National Defence Défense nationale

Maritime Engineering Journal

June 1997

Photo Feature: MCDV Construction

Also:

- *Forum — Striking a Balance*
- *Looking Back at Project Mermaid*

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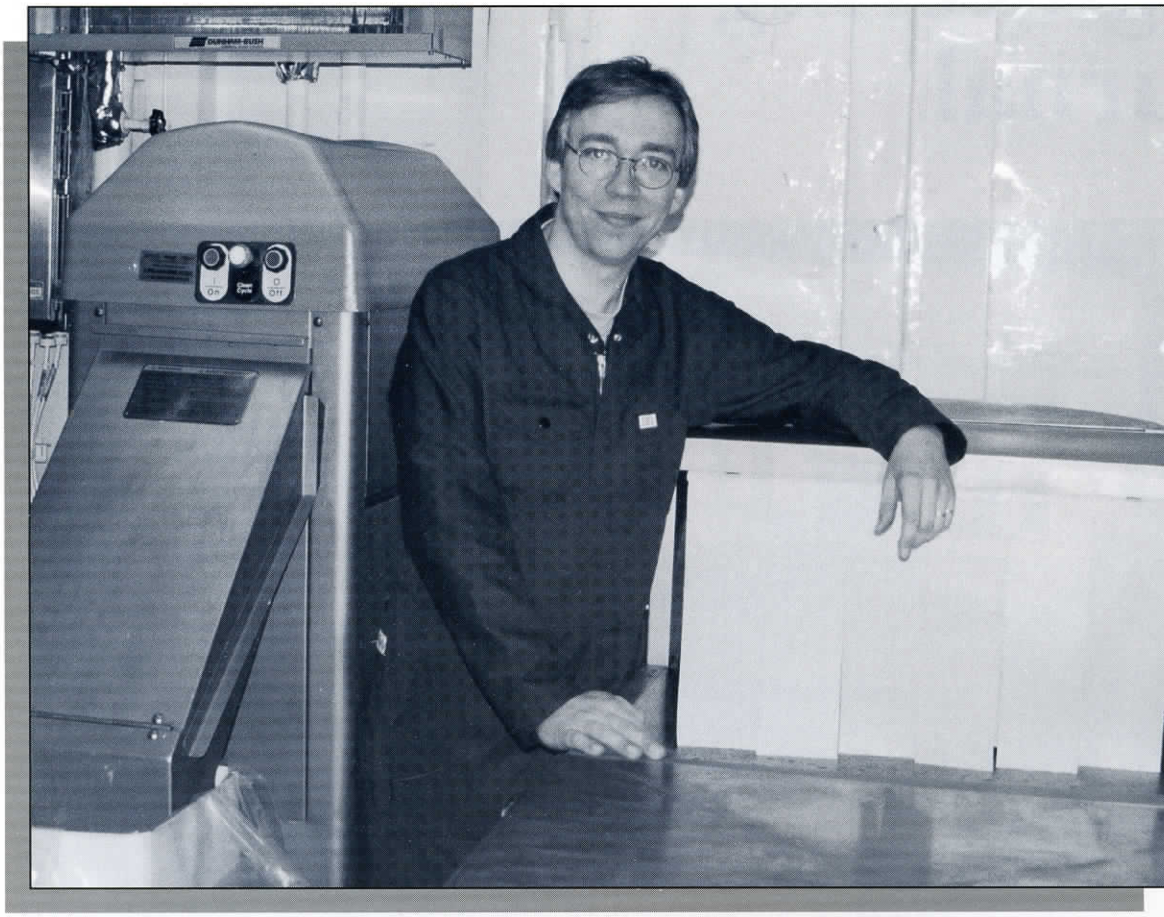

(M. Gingras Photo)

DMSS 4 environmental systems engineer Mario Gingras with *Protecteur's* new waste pulper.

Maritime Engineering Journal

Established 1982

Director General
Maritime Equipment Program
Management
Commodore F.W. Gibson

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DEPARTMENTS

FEATURES

Our Cover:
The after two thirds of HMCS *Glace Bay* near the HSL slipway to Halifax Harbour. The bow section will be slid out of the shed and aligned with the after section for welding. (*HSC96-0721-03*)

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Guest Editorial

Fleet Maintenance Facilities are Ready for the 21st Century

By Captain(N) Bert Blattmann

Having had the pleasure of serving three eventful years at Ship Repair Unit Pacific and FMF *Cape Breton*, I take a brief pause to gaze in my crystal ball with the hope of better defining for you the future of the naval dockyards. The FMFs readily understand the full meaning of the popular maxim, "change is the only constant affecting us." The naval dockyards are not afraid of change. In fact, during these past few years they have experienced a transition without parallel in the annals of the ship repair units since the Second World War. I take this opportunity to briefly acknowledge some of the innovative ideas that have been implemented to ensure the FMFs are indeed ready to tackle the 21st century as solid and efficient enterprises.

It was only one year ago that FMF *Cape Breton* in Esquimalt and FMF *Cape Scott* in Halifax stood up as new entities, having amalgamated three separate units — the ship repair units, naval engineering units and fleet maintenance groups — into a single organization. The renewal challenges set under the Naval Engineering and Maintenance System Functional Review in 1994 were indeed achieved by 1996. The main goals were:

- to consolidate all naval engineering functions under one command structure;
- to reduce costs of service delivery by 20 percent;
- to integrate military personnel into the production shops; and
- to adopt cost accounting and productivity measurement comparable to that found in private industry.

These goals were ultimately achieved by both FMFs. However, the impetus for continuous improvement did not die with the closure of the NEMS project management office in July 1996. With one full year of operation behind us, it has become evident that a great deal of work remains to be done to transform the FMFs into a "most effective organization" (MEO). To this end, both units are working tirelessly to achieve this status well before the turn of the century. Such a task cannot be done in isolation from the naval technical community at large (regardless if you are serving in an FMF, in the fleet or at NDHQ in Ottawa). It is incumbent on the naval community as a whole to give its full commitment toward ensuring the dockyards remain under naval control and are utilized to their fullest capacity.

I am optimistic about the future of the FMFs. There are positive signs that the naval community is finally streamlining its efforts with a single goal in mind — ensuring that maintenance, logistics and engineering support services are provided to the fleet in the most cost-effective manner. The FMFs have a critical role to play in living up to this expectation, but so does the rest of the naval community.

