of the FE models of the forward compartment in which the ends are constrained to represent the rigidity of the bulkhead and forward dome. Out-of-circularity was introduced at the design level ±0.5 percent of radius. The actual OOC in the forward compartment is less than this, but the larger value allows for any future growth that may occur during the life of the vessel.

Accuracy of the FEA results is also affected by the degree of refinement in the element mesh. For all of these analyses, the meshes used in the various models are progressively refined until convergence in the results is observed (e.g., less than one percent change in results when element size is halved).

Fig. 8. Stress distribution for the damaged model.

Figure 7 on the next page shows pressure-deflection plots for damaged and undamaged models calculated with the ANSYS non-linear FEA program. The indicated deflection is the maximum radial deflection in the model, which for the damaged model occurs at the centre of the dent. At a given pressure, deflections are significantly increased by the existence of the dent. Note that these deflections are in addition to the pre-existing permanent deformation in the damaged plating.

The pressure-deflection plots also show that the change in the yield pressure (ΔP_y) is much larger than the change in the collapse pressure (ΔP_c). The yield pressure results were confirmed with linear stress predictions (*Fig. 8*), which clearly show the concentration of stress that occurs in the dented region. Thus the primary concern was not that the damage could precipitate a premature collapse of the hull, but rather that localized yielding would cause the dent to grow in size, and that under repeated loadings this growth would not reach a stable limit. It was based on this consideration that a reduction in the deep-diving depth of the vessel was recommended until the damage was repaired. As a precaution, strain gauges were installed on the damaged plating so that deformations could be monitored.

In this case, the reduction in deep-diving depth is not simply a function of the reduction in yield pressure, but must also take into account the existing margin of safety in the forward compartment, and the strength of this compartment relative to the middle and aft compartments.

Corrosion Damage Assessment

During reactivation in the UK, HMCS *Chicoutimi* was found to have corrosion on the exterior of the pressure hull on and around the aft compartment shipping hatch. The corroded areas were ground and partially restored by clad welding, leaving a region with reduced hull thickness.

In our assessments, corrosion was modelled as reduced thickness of hull plating. Secondary effects such as residual stresses induced by the clad welding repair were not considered. Because of some uncertainty as to the extent of the repairs that had been made, conservative thickness distributions were assumed based on pre-repaired measurements. The assessments were then performed in the following stages:

1. The original design calculations for the aft compartment were confirmed with analytical models.

2. A baseline for the FE calculations was established using models of the undamaged aft compartment.

3. The strength of the corroded compartment was evaluated using a series of FE models with three different distributions for the hull thinning.

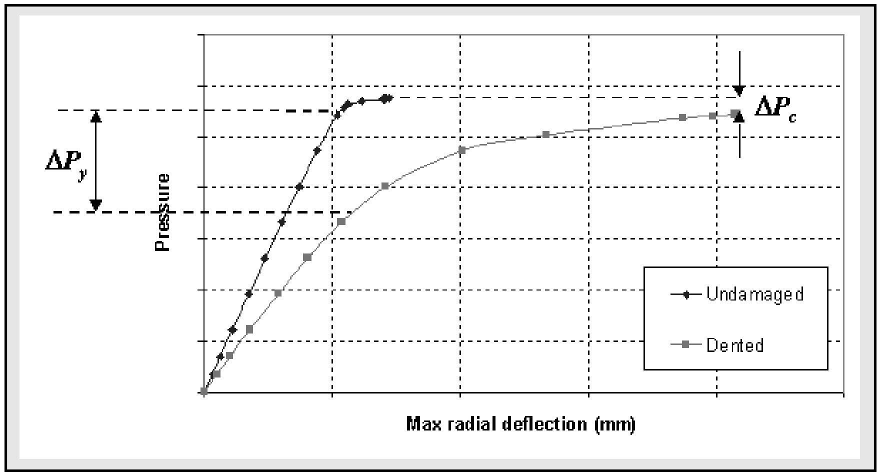


Fig. 7. Effect of dent on collapse pressure (ΔP_c) and yield pressure (ΔP_y).

A wide variety of out-of-circularity shapes were applied to the models to ensure that all possible collapse modes could be predicted. The shapes used included idealized harmonic shapes applied at the design OOC amplitude of 0.5 percent of radius (*Fig. 9*). Out-of-circularity shapes derived from chord gauge measurements taken during reactivation were also used, supplemented where necessary by the original build measurements. These shapes were applied to some of the models as-is, and in others were magnified so that the maximum excursion was 0.5 percent of radius.

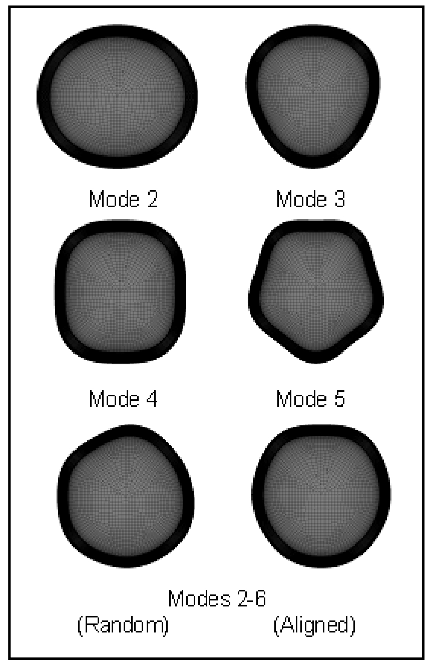


Fig. 9. OOC shapes (shown here greatly magnified) applied to aft compartment models.

More than one hundred different FE models were analyzed, each representing a unique combination of thickness and OOC shape. Both overall and interframe collapse modes were predicted as shown in *Fig. 10*. FEA results for the damaged and corresponding undamaged models were compared, and the resulting percentage reduction in collapse pressure was then applied to the appropriate design value.

Corrosion has two separate effects on the collapse behaviour of a compartment. It weakens the shell plating between frames, thus lowering the pressure at which interframe collapse can occur. And since the shell plating also serves as an outer flange for the ring stiffeners, it also lowers the bending stiffness of the rings, thus promoting overall collapse of the compartment.

FEA results indicated that interframe collapse pressures were more greatly affected than overall collapse pressures. But collapse pressures for both mode types were reduced, which proved to be important when assessing the effect on safe diving capability. The latter assessment must take into account not only the reduced collapse pressures, but also the criticality of the modes in question.

Concluding remarks

Submarine structures research is continuing at DRDC Atlantic to improve methods for predicting strength of pressure hulls. A series of cylinder collapse tests is currently being conducted in the DRDC Atlantic pressure tank facility, in which ring-stiffened cylinder models with corrosion damage are externally pressurized to failure. The results of these tests will help assess the accuracy of the damage modelling method described in this article. Also, as was noted above, no applicable safety factor is available for FEA collapse predictions. Establishing such a safety factor requires a multi-year research effort, and DRDC Atlantic is initiating a program of work to achieve this goal.

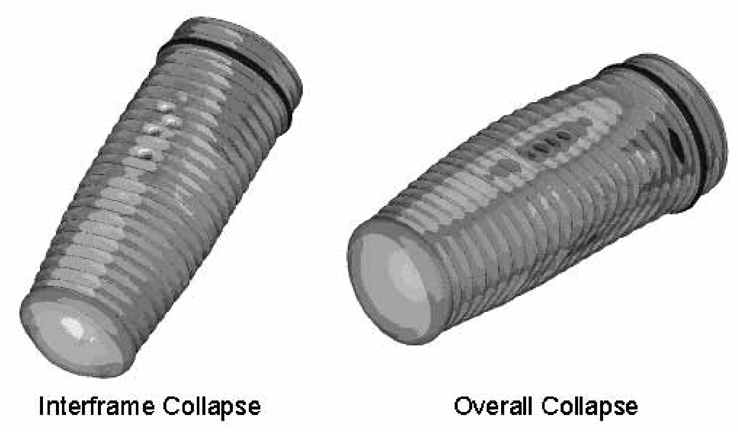


Fig. 10. Collapse modes for the aft compartment.

Acknowledgement

The author would like to thank DMSS personnel LCdr Mark Russell, LCdr Jocelyn Turgeon and Mr. Mario Caron for comments and suggestions provided during the preparation of this article.

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Embedded Software and the Mid-life Sustainment of the *Halifax*-class Bofors 57-mm Mk 2 Gun

Software control issues have made the 57-mm gun's mid-life sustainment project anything but simple

Article by Joseph Podrebarac, P.Eng, PMP

Life-cycle materiel managers are the principal logistics managers for military equipment and systems. LCMMs have primary responsibility for coordinating the management activities associated with their equipment, overseeing all aspects of design, engineering, acquisition, installation, logistic support and disposal. How an equipment or system contract is awarded, however, may limit an LCMM's involvement with the front end of this process. This can have serious implications with respect to the in-service maintenance and control of certain aspects of systems, particularly where embedded mission system software is involved. While embedded software has predefined functions and is less risky to manage, the technical and logistical management can be daunting.

Such has been the case with the embedded software components of the Celsius Sweden (Bofors) 57-mm multipurpose gun weapon system fitted in the Canadian navy's 12 *Halifax*-class patrol frigates. The gun has now reached its planned mid-life, but software control issues have introduced major complications in finalizing a way ahead for the gun system's needed upgrade.