> ***"There are positive signs that the naval community is finally streamlining its efforts with a single goal in mind."***

What does my crystal ball reveal? By year 2000, which is not so far away, the FMFs will have reached their smallest critical mass, less than half the size they were during 1994/95. With their hi-tech management information system, the FMFs will have the ability to accurately capture, record and analyze the cost of all activities and daily operations through the use of continually updated performance indices and productivity criteria. Personnel in the Chief of Maritime Staff and on DGMEPM staff will have full access to this information, and will regularly benchmark this productivity against similar activities being conducted in the private sector. In this way the navy will ensure that FMF services remain the most cost-effective.

By year 2000 maintenance and engineering services will be provided by a small, but highly specialized and talented core of civilian tradespeople and naval technicians, supplemented by casual labour and assisted by a bank of private firms. The FMFs will have reached optimum flexibility (read efficiency) to cater to the extremely diverse workload associated with naval ship repair. They will also have achieved a comfortable degree of partnering with local and regional industries and will ensure through the competitive process the lowest cost of service delivery to the fleet. Under these arrangements, the FMFs' primary mandate will be limited to what could he defined as "basic fleet support," mainly involving running repair activities, with third-line repair and overhaul brought in as required to level the shop workloads. Thanks to the CPF maintenance profile consisting exclusively of short work periods and docking work periods, the FMFs will no longer be involved in extensive refit work.

It is just recently that the concept of a fleet support plan (FSP) has been introduced by DGMEPM. There are various agencies involved in implementing the FSP — private consulting firms, private shipyards and the FMFs, to name a few. The aim of this plan is to capture and consolidate all fleet support requirements into a single document which is seen as an essential planning tool. By its nature, the workload associated with basic fleet support changes dramatically as the ships deploy. Hence, assigning work from the FSP to the FMFs as a means of level-loading the units would guarantee the best use and stability of the FMF workforce. In my opinion there is an urgent need for the naval community to embrace the concept of the FSP and to come to grips with it, especially that portion that is to be shared between the various service delivery agencies.

There is no question that our naval dockyards are unique in the Public Service. As to whether or not they should be privatized, the Forces responded to this question by stating that, "Properly managed, they are best left within the Public Service and within instant reach of Naval Requirements." Considering the FMFs are a proven strategic asset to the navy, we must ensure we treat them as such.

If you haven't yet experienced the FMF environment, believe me when I say that it is a rich mix of men and women, officers and enlisted personnel, managers and unions, tradespeople and apprentices — all fiercely dedicated to providing the best possible support to the fleet. It is a culture unto itself, with a work environment optimized for dealing with the technical challenges of the navy well into the 21st century. On that note I would invite all naval personnel to acquaint themselves with the FMFs' capabilities and tax them to their fullest extent.

Captain(N) Blattmann has been the commanding officer of Ship Repair Unit Pacific/ FMF Cape Breton since 1994. He leaves the position this summer to attend a year-long course at the CF Language School in Ottawa as a prelude to joining the Canadian embassy in Bonn, Germany as the military attaché.

The *Journal* welcomes **unclassified** submissions, in English or French. To avoid duplication of effort and to ensure suitability of subject matter, prospective contributors are strongly advised to contact **the Editor, Maritime Engineering Journal, DMMS, National Defence Headquarters, Ottawa, Ontario, K1A 0K2, Tel.(819) 997-9355**, before submitting material. Final selection of articles for publication is made by the *Journal*'s editorial committee. Letters of any length are always welcome, but only signed correspondence will be considered for publication.

Letters

Another look at HMCS Bonaventure

Congratulations on the excellent choice of "*Canadian Technical Involvement in the Design and Construction of HMCS* Bonaventure" as the inaugural CNTHA Looking Back article for the *Maritime Engineering Journal*. I do however have some observations to make on the article.

First, the picture on page 22 purportedly showing flight-deck operations in 1969 was obviously taken several years before that as certain items of pre-refit configuration are clearly visible, viz. the UHF antennas which were replaced by more modern multi-channel units, and the height finding radar that was removed.

Second, the "Bonnie Specs" on page 24 mention the Fresnel lens as replacing the mirror landing system. *Bonaventure* was originally fitted with two mirrors; only the primary system (port side fitting) was replaced during refit, the other remaining in place. Incidentally, on decommissioning, the Fresnel lens was sold back to the U.S. Navy from whence it came for what was reported as the same cost as for acquisition!

Third (and last!), on the subject of the L70 Bofors, an air-defence artillery officer who commanded a battery in Europe, as well as being the Canadian Forces Europe staff officer for air defence, informed me that these particular guns were never used in Europe. The Canadian airfields in Europe were "defended" solely by the ubiquitous L60 Boffins, now getting yet another lease on life in the MCDVs. Perhaps one of your readers is aware of the final disposition of the L70s.

Yours aye,
P.D.C. Barnhouse, Ottawa

Abusing the title "engineer"

A footnote should be included in Lt(N) Howard Morris' insightful article, "*Software Engineering - It's More than Programming*." In Canada (via provincial legislation) an engineer is someone who is licensed to practise engineering and possesses the designation P.Eng. Simply put, if you do not hold a P.Eng. you cannot call yourself an engineer. Exceptions to this rule (unfortunately, only for financial reasons) include federally employed engineers (military and civilian) who otherwise have a choice in seeking out professional recognition.

Private sector firms advertising for programmers and using the sexier title "software engineer" without specifying a P.Eng. qualification are breaking provincial laws and risk prosecution. In contracting out for software engineering services without ensuring the P.Eng. accreditation of the company or personnel authorizing the product, the customer risks an inferior product and a weaker legal foothold in prosecuting the company for software failings.

In taking this strong stance against abuse of the title "engineer," the professional engineering associations in Canada are protecting the public and ensuring that the profession maintains its high level of prestige and accountability.

LCdr Christopher P. Tingle, CD, P.Eng., Nuclear Research Group, Department of Chemistry and Chemical Engineering, Royal Military College, Kingston, Ont.