57-mm History

The Bofors 57-mm Mk 2 medium-calibre gun weapon system has been in service for approximately sixteen years worldwide, and in service with Canada's *Halifax*-class frigates since 1990. The system design dates back to the early 1980s, and as such contains 8086-based electrical components which are nearing the end of their technological life.

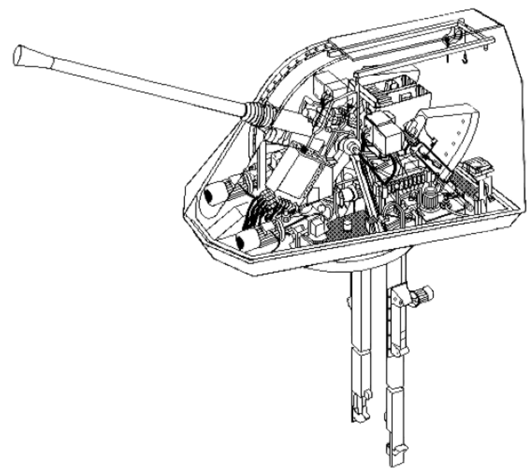

Fig. 1. The Bofors 57-mm Mk 2 multipurpose gun weapon system.

The Canadian navy currently uses the 57-mm Mk 2 Bofors gun weapon system as the main gun armament in the *Halifax*-class ships. Thirteen guns were initially procured from Bofors AB in Sweden through the Canadian Patrol Frigate (CPF) Project, and a 14th gun was procured as a hot spare in 1999. The 57-mm gun has proven to be both reliable and maintainable. Canada currently has support contracts with Bofors for the gun system's repair and overhaul, as well as for other technical investigation and engineering services (TIES) relating to the Mk 2 gun system.

Under the terms of the CPF Project, the Department of National Defence did not specify a particular gun system for the new frigates. Instead, DND provided Saint John Shipbuilding Ltd., the CPF project's prime contractor, with specifications relating to a gun system functional requirement that had to be met. All aspects of the gun's design, testing and interface were left in the hands of Saint John Shipbuilding and its subcontractor, Montreal-based Paramax Electronics Inc. (now Lockheed Martin). DND personnel attended factory acceptance tests at AB Bofors to observe the final testing and to confirm the 57-mm gun weapon system would meet the stated requirements.

Transfer of the gun system to LCMMs within the Department of National Defence was made in the early 1990s, but did not include design details relating to the onboard computers and their embedded software. Known also as mission system software, embedded software covers the electronic element of systems such as timers, controllers, monitoring and data logging equipment, diagnostic and test equipment, simulators and trainers, and command and control functions. Prior to delivery of the system to the fleet, changes, modifications and waivers were handled between Paramax and Bofors, but there was no deliverable to the Crown showing a summary of the modifications or waivers made during the build process. Instead, only a simple listing of the circuit cards by part number and revision level was provided to the Department of National Defence.

A Primer on 57-mm Gun System Control

The *Halifax*-class medium-calibre gun weapon system (*Fig. 1*) consists of a Bofors 57-mm Mk 2 gun, ammunition hoists, a main power distribution box, ready-use ammunition racks, and control and test panels. The multipurpose gun is capable of fully automatic operation, delivering 220 rounds per minute, and is designed to provide effective performance against aircraft, anti-ship missiles and surface targets.

The operation and monitoring of the gun functions are supported by two computers — the gun control computer, and the aiming and firing limiting computer. The gun control computer controls and supervises the complete gun system by interpreting signals from panels and subsystems. The aiming and firing limiting computer supervises the laying (train and elevation) of the gun and takes control before the gun enters no-fire limiting zones where superstructure obstructions interfere with the firing arcs.

Under normal circumstances the STIR fire-control system and the remote control panel in the operations room are used to control the gun. For emergencies or testing, the gun can also be operated from a servo test panel in the operations room in conjunction with the remote control panel. In remote control mode the gun is controlled from the operations room from either of two STIR control consoles. In local control mode the gun is controlled from the gun panel inside the gun housing.

Figure 2 shows a high-level view of the computers in the gun, along with the input panels an operator can use to operate the system. During normal operation the STIR control console interfaces with the remote control panel (RCP) in the ops room. The operator can control the gun from this panel and supervise it during operational use. The remote control panel displays text messages from the software reporting on the gun weapon system's status and condition.

The loading panel (LP) is normally used for inventory, unloading and tests, but can also be used to load the gun. The panel shows inventory values, information codes and gun weapon system error messages.

The aiming and firing limiting computer (AFLC) is the responsible computer for controlling these functions of the gun. In normal operation its display indicates that the computer is running. If an error message occurs, a thumb wheel can be used to display working parameters in the software to help determine the causes of the error. A terminal can be connected to the AFLC to perform detailed fault-finding and to reprogram the gun's limiting arcs when any changes have been made to the ship's superstructure.

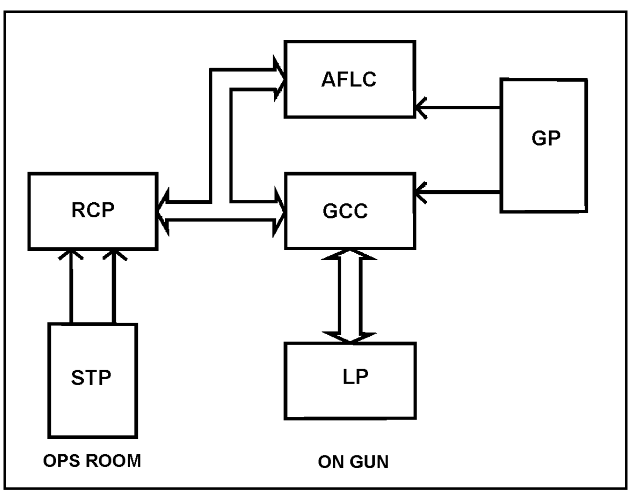

Fig. 2. The gun computer system. A high-level view of the computers in the 57-mm Bofors gun and the input panels an operator can use to operate the system. The computer interfaces are shown as large arrows. The thin dark arrows connecting the panels represent inputs from switches, push buttons and other devices.

The gun control computer (GCC) controls the loading system and the firing functions. The GCC can be connected to a terminal to perform fault-finding, and to download information saved by an event recorder. The automatic event recorder is a valuable trouble-shooting aid as it continuously samples and saves in read-write memory a history of the gun control computer's input/output signals. Sampling is performed every 10 milliseconds, and any changes that are detected will automatically overwrite older information. The memory can store 512 samples of 16 words, allowing approximately five seconds' worth of recorded data during high activity events such as when the gun is firing. In periods of low activity, events can be recorded over a longer period of time.

Bofors' diagnostic software is an essential first- and second-line maintenance troubleshooting tool for tracking and identifying defects in the gun system's hardware and software. The diagnostic software, which interfaces with the gun control computer via a standard laptop and a special cable, interrogates the GCC to trace out command signals, responses of subsystems, and timings of all processes.

Inventory Holdings

The gun control and aiming and firing limiting computers have a number of electronic circuit card assemblies (CCAs) which contain embedded software. During 1999-2000 an analysis was performed to examine the cost of maintenance. The choice came down to considering making a lifetime buy of replacement card assemblies and diagnostic equipment, or have the original equipment manufacturer (OEM) do a complete overhaul of the CCAs. Based on the low failure rates and the relatively small number of circuit cards that were involved, it was determined that it would be most economical to have the OEM overhaul the CCAs. During the course of overhauling these cards it was discovered that the electronic circuit card assemblies for the gun system's two computers (the GCC and the AFLC) can be at most only two revisions apart. Any further separation and the computers will not communicate properly with one another.

The solution seemed simple enough — locate all fitted and spare cards and ascertain the revision levels so that updates could be made. The Canadian Forces Supply System was tasked to locate all 33 spares by part number so that revision levels could be checked. Unfortunately only 75 percent of the inventory could be found. A manual search was conducted of the warehouses and ship spares, but turned up no additional inventory. After an 18-month search for inventory a contract order was raised and new software was burned in batches to ensure operational platforms had the correct software version spares in sufficient quantities.

Mismatched software versions also showed up in the Bofors 57-mm gun simulator located at the Combat Systems Training Centre in Halifax. With the operational gun systems being updated progressively, the simulator system's specialized software could easily find itself out of step with the software loaded into the shipboard gun systems. A contract was raised with the OEM for modifications to the gun simulator's circuit cards.

Modifications and Updates

Toward the end of the delivery of the 57-mm gun weapon system in the 1990s, the original equipment manufacturer implemented software changes to the gun control computer that corrected some faults found during the factory acceptance tests. Although the corrective software developed as a package for the Swedish Navy and implemented on Canadian systems was well documented, 22 new changes were not. Canada was not provided design data, documentation or training plans to support the additional changes, and had to purchase these items separately. The software changes would improve the overall performance of the gun weapon system, but something as simple as changing the response time of a sensor had a significant impact on the operation of the STIR control console and combat control system. Interface tests and certifications were required to deduce changes to procedures and documentation so that modifications could be made to the controlling documents for the affected systems.