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If you would like to change the number of magazines we ship to your unit or institution, please fax us your up-to-date requirements so that we can continue to provide you and your staff with the best possible service. Faxes may be sent to: **Editor, Maritime Engineering Journal, (819) 994-9929.**

Commodore's Corner

A Perspective on What We Do in the Navy

By Commodore F.W. Gibson, OMM, CD
Director General Maritime Equipment Program Management

What do you say when you introduce yourself to the new people next door and they ask you what you do for a living? Give them the usual response of, "I'm in the navy!" and you can just see a picture forming in their minds of Second World War corvettes duking it out with U-boats in a North Atlantic gale. At this point there may be a pause as they remember that this is 1997, and you might then catch a glimmer of a shiny new patrol frigate coming over the horizon of their consciousness, only to be lost from view in a fog of media accounts of project blunders, technical glitches, crossing-the-line ceremonies and other tabloid-worthy news items.

You see the question marks appearing, so you jump in and fill the breach with, "I'm a MARE — you know, a Maritime Engineer," or "I'm an NET(Tactical) — you know, a naval electronics technician specializing in navigation, active and passive electronic surveillance, and fire-control systems."

They still don't get it. You continue, desperately trying to bridge the gap in understanding with, "I'm a Marine Systems Engineer and I work in the fleet maintenance facility as the technical services officer for steamers and auxiliary vessels." By this time their eyes have glazed over, they are shuffling their feet, and their heads are turning in the hope that the cable guy will show up so that they can make a graceful but speedy exit.

How many times have we all been through a similar experience, in the end finding ourselves wondering afterward, Why is it so difficult to explain what it is that we do? People understand what a chartered accountant is. Likewise, they have a fairly good idea of what a postal worker does for a living. Why, then, is it so difficult to get people to understand exactly what it is *we* do?

The reason that we have difficulty is that what we do has no parallel in the civilian sector. What we do as MARE officers or Naval Technicians is actually an amalgamation of many diverse roles and responsibilities that are unique to our calling. We have come to understand the labels that stand for these groupings, like "MARE" or "Mar Eng Tech," but to others it is only so much jargon. It doesn't help either that we experience such a broad range of activity in our careers.

Whatever job we are doing today, it is likely we will be doing something completely different three years from now, and something totally different again three years after that. From seagoing department head or senior tech, to deskbound career manager in Ottawa or Green Machine recruiter in the Gaspé —we do it all.

So how do we put some perspective into what we "do" in the navy?

When we are at sea we are part of the fleet and are there to do a specific job as part of the combat team. As VAdm Mason put it when he was the maritime commander, "When naval forces go to sea, all personnel fight their ship as full members of the combat team, whether weapons or sensor operators, electronics or weapons technicians, electrical or engineering tradesmen, or in supply, finance or personnel support." When we come ashore, we support the fleet. It's as simple as that.

Service at sea prepares MAREs and Naval Technicians alike for the demands they will face in providing effective technical support to the fleet. The knowledge and experience we gain at sea, among other aspects of our expertise, are not available in the private marketplace. They must be developed within the service if the fleet is to receive the support that it needs. We support the fleet from ashore in many ways, and not only in engineering or technical roles. The recruiter in the Gaspé, the career manager in Ottawa and the MOC manager in Halifax are also there to support the fleet, whether directly or through a Forces-wide agency.

When we come ashore, we also find that the nature and structure of the organizations within which we provide support to the fleet are changing rapidly. Old relationships and ways of doing business have been modified or replaced. This is especially true for Maritime Command Headquarters, the fleet maintenance facilities and the MEPM division. The standing down of MARCOM Headquarters and the standing up of the Chief of Maritime Staff organization in Ottawa have provided a requirement and an opportunity to improve the nature of the partnership between these entities.

The personnel side of the house is no less subject to change. The MOS reviews and occupation analyses of the MARE and Naval Technician occupations have assisted us in reexamining the way in which we structure our occupations and develop and employ our people within them.

The MARE occupation analysis (OA) has been a beneficial exercise, notwithstanding the fact that the major recommendation to restructure has not been accepted. It was necessary to examine the MARE occupation in light of the transition of our new ships to in-service status, and the organizational changes that were affecting MARE employment in coastal and NDHQ organizations. The MARE OA was, and still is, an important element in this process.

"We cannot expect people to quickly comprehend all the...factors that affect what we do as MARE officers and Naval Technicians."

Many important changes, especially in training, are being progressed as a result of the OA. Structural change will continue to be considered part of the evolutionary process of monitoring the MARE occupation and assessing the way ahead. The success of the naval and engineering skill sets used during the development, acquisition and in-service support of the Canadian patrol frigates, TRUMP destroyers and maritime coastal defence vessels indicates that the current MARE occupation structure is working well. Still, the occupation must continue to adapt if it is to be as relevant in the future.

The Naval Technician trades have also been subject to close reexamination in light of changing requirements. The MOS Review of all hard-sea occupations, the occupation analysis of Marine Systems Technician trades, and the Combat System Technician Vision Paper are all important elements in determining how the navy is to develop and employ Naval Technicians to meet new requirements.

So, when faced with the question, "What do you do for a living?" a reasonable reply would be to say, "I'm in the navy and I'm an engineer on board HMCS *Whompity-whomp*" or, "I'm in the navy and I'm involved with fleet support." More information can be offered relative to the level of interest this provokes, but don't be upset if the person says, "Oh, that's nice," and turns the conversation to the Stanley Cup playoffs.

The education of the Canadian public to the need for, and understanding of, their navy must continue. However, we cannot expect people to quickly comprehend all the requirements, relationships and other factors that affect what we do as MARE officers and Naval Technicians. Sometimes we can barely understand them ourselves.

Submission Formats

As a general rule, article submissions should not exceed 12 double-spaced pages of text. The preferred format is MS Word, or WordPerfect, on 3.5" diskette, accompanied by one copy of the typescript. The author's name, title, address and telephone number should appear on the first page. The last page should contain complete figure captions for all photographs and illustrations accompanying the article.

Photos and other artwork should not be incorporated with the typescript, but should be protected and inserted loose in the mailing envelope. If at all possible, electronic photographs and drawings should be in TIFF format. A photograph of the author would be appreciated.

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

Nobody asked me, but...

Article by Cdr P.J. Brinkhurst

Over the past few years I have had an opportunity to watch the naval community from a variety of vantage points within DGMEPM and MARCOM, looking both toward the waterfront and the fleet maintenance facilities, and back toward the "centre." While we have successfully made changes to adapt to our evolving environment, what is even more evident is the ongoing conflict that prevents us from moving at the pace at which we could be proceeding to support the navy. I have watched conflicts come and go between units, between units and formations, units and MARCOM, formations and MARCOM, and between all of the above and DGMEPM. To be fair these conflicts often concern deeply held beliefs, but what is surprising is that the beliefs seem so disparate for what is in fact one navy. All too often debate does not end when decisions are taken. Rather, the implementation of decisions is slowed by individuals and small groups of people who, through creative reasoning, are able to mould the final decision to fit their original preferences.

Why is this? Perhaps it stems in part from the desirable independence of thought and will we try to engender in naval officers. Maybe we are all so focused on leading that we do not easily submit to being led. Maybe. I think the problem has a great deal to do with the segmented nature of our naval community. We are too ready to argue our own point before stopping to listen and understand an opposing view. There is a tendency to address issues within the engineering or logistic or operator communities, without the benefit of direct input from the other communities. This means that individuals in one group must *interpret* the needs and viewpoints of another group without the benefit of their direct voices. I believe much of the debate internal to our subnaval communities could be streamlined by an injection of views from all sides of the naval support community.

But what can we do? We lack such forums, at least at a rank level where they can be useful to the community as a whole. I think that we in the engineering community should set an example by making a greater effort to regenerate our naval focus on considering what is best for the navy as a whole, not just our own unit.

For a start, we have tended to isolate ourselves, focusing on ourselves as engineers rather than as naval officers. An institution like the MARE Council, operating without MARS and SEALOG participation, carries with it the danger of having a somewhat parochial outlook. Considering some recent comments made by our senior leaders on the possibility of unions or similar associations taking root in the Canadian Forces, I think we should move to eliminate MOC-specific bodies and replace them with a true naval support council in which our three communities can share problems, communicate good ideas and learn more about each other. The membership of such a council should not be drawn solely from the senior ranks, as this tends to isolate the group from first-hand input on what is actually happening in the fleet. Rather, it should be a mix of selected and elected representatives drawn from across the fleet's rank and occupation structure. Such a forum, akin to those of other professional groups, would provide a reasonably direct route for concerns to be raised and discussed within the community, rather than relying on a divisional system that at times seems like an obstacle to innovative ideas. As a minimum, if such a naval support council were not accepted, the MARE Council could set an example by including representatives of the MARS and SEALOG communities, as well as direct representation from the lower ranks.

Secondly we in the support community still need a unifying vision that goes beyond the boundaries of ADM(Mat), MARCOM and specific units. While accountability for the naval support function will remain split for the foreseeable future, we cannot allow it to be managed in this way. It must be a team effort. Past efforts at producing a unifying vision have failed perhaps because they have sought to paper over the issues that seem to divide us. Who is responsible for the long-term viability of the fleet? What about the immediate problems? What role must we play with respect to ensuring an effective industrial support structure? Whatever the answers, I suggest they all require us to act as a team. But we must reach this understanding jointly and try to remove the distrust that has built up between the coasts and ADM(Mat) over the years.

The vision we seek must be broad enough to allow individuals to understand it in their own context. Too specific and the group feels it is being led by the nose; too vague and we start to wander back into conflict. The challenge to our council in either its current or hopefully amended form, is to strike the balance that will both inspire and lead at the same time. Its chances of success are much improved, I believe, if it adopts a more open and inclusive approach to its deliberations.

Last, we must all decide whether or not we are going to dedicate ourselves to improving our relationships both within and outside the MARE community, and to acting in a unified manner toward a common vision of what material support means. This is not easy. It takes a strong act of will to listen to opposing views, and an even stronger one to support them if a decision goes against you. But that is what is necessary if we are to continuously demonstrate that we are valuable members of the naval team. These days none of us has the time to waste on fighting parochial battles — it is time to move on.

Commander Brinkhurst is the Deputy Chief of Staff for Materiel Program Management in MARCOM.

On the Shock Resistance of Naval Ships

Article by Z.J. Czaban

Mr. Norminton's concerns regarding the need for continued shock qualification proof testing voiced in the February issue of the *Maritime Engineering Journal* are well stated. It is gratifying to know that elements of the commercial establishment realize the importance and necessity of maintaining warship design standards in the modern world. There is no initiative within the Canadian navy to degrade the shock survivability requirements of Canadian warships.

There are (and have been for some time) efforts underway, however, to enable achieving these goals using commercial equipment. Canadian design practice has encouraged the use of resilient mountings for many years. Such "shock mounts" have demonstrated more than adequate capability in protecting fragile equipment from the potentially devastating effects of weapons. Recent tests have shown that suitably mounted commercial motors and pump sets can survive full shock test levels. In short, to qualify for shock, any equipment, be it commercial or military, must simply just pass the shock test. There is no intention to forego shock qualification testing of any equipment which affects the safety or combat capability of naval combatants.

Whereas equipment may meet shock using suitable mountings, there remain other problems concerned with operation in the naval marine environment. Once commercial equipment is further hardened to meet requirements for EMI, submersibility, shipboard vibration, corrosion, power quality and other environmental conditions, to name but a few, it begins to change its appearance somewhat.

Canadian naval ships and their equipment are designed and qualified to withstand the damaging potential arising from underwater explosions. This requirement alone sets naval construction standards apart from those of the commercial realm. While the capability of modern naval ships has grown astronomically in this century, improvements in their ability to resist damage from weapon effects have, in general, not kept pace.

There exists a perception that there is little point in battle hardening modern ships given the devastating effects of modern weapons. This resigned attitude would surely raise the eyebrows of our forefathers. That ships of the line were battle hardened as a matter of fact is well illustrated by the final sortie of the British warship *Revenge* against the Spanish Armada. Acting alone in somewhat of a rearguard action, *Revenge* engaged six galleons which pummelled her for more than a day, but were unable to destroy her. She sustained more than 1,500 direct hits, repulsed repeated boarding attempts, yet retained sufficient capability to arrange a negotiated settlement. To suggest that a ship could survive even a tiny fraction of such devastation today is to invite disdain and disbelief.

Floating shock test platform

Modern weapon effects are usually categorized as conventional, nuclear, or chemical, and are often accompanied by secondary effects such as fire or radiation. Their destructive potential (regardless of whether they are delivered as direct hits or near misses) depends on an item's ability to withstand damage from a combination of shock, blast overpressure, fragmentation (shrapnel) and heat.