DND had gone through a similar discovery process as the year 2000 approached when the life-cycle materiel manager for the 57-mm gun contacted the after-sales support people at Celsius Sweden (Bofors)

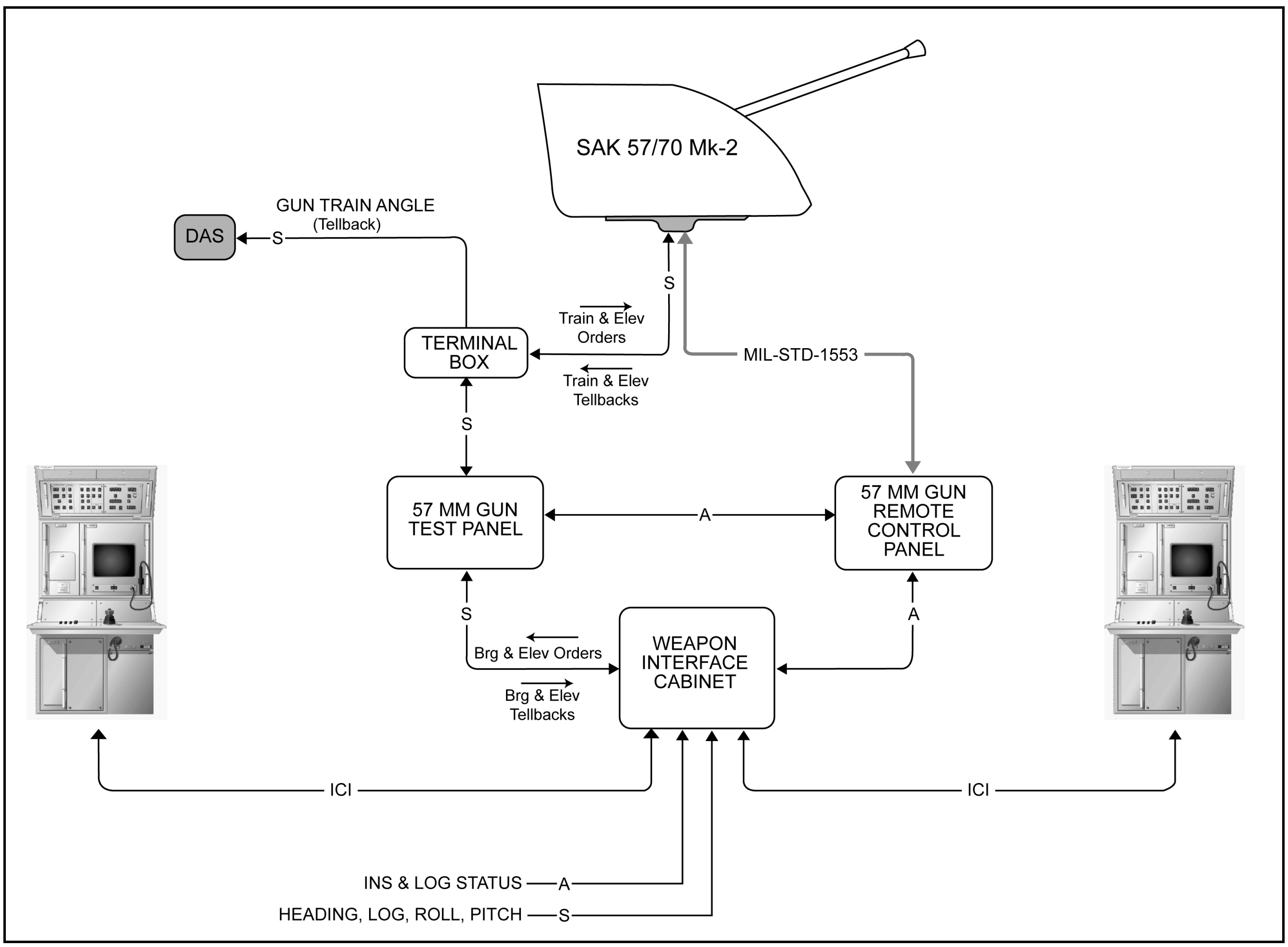

Fig. 3. 57-mm Gun Interface Block Diagram

for confirmation that the gun system interfaces would demonstrate "Y2K" date/time clock compliance (see "Year 2000 Ship Readiness," MEJ: June 1999). The situation was complicated. Because the chips for the 57-mm gun's circuit boards had been sourced from the world market based on availability, Bofors had to review its purchase orders and manufacturing and configuration control documents to find the information it needed to verify Y2K compliance. In cases where there were no test data on a chip, the original equipment manufacturers ran certification tests. In the end, all installed and spare chips were certified Y2K compliant.

In 2002 both the Swedish Materiel Command (FMV) and DMSS 6 began enquiries regarding the long-term support of the 57-mm Mk 2 gun. From the DMSS 6 perspective, this was largely driven by the recognition that the Mk 2 gun had been in service for more than twelve years in Canada and would soon be older than the 15-year designed supportability lifespan of the CPF combat system. An exhaustive analysis was made of the 57-mm Mk 2 spares held by DND to determine the quantity held and future supportability concerns. As the study progressed, the focus quickly shifted to the electronic circuit card assemblies contained within the gun system's computers, the remote control panel and the servo test panel. Although the simpler CCAs were supportable (i.e. either a sufficient quantity was still on hand, or were still manufacturable), a significant proportion of the more complex CCAs in the gun control computer and the aiming and firing limiting computer were deemed to be unsupportable within three to five years. Bofors AB was therefore asked to provide options for supporting these critical CCAs, but by mid-2003 it became obvious to both DND and Bofors AB that redesigning or repairing the Mk 2 CCAs would be an untenable option for reasons of both cost and technical risk.

In the meanwhile, Bofors AB had finalized design and qualification testing of the thoroughly modernized Mk 3 version of the 57-mm gun. FMV and DND, largely under the auspices of a broad memorandum of understanding, cost-shared a feasibility study to determine whether there existed a valid upgrade path from the Mk 2 to the Mk 3 version of the gun. The study, which was completed in April 2004, confirmed there was indeed a cost-effective, low-risk method to upgrade the existing Mk 2 mounts to Bofors AB's export version of the Mk 3 gun. The upgrade would roughly consist of retaining all the fully supportable mechanical and electrical subassemblies of the Mk 2 gun, with the exception of the hydraulic laying motors for the train and elevation subsystems. From an electronics standpoint, the AFLC and GCC of the Mk 2 gun, comprising roughly 40 CCAs, would be replaced by a new, fully-supportable single computer (also called the gun control computer) operating on only 10 CCAs.

DMSS 6 has subsequently stood up a new DGMEPM national procurement project to upgrade all 14 mounts (including the one located at the Gunnery Support Facility and a spare mount) to the sustainable Mk 3 configuration. The project predefinition study which focused on the mount itself has since been followed by a study of the work needed to interface the new, completely digital gun with the mixed synchro/digital fire-control system in the *Halifax*-class ships. The interface study also outlined the remainder of the required "below decks" upgrade work on such things as new equipment seatings, and new and existing cable runs.

DMSS 6 is now preparing a statement of work for the Mk 2 sustainability program, which is projected to launch in 2007. The first mount should be delivered that same year, with the entire program completing by early 2010 to give the navy a fully-supportable 57-mm gun for at least another 15 years.

Joseph Podrebarac is a former life-cycle material manager for the 57-mm gun. He is currently the sub-section head for mine warfare in the Directorate of Maritime Ship Support in Ottawa.

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NETE Technical Investigation:

Main Gearbox Lube Oil Supply Line Cracking in *Halifax*-class Ships

Article by Stanley Lyczko, P.Eng. and Claude Tremblay, Eng.

Illustrations courtesy the authors

Cracks have been discovered in some of the welded joints of lube oil lines supplying the main gearbox bearings on board several *Halifax*-class ships. Repairs have been challenging because most of the cracks are occurring in hard-to-reach locations where the lines penetrate the gearbox casing (*Fig. 1*), and also because welding on the gearbox casing is not authorized. The lube oil supply lines that have a history of failure are small bore lines only, i.e. 2.5 cm (one inch) in diameter and smaller — no failures have been reported in larger diameter lube oil lines — with failures reported at four different locations. One particular weld connection at the gearbox casing has failed five times in four different ships.

Faced with ongoing failures, the Directorate of Maritime Ship Support (DMSS 3-2) tasked the Naval Engineering Test Establishment (NETE) in Montréal to investigate the causes of the cracking in the *Halifax*-class main gearbox lube oil supply lines and to provide possible solutions to the problem. NETE subsequently conducted a physical survey of the lube oil supply lines on board HMCS *Fredericton* (FFH-337) and carried out impact (resonance) tests to determine their natural frequency. From these efforts NETE was able to draw certain conclusions regarding the causes of the cracking, and to make recommendations for eliminating or reducing the incidence of such failures.

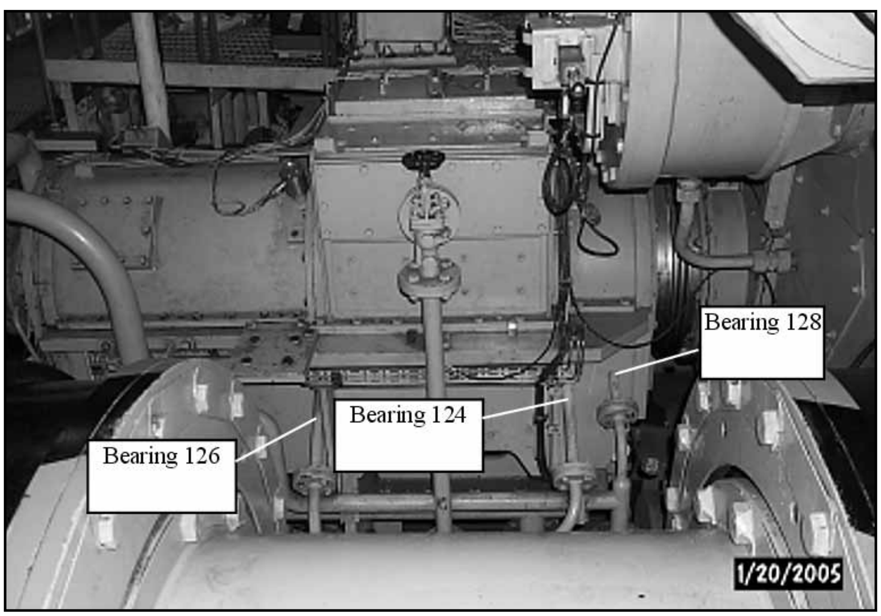

Fig. 1. Small-bore lube oil supply lines entering the main gearbox of *Halifax*-class frigates are inherently weak and prone to cracking.

Survey Results

Separate from the visual survey that was made of the main gearbox lube oil supply lines, impact (resonance) tests were performed on lines for which cracks had been reported, and on lube oil lines having a similar installation design. During the impact tests, also known as resonance tests, the lube oil lines were struck with a soft hammer to excite their natural frequency. The lines will ring when excited by the impact of the hammer. *Figure 2* shows a typical natural frequency spectrum for a lube oil line. For the tests, an accelerometer was glued to the lube oil line and connected to a charge amplifier and signal analyzer.

The results of the impact tests told an interesting story. The lube oil lines that have a history of failure shared a common characteristic in that they all displayed low natural frequencies around 40 Hz, indicating the lines are not sufficiently rigid for the application. Lines that had a natural frequency above 100 Hz are stiffer and do not have a history of failure. Normal practice requires that the natural frequency of pipes be at least two-and-a-half times greater than the highest forcing frequency they could be subjected to. In this case these were the gearbox vibration frequencies which the smaller bore lines were clearly not capable of withstanding.

The ship survey identified other common characteristics of the lube oil lines that can contribute to failures, confirming what was discovered through the impact tests. The lines were found to have very few

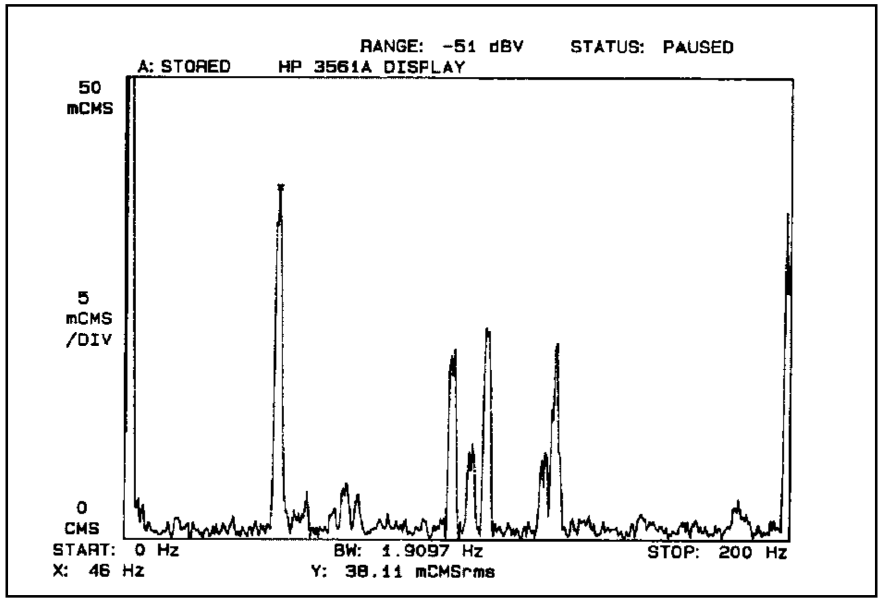

Fig. 2. A typical natural frequency spectrum produced by an impact (resonance) test of a lube oil line.

pipe supports, which makes them less rigid and, as explained, lowers their natural frequency. *Figure 3* is a good illustration of a typical arrangement in which a pipe that is close to one metre long is supported by only a 6-mm (quarter-inch) or smaller weld where it penetrates the gearbox casing. Although solid structure is available above and below the pipe for additional support, this has not been used. None of the lines surveyed was supported at the butt weld joint by a collar, pad or saddle where it penetrates the gearbox casing.

It was also discovered that the lube oil supply lines located outside the gearbox covers are often used as a convenient foothold or grab bar by personnel climbing down into the bilges, or up to access the gearbox covers. The weakest point of the line is at the gearbox casing weld, where a crack can be initiated by the extra weight of a person on the line. Once a crack has been initiated, normal gearbox vibration can cause the crack to grow until the line fails through fatigue.

Another characteristic of the lube oil lines is their lack of flexible joints, and an abundance of flanged connections. The flanged sections are often curved, making it difficult to align the piping without forcing the flanges together, This ultimately introduces "fit-up" stresses into the piping during installation, and significant spring-back has been reported when some flanged joints in the lube oil lines have been unbolted. Most of the weld connections at the gearbox casing are located within centimetres of a flange (*see Fig. 1*), and any fit-up stress at the flange will invariably stress the weld connection.

The survey of the lube oil lines inside the gearbox indicated that the internal lines are arranged in a similar manner to the external segments. The internal lines have few supports, are butt-welded to the gearbox casing without reinforcement, and consist of curved, flanged pipe sections that are difficult to align. Several of the flanges inside the gearbox covers in HMCS *Fredericton* were also found to be leaking, with puddles of oil visible underneath the flanges. No cracks were noticed during the survey of the internal lube oil lines, but based on their characteristics it is likely that cracks could develop in the smaller bore lines at the gearbox casing penetration point inside the gearbox covers.

Possible Solutions

After reviewing the results of the physical survey and the impact tests, NETE was able to offer several recommendations. To begin with, welded joints that have failed in the

Fig. 3. The oil supply line to bearing no. 1 is nearly one metre long, but is supported only by a very small weld where it enters the gearbox casing. The presence of a flanged connection within a few centimetres of the weld point could be adding stress to the weld if the flange connection itself is under stress. As can be seen, the oil line provides a convenient, but damaging foothold for personnel climbing up to the casing top.

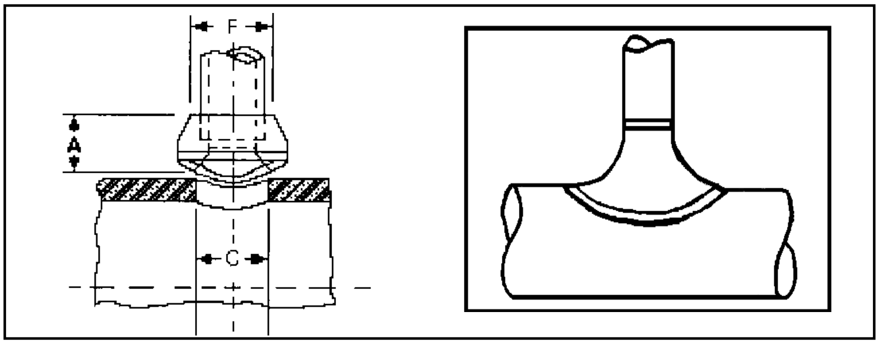

Fig. 4. Manufacturer's proprietary designs for pipe weld reinforcement fittings that could be used to strengthen lube oil supply lines at locations away from the gearbox casing.

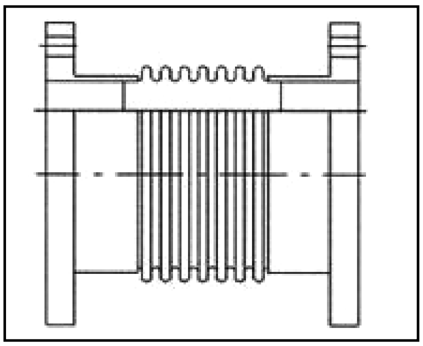

Fig. 5. A flexible metal bellows expansion joint such as this could be used in place of a welded connection between an oil supply line and the gearbox casing.

past should be reinforced with a collar, pad or saddle. Due to welding restrictions, joints at gearbox casing penetration points would have to be strengthened using bolted pads. The gearbox casing could be drilled and tapped to take studs to support the pads which would contain a socket into which a lube oil line could be welded. In instances where a failure has occurred at a butt joint away from the gearbox casing, the weld connection could be stiffened using a pipe weld reinforcement fitting such as the manufacturer's proprietary designs shown in *Fig. 4*. The fitting on the right provides a stronger joint than the one on the left because its larger surface area enables a longer weld to be made along the perimeter. The fittings would need to be of a socket-weld type rather than a butt-weld type so that a lube oil line could slip into a socket in the fitting to give it additional strength, and then be welded to it.