Fortunately, modern Canadian naval ships are indeed battle hardened in many respects and have the ability to fight hurt. Their capability to withstand set blast overpressures arising from internal and external explosions is attained by design standards and qualification through test and analysis of various components. Similarly, resistance to fragmentation damage is provided by means of structural detail (e.g. equivalent armour) sufficient to protect vital equipment and spaces against a specific fragment attack. While these design attributes cannot protect a frigate from direct hits within such vital spaces, they provide an excellent means of reducing the extent of fragmentation damage and are particularly effective against near misses, external bursts and small arms fire.

Given a frigate's size, shape and normal degree of watertight subdivision, damage from an internal detonation of an anti-ship missile will tend to be constrained to one or two watertight subdivisions, assuming the ship does not break in half. Ship designs must thus be able to maintain adequate longitudinal strength and ensure sufficient enclaving and distribution of systems to retain capability outside of the damaged region.

By far the most pervasive weapon effect experienced in ships is the "shock" generated by the detonation of munitions. Whether induced by air blast or by underwater explosion, the effects are similar. They are characterized by a very energetic surface wave travelling through ship structure with a rapid, high-magnitude acceleration followed by a rapid deceleration and possible subsequent excitation of equipment seatings and ship structures which generate large displacements. Materials of construction which have inadequate elongation properties (e.g. cast iron) suffer brittle fracture under such loading conditions. Equipment improperly mounted or supported can become dislodged or otherwise damaged.

Naval ship structures are not, and have never been *specially* designed to withstand the shock induced by underwater explosions. Naval practice, following design rules developed for surviving dynamic, but not weapons-induced sea loads, essentially defines the shock hardness potential inherent to a class. Changing the shock resistance requirement by an order of magnitude in either direction will not significantly change the fundamental characteristics of ship structures. However, designing a ship for shock (any level) does require that attention be paid to detail to avoid "cheap kill" damage as may arise from overhangs, discontinuities and flimsy seatings. The design analysis efforts exerted during shipbuilding programs are generally restricted to proving that structures will not deform beyond limits imposed for the design, rather than optimizing for shock in any particular manner.

Note that it is possible to create more damage from a relatively small sized charge correctly placed, than from a very large charge located in an arbitrary position, even though the latter may generate a far greater shock load. It is ill-advised to overdesign for shock. It is, however, mandatory to balance the design. There is little point in having an intact hull, or even a damaged but floating hull, if the ship is unable to fight. Whereas the blast effects arising from underwater weapons may be sufficient to breach the hull or otherwise damage ship structures, this type of damage will tend to be localized. The shock effects from such detonations generally affect every system and each piece of shipboard equipment.

In order to control damage to ship's equipment, the single-most important aspect related to ship hardening is the Shock Qualification and Control Program, imposed on all Canadian warship building programs. This program requires that all equipment necessary for the continued combat capability of the ship, and such that may affect ship safety, undergo formal shock qualification by test to the full design level required by the building program. All equipment on Canadian warships undergoes such qualification. The tests require that the machinery continue to operate without degradation during application of such shock tests.

The Canadian shock specification (CFTO D-03-003-007/SG-000) defines the shock test criteria that need to be met. The criteria are similar to those imposed by the Royal Navy and the U.S. Navy. The Canadian shock test procedure requires the equipment to survive shock tests on either the lightweight, medium-weight or heavyweight shock test machines. The light- and medium-weight machines comprise a test bed with a large swinging hammer which strikes the mounted equipment with sufficient force to accurately simulate the shock environment expected on board ships at hull lethality levels. The heavyweight tests are conducted on board a floating shock test platform which can accept equipment weighing up to 15 tonnes with a footprint of up to five metres by 10 metres.

The swinging hammer machines have been available in Canada for many years. The principal installation is at the Naval Engineering Test Establishment (NETE) in Montreal. In 1989 NETE was provided with a floating shock test platform to allow qualification of components beyond the capacity of the smaller machines. The requirement to proof test rather than qualify by analysis is fundamental to assuring that systems will continue to perform satisfactorily when in harm's way. While analytical procedures can demonstrate whether structural components may become overloaded during the application of a shock, they are rather limited in their ability to model equipment performance.

Contrary to popular opinion, shock testing in accordance with the CFTO does not generally induce a great deal of physical damage. The shock test procedure requires the equipment to survive a series of blows of increasing severity. Onset of failure is thus noted at lighter shock test levels and hence costly catastrophic failures are avoided. Elementary shock analyses conducted by equipment manufacturers are generally adequate to ensure major components survive the shock test. The principal benefit of the test procedure is to enable finding potential details of the assembly and its subcomponents which may for some reason introduce a transient characteristic while undergoing shock loading that impairs performance of the equipment and the systems it supports. For this reason, much attention must be given to correct loading and simulating the functionality of the unit undergoing test. To a certain extent it is this operational performance requirement that distinguishes shock tests conducted following USN and Canadian procedures from those conducted by other nations.

Procedures are in place to ensure that modifications made to ships following construction conform to these stringent criteria in order not to degrade the design. All ship changes and modifications are reviewed by the design authority to ensure that the requirements stipulated by the CFTO for shock qualification are fully met. Note also that of all the USN standards and specifications which have been recently rescinded in their efforts to adopt simpler "commercialized" procedures, the MIL-S-901 specification concerned with shock qualification of naval equipment has been retained as an essential requirement.

Jan Czaban is the DMSS 2-5 head of the Ship Survivability Section in NDHQ.

Maritime Coastal Defence Vessel Construction:

A Walk Through Halifax Shipyard Ltd.

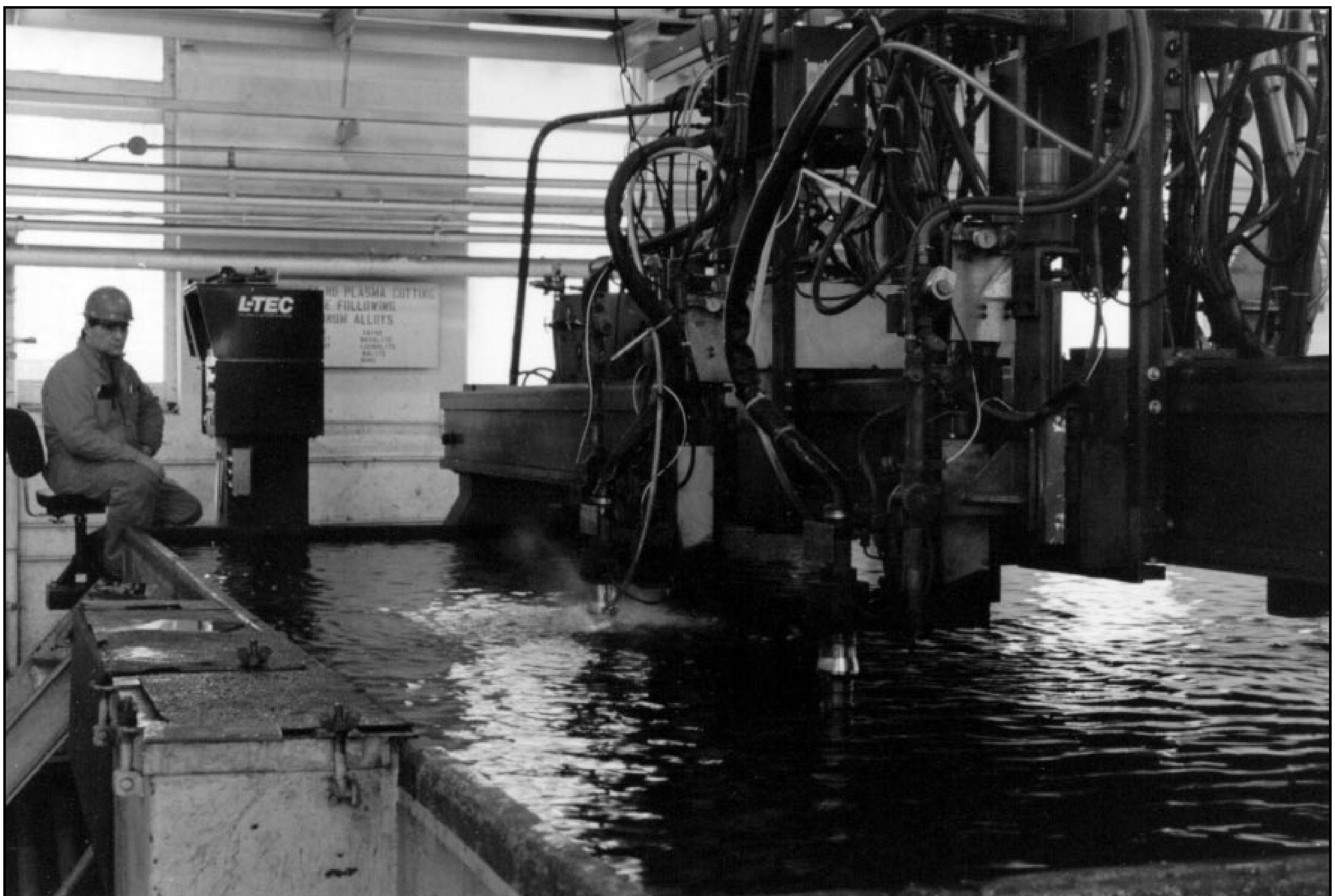
Article by CPO2 Mike Syzek, Chief Engineer, HMCS *Glace Bay*
Canadian Forces photos by Base Photo Halifax

While working with the PMO MCDV detachment during the construction of HMCS *Glace Bay* (MM-701) at Halifax Shipyard Ltd., innumerable people approached me for tours of the yard and, specifically, of my ship. It was not possible to give everyone a tour, however, as most of the people asking were not even in Halifax (they somewhere far to the west of us in a warmer place where many Canadian sailors seem to lurk). This pictorial essay gives a thumbnail tour of the MCDV production facilities at Halifax Shipyard Ltd. (HSL).

The majority of production activity in HSL takes place in two adjoining rectangular buildings. A 20-metre opening in the centre of the common wall between the two buildings allows for the passage of material and personnel. Since the production facilities are set up in line with the build strategy, a quick overview of the MCDV build strategy will provide a better appreciation of the facilities.

The Build Strategy

The MCDV build strategy, as developed by HSL, involves nine stages of construction. In some cases these stages overlap and, depending on the unit being constructed, may not always be done in order.



The plasma cutter uses a combination of electric arc and oxygen to produce an extremely hot and precise cut. Tolerance for the cutter is one to two millimetres compared to a CNC acetylene torch which would typically produce a 3-mm to 6-mm tolerance. The cut produced by the plasma cutter is extremely clean and ready for welding without any additional preparation. The water bath is flooded, covering the steel plate. The bath provides cooling water to the metal which helps prevent heat warpage and dampens harmful radiation produced by the plasma cutter, negating the need for costly shielding. (*HSC95-0840-05a*)

The nine stages of construction are defined as follows:

Stage One (**steel/outfit preparation**) — Steel plates and bars are cut and formed, pipe spools, hangers, foundations and ducting are manufactured, and outfitting equipment is marshalled for later installation.

Stage Two (**minor assembly**) — Individual pieces are fitted and welded to form small components.

Stage Three (**flat and curved panel assembly**) —Stiffeners are welded to panels for bulkheads, decks and side shells.

Stage Four (**subunit and unit assembly**) — Panels are welded together to form larger assembly units.

Stage Five (**hot pre-outfitting of assembly units**) — Completion of items such as pipe hangers, cable hangers, equipment foundations, and anything that involves hot work (welding).

Stage Six (**block assembly**) — Assembly units are joined to form three distinct blocks that will be joined to produce a complete MCDV. The three sections are roughly the same size and consist of a bow unit, midsection and stern section. The mast is installed separately once the ship is on the slipway.

Stage Seven (**pre-outfit two**) — Installation of equipment, bulkhead insulation, false bulkheads and deckheads, piping systems, electrical cables, distribution panels, etc., and painting. With the exception of equipment that is mounted across the erection butt of the blocks, remaining equipment is installed prior to the block leaving the assembly building.

Stage Eight (**block erection**) — Blocks are transported from the assembly hall to the slipway and welded at the erection butt in preparation for the vessel's launch. (MCDVs four through twelve were constructed using only two major blocks, with the bow being joined to the remainder of the ship on the slipway.)