The lube oil supply lines that have a history of failure should be stiffened to increase their natural frequency above 100 Hz by increasing the wall thickness of the lines and by adding adjustable pipe supports. Each support should be designed for the specific orientation of the pipe in the area, and be adjustable so as not to impose additional stresses on the welded joints. Supports should be located close to where the joints failed in the past.

The lube oil lines that have a history of failure should be carefully aligned during installation to minimize fit-up stresses on the welded joints. The lube oil lines that are susceptible to being used as footholds and grab bars should be shielded with gratings and angle bar.

If attempts to strengthen the welded joints and stiffen the piping prove to be unsuccessful, consideration can also be given to using an approved flexible connection for the lube oil supply lines. The specific type of flexible connection used should be chosen carefully to minimize the likelihood of leaks. Flanged, flexible metal bellows expansion joints such as the ones shown in *Fig. 5* would provide an alternative with a relatively low probability of leakage. However, the suitability of a particular fitting for this application would need to be proven through shock and vibration testing. In addition, the piping would need to be supported on both sides of the expansion joint. The process of qualifying and installing suitable flexible connections makes this the most involved option, which should only be considered if strengthening and stiffening the existing lines proves to be unsuccessful.

Conclusions

The survey and tests of the main gearbox lube oil supply lines conducted in HMCS *Fredericton* determined that the small-bore lube oil lines with a history of cracking failure are inherently weak. They were found to have the lowest natural frequencies when subjected to an impact test, and should be repaired as discussed as a priority. Although other lines surveyed had higher natural frequencies, their possible failure in the future cannot be ruled out.

DMSS 3-2 is proceeding with the development of repairs for the most serious cases of main gearbox lube oil supply line cracking.

Stanley Lyczko works in the Marine Systems section of the Naval Engineering Test Establishment in Montréal. Claude Tremblay is the Transmission Systems Engineer in the Main Propulsion Systems section of the Directorate of Maritime Ship Support in NDHQ Ottawa.

ISWM — First Step Toward an Integrated Shipboard Waste Management Model

A developing computer simulation model could harmonize operational, material and waste management decision-making in the navy

Article by LCdr Robert Skinner

The Canadian navy began to fit ships with solid-waste processing equipment in 1989.[1] By 2001, with the inception of the Maritime Environmental Protection Program (MEPP), all major warship classes were fitted with solid-waste handling equipment of some form.[2] The MEPP has provided the navy with a variety of technological waste management solutions that, for the most part, have met the two principle objectives of the program: compliance with environmental legislation, and reduction of waste volume.[3] These objectives are consistent with the goals of the Maritime Forces Pacific Ship Class Environmental Management System introduced at about the same time as the MEPP. Specifically, the objectives of the Environmental Management System are:

> "...to ensure compliance with relevant environmental legislation, regulations, policies, procedures and directives; and to measure and continually improve environmental performance."[4]

The success of these programs in terms of waste volume reduction has been mixed. The *Iroquois*-class destroyers are an example of a less than optimal waste-reduction solution. Despite carrying a larger average complement than the *Halifax*-class frigates, the *Iroquois*-class' solid-waste handling equipment fit is very limited compared to that fitted in the *Halifax* class. Furthermore, the *Iroquois* destroyers do not have sufficient space expressly engineered for waste storage, and so must therefore rely on ad hoc upper-deck storage arrangements. While future retrofits of improved equipment may reduce waste storage issues in this and other classes, technological fixes are rarely a sufficient basis for developing holistic waste management solutions. Improving waste management effectiveness requires a comprehensive understanding both of the processes that generate waste, and of the processes related to waste-handling.

HMCS *Algonquin*'s quarterdeck waste storage bin 60 percent full after eight days at sea. *(Source: LCdr R. Skinner)*

Selecting waste processing equipment based on volume reduction has its disadvantages. In the first place, reducing the *volume* of shipboard wastes does not necessarily result in a corresponding reduction in the *mass* of the same wastes. In view of the extreme space constraints typical in most warships, the importance of waste volume reduction is undeniable. However, reducing waste mass has important benefits in terms of environmental sustainability and corporate social responsibility. Another important reason to consider mass reduction strategies for waste management stems from regulation 9 of Annex V of MARPOL 73/78, which requires that:

> "...all ships of 400 gross tonnage and above and every ship certified to carry 15 persons or more...must provide a Garbage Record Book, to record all disposal and incineration operations."[5]

Although Canada has not yet acceded to the requirements of Annex V, there is no guarantee this will remain the case indefinitely. It is entirely conceivable that it could become mandatory to record the amount and type of waste generated in our ships at sea. Reducing the impact of such a task would arguably include methods for reducing the mass as well as the volume of shipboard waste.

Since the MEPP is effectively an "end-of-pipe" waste management strategy, it is not well suited to integrating waste management objectives with the navy's overarching sustainability objectives, particularly those related to material management. Indeed, development of a green procurement policy and the promotion of environmentally responsible procurement of goods and services remain important Sustainable Development Strategy objectives in DND and the navy.[6,7] At present, the absence of sufficiently integrated material and waste management decision-making means that upstream material procurement decisions can overwhelm or confound downstream waste processing equipment or decision-making. When stores are procured without due consideration to the sorts of wastes that are produced, or even to the limitations of the equipment that is being used to process waste, the result is frequently a waste storage problem that can be at cross-purposes with operational uses for limited shipboard space.

What is required is a means for integrating operational, material and waste management decision-making such that a decision taken within any one of the three domains can be assessed in terms of how it affects both of the other domains. A newly developed computer simulation model may well hold the solution to solving this complicated task.

The Integrated Shipboard Waste Management model (ISWM)

The ISWM, developed by Inter-Dynamics PTY Ltd. of Australia with this author as the program architect (i.e. DND's project manager and the principal designer of the ISWM — see author note at the end of this article), is a computer-based simulation model designed to mimic operational, material and waste management decision-making in an operational setting. The ISWM incorporates actual shipboard daily routine and fleet exercise (FLEX) programs in a generic prediction engine. The program can be configured to produce estimates of stores' depletion and waste accumulation in locations of interest within the ship. Changes to either the daily routine or the FLEX can be readily incorporated in the prediction framework to assess the effects of these changes.

The model is configured with a generic set of compartment types and a set of about one hundred different waste generating algorithms, termed *waste generating activities* (WGAs). WGAs convert one or more stores to one or more corresponding wastes at predetermined rates. To build the complete program of WGAs, the user selects the appropriate virtual daily routine schedule and constructs a virtual FLEX from a list of preprogrammed activities. Once this task is complete the prediction can be executed to show the accumulation trend for any waste, or multiple wastes, in any space. *Figure 1* shows the predicted accumulation for preprocessed plastic in HMCS *Algonquin*'s dry garbage compartment.

An added feature of the ISWM is that the user is prompted to resolve a variety of predicted capacity triggers as well as space or human resource-related conflicts. To resolve these triggers and conflicts, the user must know or determine what is actually taking place in the ship and respond to the prompt accordingly.

Results of the sea trials

Although the results of limited sea trials conducted thus far in *Algonquin* cannot be considered conclusive, the program's capacity for accurate prediction under operational circumstances has been adequately demonstrated. *Figure 2* illustrates the results of the original ISWM prediction versus actual accumulation data for preprocessed paper in the ship's dry garbage compartment. Predictions based on the daily routine as well as the daily routine and FLEX programs are illustrated to highlight the relative influence of the FLEX. The arrows indicate significant differences between the two predictions. *Figure 3* shows the difference between actual and predicted accumulations for the daily routine and FLEX schedules. The arrow indicates an event where the FLEX-based prediction error is substantially greater than the mean error of approximately 40 kg of waste. When the applicable activities were recalibrated based on analysis of the original predictions, the ISWM prediction was rerun and produced significantly better results (*Fig. 4*).

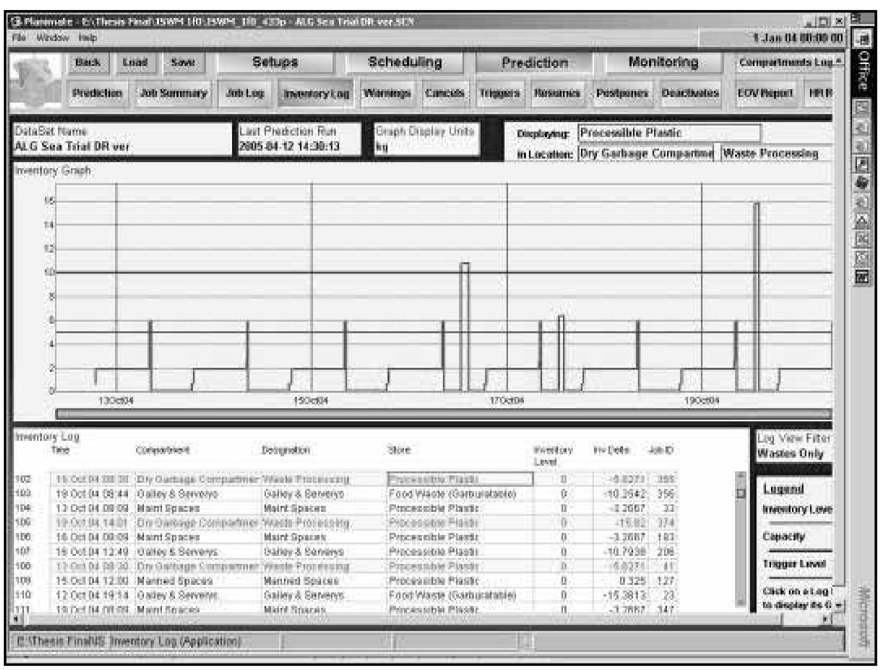

Fig. 1. The ISWM Inventory Log Display for preprocessed plastic in HMCS *Algonquin*'s dry garbage compartment.