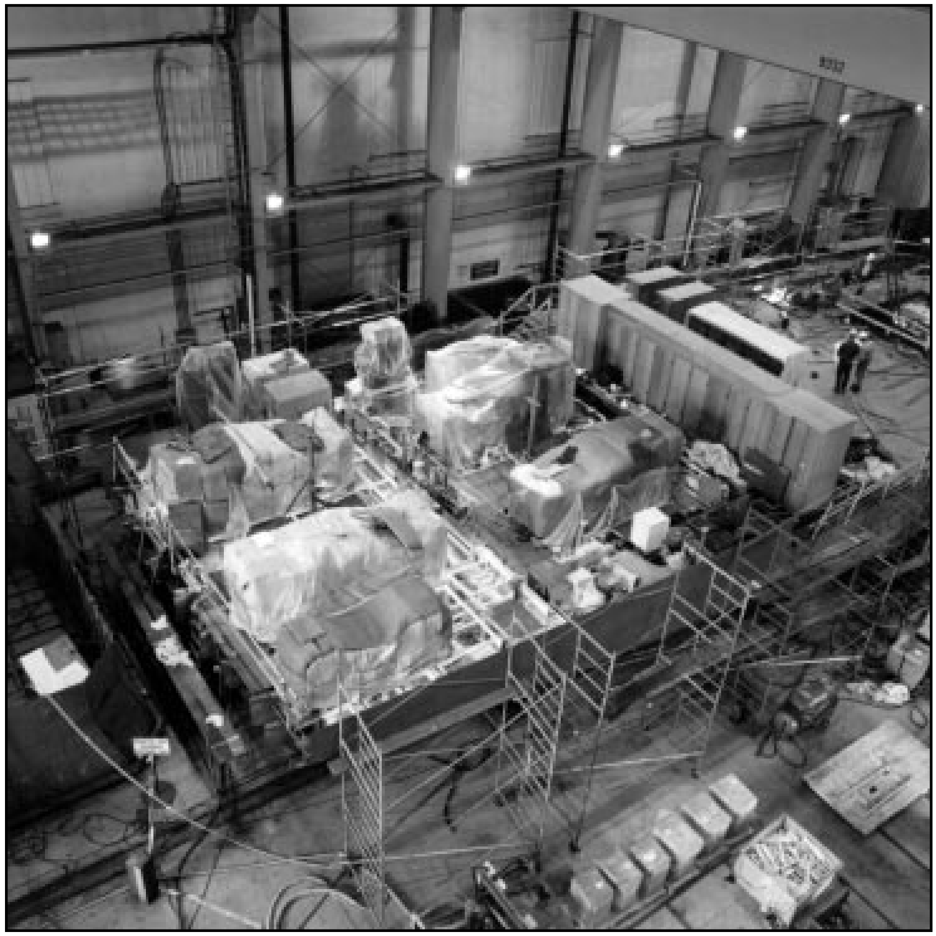
Stage Nine (**finishing work**) — Completion of cable terminations and final outfitting and finishing of ship's compartments; set-to-work of ship's systems in preparation for sea trials and final acceptance of the ship by the navy.

Each piece is labelled by a part number and by ship and unit number. The pieces are then placed in bins or on pallets to facilitate ease of assembly. The part number will identify the piece within the unit and the unit number identifies where in the ship the part goes. (*HSC95-0840-07*)

Grinding parts for HMCS *Edmonton*'s centre block hull (*HSC95-0840-09/10*)

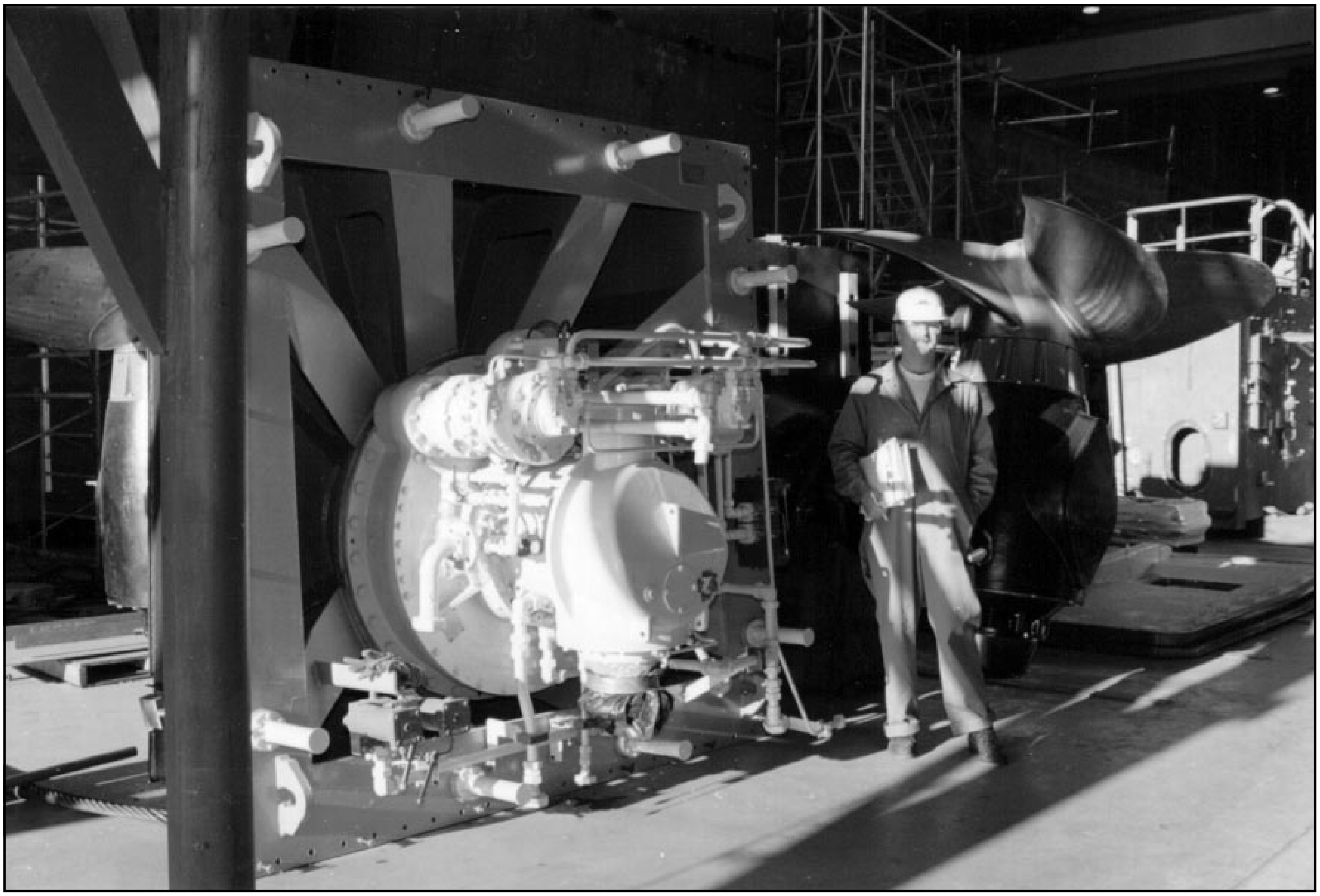
A nearly completed mast unit destined for HMCS *Glace Bay*. In the foreground is additional framing for HMCS *Nanaimo*'s mast. (*HSC95-0840-11*)