The need for further study and analysis

The simple adjustment made in the previous example resulted in an improved prediction accuracy that was within approximately 15 kg of the actual waste accumulation. Notwithstanding, the adjustment made to the program in this case was derived without the benefit of specific data related to the waste-generating activity in question, so the adjustment itself lacks empirical validity. In fact, in the existing version of the ISWM, predictions are entirely based on estimated accumulation data derived from historical studies. These studies were conducted during the 1990s in USN ships ranging in size from frigates to aircraft carriers. Unfortunately, very little useful data from Canadian sources is available. Further data related to actual waste-generating activities in Canadian warships under operationally meaningful circumstances is required to further calibrate the ISWM and achieve reliably accurate prediction results (i.e. a difference of 10 percent or less).

Fortunately, the ISWM itself can greatly facilitate both the identification of the precise activities requiring additional study and the necessary data gathering exercises. In addition, a slightly more enhanced version of the ISWM could also facilitate analysis of actual and predicted data directly without the current need to make use of other analysis software. A deployable version of the ISWM could enable one or two members of a ship's company to gather a considerable amount of data. Amplified by several ships, sufficient quantities of reliable data should greatly simplify the calibration effort. This makes the ISWM an efficient, "low impact" vehicle for shipboard waste analysis compared to more brute force methods that rely on dedicated data gathering teams or require control of the ship's program and activities.

Further data gathering, analysis and sea trials are needed to fully verify and validate the ISWM as a simulation model before more costly investment is made in a production version. In essence, verification answers the question: Does the model perform as designed? Validation, on the other hand, answers the question: Does the model produce results that are within predetermined reliability and accuracy specifications? Typically, verification and validation are conducted iteratively throughout the conceptual and programming stages of a model's development. A comprehensive set of well-designed sea trials conducted on several platforms over a variety of mission types and durations will be necessary to fully validate the ISWM.

Conclusion

The ISWM represents another step toward fully integrated operational, material and waste management decision-making. The ISWM was designed to provide relevant information to commanding officers and other decision-makers about the consequences of operational, material and waste management decisions as each affects waste accumulation and operations in turn. Other potential benefits of the ISWM or similar models include:

- Prediction of waste accumulation in furtherance of more stringent, regulatory constraints;
- Improved environmental sustainability of naval operations;
- Refinement of existing waste processing equipment, procedures and infrastructure;
- Refinement of decision-making with respect to waste processing equipment fits and processes for ships in the design phase.

The Integrated Shipboard Waste Management model has the capacity to produce accurate waste accumulation predictions in furtherance of a number of important Canadian Forces and navy objectives; however, more work is needed. Specific

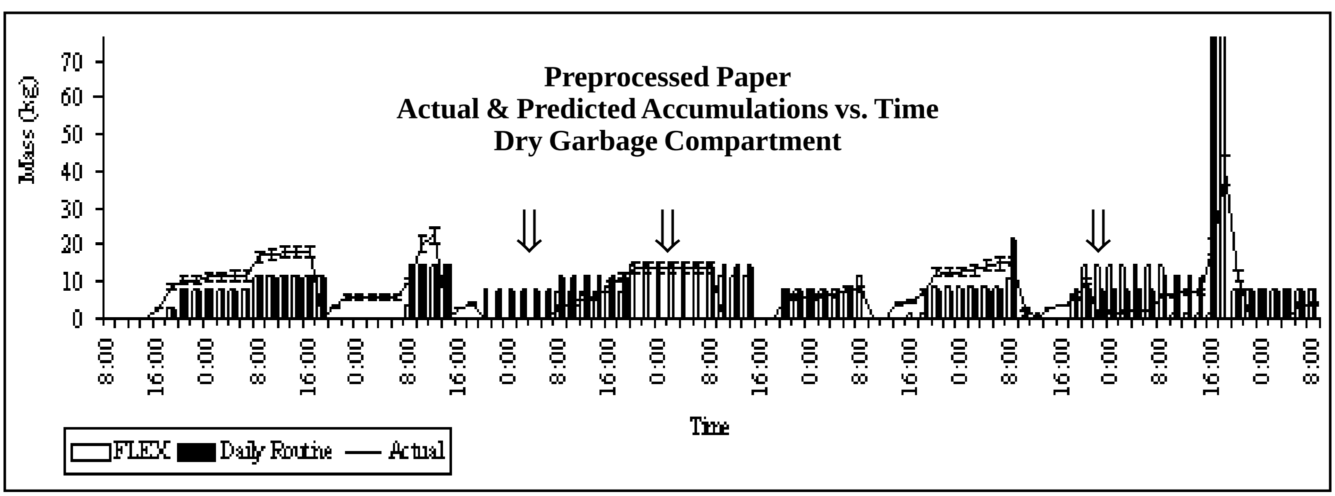

Fig. 2. Actual vs. predicted accumulation of preprocessed paper in the dry garbage compartment.

information about important shipboard waste-generating activities and their respective stores-waste conversion rates can only be obtained through further study and data gathering efforts at sea. It is hoped that the ISWM can eventually serve as an effective waste prediction tool and facilitate the further integration of operational, waste and material management decision-making.

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LCdr Skinner is the Engineering Division Commander of Canadian Forces Fleet School Esquimalt in British Columbia. The author conceived and developed the Integrated Shipboard Waste Management model for his MSc thesis at Royal Roads University in Victoria (completed in April 2005). Programming services were provided by InterDynamics PTY Ltd. of Australia under funding from the Naval Engineering Test Establishment in Montréal. The ISWM is the shared intellectual property of LCdr Skinner and InterDynamics PTY Ltd.

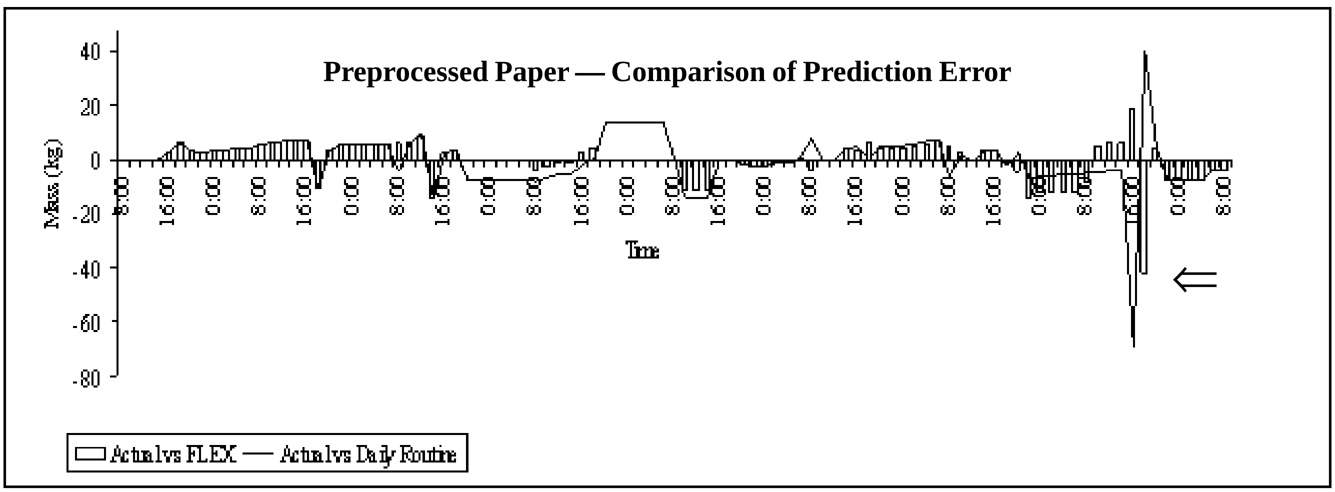

Fig. 3. ISWM original prediction error plots.

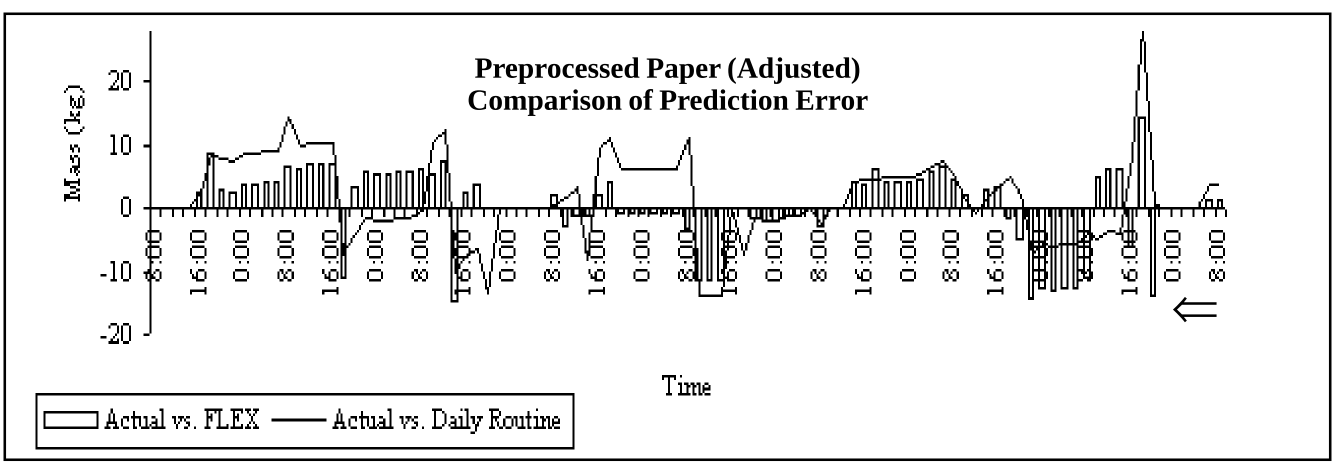

Fig. 4. ISWM adjusted prediction error plots.

Looking Back

Meet the Elfords

by Brian McCullough

Well, you just never know who you're going to meet. During my visit to Victoria last April to attend the MARPAC naval engineering seminar, I had the very good fortune to meet **Clyde** and **Ruth Elford** over breakfast one morning at our hotel. I soon discovered that the Elfords, two very active and personable 1920s-something senior citizens from Calgary, have their own interesting connection with the Canadian navy that dates back to the Second World War.

Clyde wore navy blues in the Royal Canadian Navy from 1939 to 1946. He saw service in the destroyer HMCS *Restigouche* as a torpedoman, the frigate *Prestonian* as a leading torpedo operator, and the corvette *Sorel* as buffer, then coxswain. Ruth joined the Women's Royal Canadian Naval Service (Wrens) in1943, training at HMCS *Conestoga* in Galt, Ontario and at HMCS *Cornwallis* in Nova Scotia before serving as a captain's writer at Naval Service Headquarters in Ottawa and at HMCS *Stadacona* in Halifax. She "demobbed" in 1945.

Clyde and Ruth Elford "pressed into service" for a photo outside their hotel while vacationing in Victoria last April. *(Photo by Brian McCullough)*

In later years (1988-1995) Clyde was the public relations manager for the Naval Museum of Alberta. I'd never even heard of this museum, but it turns out to be one of the largest of its kind in Canada. The NMA will definitely be on my list of must-sees when I visit Calgary for the 2007 reunion of my naval reserve officer cadet Class of '72.

By way of a nice little footnote to this story, I was very pleased to learn that Ruth and Clyde Elford actually had a chance to "go to sea" together with the Canadian navy. These honoured naval veterans were invited to day-sail in the Canadian patrol frigate HMCS *Calgary* (FFH-335) when the ship commissioned in 1995.

The Naval Museum of Alberta — "Landlocked" in Location Only

by Bridget Madill and Brian McCullough

Looking for one of the largest naval museums in Canada? If so, you're going to have to head inland — all the way to Calgary!

The Naval Museum of Alberta may be more than 500 kilometres from salt water, but it houses a comprehensive and growing collection of Canadian naval and merchant marine equipment, artifacts, photographs and historical documents.

Among the larger items on display at the Naval Museum of Alberta are a variety of naval guns, ASW mortars and — pride of collection — three vintage naval aircraft. The museum's beautifully restored F2H-3 Banshee was the last aircraft of its type to be flown by

(Cont'd next page)

This silk-screen of six young RCN sailors holds a place of honour at the Naval Museum of Alberta in Calgary. An 18-year-old Clyde Elford is on the far right. *(All museum images courtesy the Naval Museum of Alberta)*

the RCN when it was delivered from Shearwater to the Southern Alberta Institue of Technology in 1963. The naval air display also includes a Mk XV Supermarine Seafire and a Mk II Hawker Sea Fury.

The Naval Museum of Alberta also also maintains an extensive archive of Canadian naval photographs, documents, ship plans and the like, including 16,000 photographic prints donated by naval historian and author Ken Macpherson. The museum's John Burgess Library book collection alone contains 4,000 volumes.

The Naval Museum of Alberta is a recently accredited Canadian Forces museum, but has been in existence for nearly two decades. The facility opened its doors in 1988 in downtown Calgary, right next to the local naval reserve division HMCS *Tecumseh*. Wartime recruit screening buildings used to stand nearby. The museum will be moving within the city during the 2006-07 time frame, establishing new digs at the joint service Museum of the Regiments.

Information about the $16-million move on the museum's website idicates that:

> "The Department of National Defence as the landlord will manage the plant and the Calgary Military Museums Society (CMMS) will be responsible for museum programming. Each of the participating museum societies will continue to own their collections and will contribute to the overall museum programmes. Each of the major (army, navy, air force) museums will be represented at the executive level on the CMMS."

To celebrate this year's 200th anniversary of the Battle of Trafalgar, the museum has mounted a special exhibit to provide a "Canadian perspective" on Vice-admiral Horatio Nelson's epic career. The exhibit includes an almost three-metre-long (by two metres high) detailed model of Lord Nelson's flagship HMS *Victory*, donated to the museum by Calgary model-maker Hans Schallhorn.

If you can't get there in person, why not take a virtual tour of the facility on the museum's website at **www.navalmuseum.ab.ca**. The website is easy to navigate, beautifully illustrated, and fairly quick to download, even from a dial-up connection.

Bridget Madill and Brian McCullough produce the Maritime Engineering Journal *for DGMEPM in Ottawa.*

2004 Naval Technical Officer Awards

Text by Lt(N) S.T. Hughes,
CFNES Officer Training Division

Photos by MCpl Carrie Roy, Formation Halifax Imaging Services

The Naval Technical Officer Awards are presented annually to recognize the achievements of our best junior Naval Technical Officers in their pursuit of leadership and engineering excellence. The 2004 NTO Awards were presented at the annual Eastern Region Naval Technical Officer mess dinner on April 7, 2005 at the CFB Shearwater officer's mess.

L-3 MAPPS Saunders Memorial Award

The L-3 MAPPS Saunders Memorial Award (formerly the CAE Award) was renamed in memory of Lt(N) Chris Saunders. It is presented annually to the candidate with the best academic standing on the MS Eng Applications Course. Ms. Wendy Allerton of L-3 Communications MAPPS presented the award plaque and the *Modern Engineers' Journal* to **SLt Mark McKiel**.

Lockheed Martin Canada Award

The Lockheed Martin Award is presented annually to the best overall candidate achieving the NCS Eng (AIRX) qualification. LCdr (ret.) Stan Jacobson of Lockheed Martin Canada presented the award and a naval sword to **Lt(N) Tim O'Brien**. Runners-up were Lt(N) Douglas Anderson, Lt(N) Ken Pepin and Lt(N) Dan Roddick.

MacDonald Dettwiler Award

The MacDonald Dettwiler Award is presented annually to the best overall naval technical officer who has achieved Head of Department qualification. Mr. Simon Jacques of MacDonald Dettwiler presented the award and a naval sword to **Lt(N) Tom Sheehan**. Runners-up were Lt(N) Amit Bagga, Lt(N) Loren Pearson and Lt(N) Mark Schaaf.

Naval Officer's Association of Canada (NOAC) Award

The NOAC Award is presented annually to the candidate with the best academic performance and officer-like qualities on completion of the Naval Engineering Indoctrination Course. Cmdre (ret.) Mike Cooper, NOAC, presented the award shield and the book *The Ships of Canada's Naval Forces* to **NCdt Jetske Goslinga**.

Mexican Navy Award

The Mexican Navy Award is presented annually to the MS Eng candidate who, in the opinion of his peers and instructors, best exemplifies the qualities of a naval technical officer. As Mexican Naval Attaché Capt Chines was unable to attend, the award was presented by Cmdre Roger Westwood to **SLt Rick Fifield**.

Weir Canada Award

The Weir Canada (formerly Peacock) Award is presented annually to the best overall candidate achieving MS Eng (AIRY) qualification. Mr. Mike Davies, Weir Canada Inc., presented the award plaque and a naval sword to **Lt(N) Norm Hodgson**. Runners-up were Lt(N) Stéphane Lachance, Lt(N) Gerry Parsons and Lt(N) Fintan Quilty.

News Briefs

Deputy Minister's Commendation

Several members of DGMEPM received the DM's commendation for their work on the High Speed Data Connectivity (HSDC) system. This technology has provided a significant leap in our ships' ability to utilize modern data communications, and proved to be a key capability during Op Apollo. The HSDC team provided this extraordinary capability in a very short time through dedication and hard work.

The recipients (from left): Lt(N) Harris Kirby, Raj Srinivasan, Bev Stewart (accepting a posthumous award for her husband Lorne), Lt(N) Mario Bernier, Dale St. Arnaud, Denis O'Brien and LCdr Perry Dombowsky.

Submarine Awareness Training

The first submarine awareness course for DGMEPM staff was held June 15-16 at the Louis St-Laurent Building in Gatineau, Québec. The course, attended by more than 30 staff, was designed to enhance general knowledge of the *Victoria*-class submarines and their onboard systems among life-cycle material managers and others involved with the submarines in their daily work.

Organized and facilitated by the Directorate of Maritime Class Management (Subs), the training was delivered by four instructors from the Canadian Forces Naval Operations School in Halifax. The program covered an overview of the submarines, material certification (delivered by DMCM Subs), and one-hour presentations from the CFNOS instructors on the trim, ballast and bilge system; hydraulic systems; compressed air systems; propulsion system; DC & AC electrical systems; tactical weapons system overview; and weapons handling & discharge system.

The course achieved its aim of enhancing DGMEPM submarine knowledge well enough that similar training is envisioned for headquarters staff in the future. **— LCdr Derek Hughes, DMCM Subs, Ottawa.**

(Photo: Brian McCullough)

Halifax-based instructors PO1 Cam MacDonald, MS Jeff Cameron, CPO2 Claude Fleury and Lt(N) Marc Pallard, along with DMCM Subs organizer LCdr Derek Hughes delivered a successful *Victoria*-class submarine awareness training program for DGMEPM personnel in June.

2004 Naval Technical Officer Award Winners and Finalists

Photo: MCpl Carrie Roy, Formation Imaging Services Halifax

Congratulations to NTO award recipients and finalists: *front row, left to right,* Lt(N) Fintan Quilty, NCdt Jetske Goslinga, Lt(N) Loren Pearson, SLt Mark McKiel, SLt Rick Fifield, Lt(N) Norm Hodgson, Lt(N) Amit Bagga, and Lt(N) Stephane Lachance. *Back row:* Lt(N) Doug Anderson, Lt(N) Mark Schaaf, Lt(N) Gerry Parsons, Lt(N) Dan Roddick, Lt(N) Tim O'Brien, Lt(N) Tom Sheehan, and Lt(N) Ken Pepin.

— See page 27 for individual award photos.

Merchant Navy Day of Remembrance Sept. 2, 2005

Photos : Brian McCullough

Generations Apart — Leagues Together

Sailors old and young alike turned out at the National War Memorial in Ottawa to remember the contribution and sacrifice of Canada's wartime merchant navy. Les White *(left)* represented the League of Merchant Mariner Veterans of Canada, while 10-year-old Able Cadet Matthias Skof was part of a well-appreciated contingent from Navy League Cadet Corps *VAdm Kingsmill,* on hand to assist with the ceremonies.

National Defence / Défense nationale

News

FALL 2005

CANADIAN NAVAL TECHNICAL HISTORY ASSOCIATION

Canadian Naval Defence Industrial Base (CANDIB) News

The CANDIB historical research project continues its work and has made some real progress recently in its goal of documenting the contribution of naval construction and equipment programs to the Canadian industrial base.

The oral history program recently conducted an interview with Captain(N) Roger Chiasson (ret.) on the multi-ship refit program the Canadian navy undertook between 1979 and 1982. The three participating groups in this program were the navy, the Department of Supply and Services, and the contractor, Canadian Vickers Ltd. of Montreal. The interview focused on the naval perspective of this interesting story.

The CANDIB committee has also been actively putting the word out to the community. Don Wilson has commissioned a new www.cntha.ca website with a CANDIB section that showcases our ongoing effort.

CANDIB also had a display at the MARI-TECH 2005 Conference held in Ottawa in June. This gathering of marine engineering professionals was a golden opportunity to establish additional contacts with people whose recollections of their experiences are sought for our archives. Several delegates from distant ports joined the growing list of "interested parties" whose memories of naval activities relating to Canadian industrial involvement will be a most useful addition to the collection of research information now being assembled.

—Tony Thatcher, **CANDIB Chairman**

Congratulations for a job well done to the members of the MARI-TECH 2005 Conference Committee (left to right): Ian Wilson (Website), Brenda Spence (Registration), Peter Cairns (Industry/Government Liaison), Anne Carroll (Sponsorship/Advertising), Gerry Lanigan (Committee Chair), Dave McCracken (Exhibition Booths), Don Wilson (Webmaster), Don Cruickshank (Publications), and Al Kennedy (Treasurer/Registrar).

Photos: Brian McCullough

CNTHA on display at MARI-TECH 2005 in Ottawa. Pat Barnhouse and Douglas Hearnshaw with VAdm Bruce MacLean, Peter Cairns and Gerry Lanigan.

CNTHA News *Est. 1997*

CNTHA Chairman
RAdm (ret.) M.T. Saker

CANDIB Committee Chairman
Tony Thatcher

Directorate of History and Heritage Liaison
Michael Whitby

DGMEPM Liaison
Capt(N) Martin Adamson

Maritime Engineering Journal Liaison
Brian McCullough

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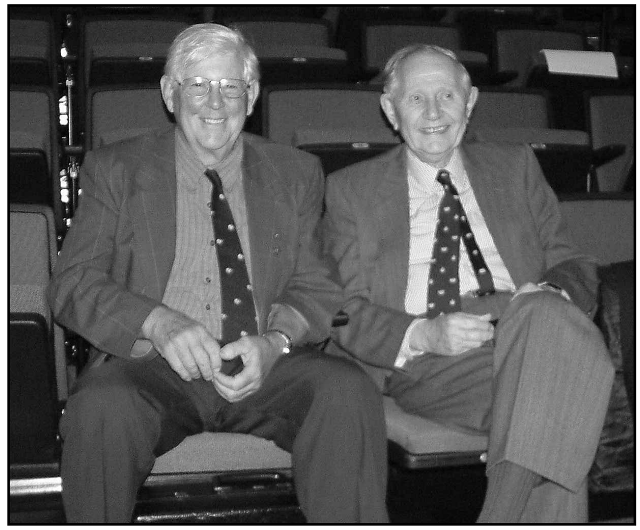
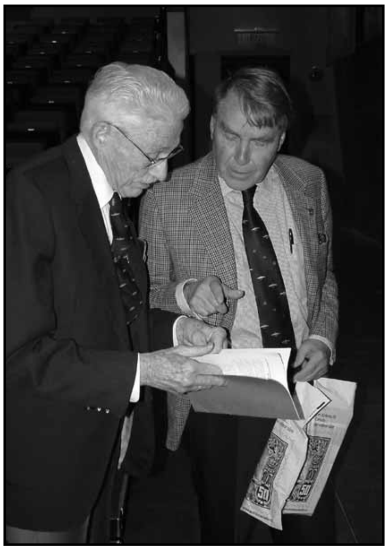
CNTHA News is the unofficial newsletter of the Canadian Naval Technical History Association. Please address all correspondence to the publisher, attention Michael Whitby, Chief of the Naval Team, Directorate of History and Heritage, NDHQ Ottawa, K1A 0K2. Tel. (613) 998-7045, fax 990-8579. Views expressed are those of the writers and do not necessarily reflect official DND opinion or policy. The editor reserves the right to edit or reject any editorial material.

Canadian Naval Technical History Association on display



VAdm (ret.) Dan Mainguy with keynote speaker VAdm Bob Stephens at the 7th MARCOM Historical Seminar.



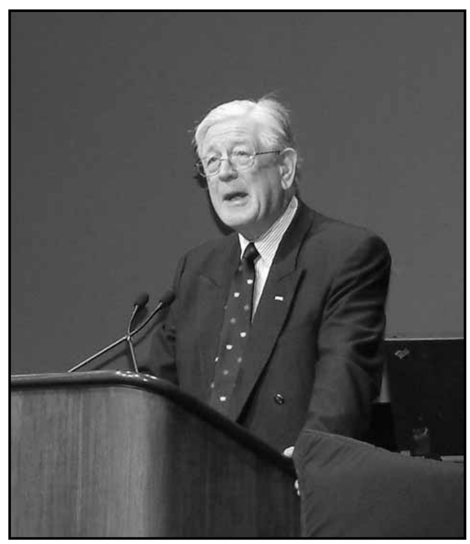
CNTHA supporters Don Jones and Rolfe Monteith.

Since its establishment in 1996, the CNTHA has always been on the lookout for opportunities to spread the word about its aim of preserving Canada's naval technical heritage. The CNTHA does this primarily volunteer activity on behalf of the Directorate of History and Heritage. The CNTHA was therefore extremely fortunate to be invited to set up display booths at two excellent, marine-related conferences in Ottawa this summer.

The first event was the Canadian Institute of Marine Engineering's MARI-TECH 2005 conference and exhibition, held at the Crowne Plaza Hotel June 2-3. The conference theme of Maritime Security and Logistics was well supported by an extremely busy exhibition hall of international defence industry people, engaging keynote and luncheon speakers, and an excellent papers program. Activity surrounding the Joint Support Ship Project was very much in evidence, adding a buzz of electricity to an already dynamic conference.

The other event — the 7th MARCOM Historical Seminar, held Sept. 22-23 at the new Canadian War Museum — was equally interesting. Sponsored by Maritime Command and the Directorate of History and Heritage, the seminar featured more than a dozen speakers examining such topics as the technological aspects of the navy during the Cold War, the Montreal visit by the German cruiser *Emden* in 1936, and courts martial in the RCN during the nineteen-fifties and sixties. The highlight was the keynote speech by **Vice-Admiral (ret.) Bob Stephens** who delivered a wonderfully personal career retrospective of his father, Engineer Rear-Admiral George Leslie Stephens. Of special note was the attendance and participation of London, England-based **Rolfe Monteith**, a "founding father" of the CNTHA.

— Brian McCullough



Historian Alec Douglas