HMCS *Nanaimo*'s bow section. The units are built inverted to maximize the use of the easier downhand welding. The units are flipped into position prior to block assembly. Due to the pace of construction and the space limitation at HSL, the bow units for MCDVs 04 through 12 are being constructed by East Isle Shipyards (EISL) in Georgetown, P.E.I. Parts are transported to EISL on flatbed truck and return as a completed bow by barge. (*HSC95-0840-13*)



The forward and after machinery rooms (FMR and AMR) for HMCS *Nanaimo* are recognizable by the two large diesel generators. Forward of the FMR is the main switchboard compartment. (*HSC96-0721-11*)

Pre-outfitting of *Nanaimo*'s engine room. Painting, cable-pulling and the installation of insulation has already begun. This unit has undergone significantly more outfitting than *Kingston* and *Glace Bay* at the same stage of construction. HSL continues to evolve the construction process to minimize cost and rework. (*HSC95-0840-16*)



The 185-cm-tall (six-foot one) author standing beside the two Z-drives for *Nanaimo*. The Z-drives are designed to be removed with the ship in the water. Removable plates on the quarterdeck allow access to lift the Z-drives out as entire units. (*HSC95-0840-18*)

The bow section of *Glace Bay*. *Nanaimo*'s middle and after sections are directly behind it inside the building. (*HSC96-0721-05*)

A teflon pad that the cradle holding the ship upright rests on. All movement of the sections is done by hydraulic jacks. (*HSC95-0840-19*)

Surviving the Tar Pit: A Few Things to Consider when Acquiring Developmental Software

Article by LCdr M. Tinney

An analogy in an article written several years ago compared software development teams to great beasts trapped in prehistoric tar pits. "Large system programming has over the past decade been...a tar pit, and many great and powerful beasts have thrashed in it violently. Most have emerged with systems running — few have met goals, schedules, and budgets'.[1]

The analogy of the tar pit is still pertinent today. All developmental projects are risky, but perhaps none more so than those which deal with software development. The topic of software project management is extensive and complex, and it would be impossible to thoroughly discuss all relevant aspects in the confines of this paper. My intent here is simply to share my thoughts on a few aspects of software development, based on what I learned while attending a DND life-cycle costing course. My hope is that this will help point beginning software development project teams in the right direction.

Defining and Validating the Requirements

As with any development project, software development begins with the user accurately and thoroughly identifying the requirement. During the project definition stage it is essential to avoid the tendency to add unnecessary functions to the software. Increased functionality translates into increased complexity, cost, time to develop and probability that the software development will be *un*successful. Requirements should be "locked in" before the formal request for proposals (RFP) is released. Further change should only be allowed after its impact has been fully assessed. Failure to do so may result in the project team finding itself thrashing around in one of those tar pits with significant cost overruns and delays, if not a complete failure of the project.

Once the requirements have been defined, they must be validated. The project team should evaluate each requirement against the following criteria:

- Is it achievable within the capabilities of the hardware to be controlled by the software?
- Is it accurately defined and not subject to interpretation?
- Does it completely specify the software product to be provided?
- Is it consistent with the other requirements and with any interfacing systems at the next higher and lower levels?
- Is it really necessary?
- Is it testable?

Any requirement that does not meet these conditions should be modified, or deleted, as it is not achievable.

Risk Analysis

Software development projects tend to be risky when a lack of good engineering and management practices leads to an underestimation of the complexity of the project. Despite the fact that writing the application program accounts for only a small portion of the total software development effort *(Fig. 1)*, estimates of cost, time and complexity to develop software are apparently typically based on this aspect alone. Thus, understanding the full scope of the project is essential to properly managing the project and understanding all of the potential risks.

Risk analysis involves identifying the risks, assessing them, and developing contingency plans for dealing with them. The key is to keep risk assessments and contingency plans up to date by monitoring progress in general and areas of risk in particular. When assessing the level of risk associated with an unfavourable event it is important to understand both the probability of that event occurring, as well as its consequences. An easy way to illustrate risk is to plot the probability and severity of various risks (based on the project team's best guesses) on an "isorisk" contour map (*Fig. 2*).[2] Once plotted, the level of risk associated with each event is quantified based on its proximity to the contoured lines, and the value allocated to the line.

The next step is to determine if there are cost-effective ways of reducing the risk. For example, in a case where it is likely that a software program will be delivered late, the project team might choose to reduce the risk by adding people to the development team. But this could make the project unwieldy (thereby introducing delays in itself) and more costly. Alternatively, the team could opt to accept the risk that the entire project might be delayed and live with any adverse affects this might have. Thus, risk assessment involves weighing the cost of reducing or eliminating the risk, against the cost or impact of accepting it.

Estimating Project Costs

Estimating the effort required to develop software is not an easy task, but it must be done at the earliest stage of the project in order to budget the necessary funds to finance the project. This can be done manually, or through the use of a software package specifically designed for this purpose.

One widely used tool for estimating the cost to develop software is the Constructive Cost Model (COCOMO). What makes the task particularly difficult is that it is necessary to have an estimate of how many lines of developmental code must be written. One way to make this estimate is to rely on the experience of previously developed programs of similar complexity. Once the number of lines of code has been estimated it is possible to estimate both the level of effort in person-months to develop the program, and a development schedule.

There are costs associated with supporting software throughout its life cycle. In general, about a third of the software life-cycle costs will be spent in the development phase, with the remaining two-thirds being spent on maintenance associated with error correction, enhancing existing functions and adding new functions. It is possible to make cost predictions for each of these activities so that they can be included in the life-cycle cost estimate.[3] Of course there are other typical costs, such as for training and documentation, which must also be considered as well.

Errors

Errors in software development can be classified as requirement errors, design errors or coding errors. Every software development project will have a measure of all three. The challenge for the project team is to ensure that requirement errors are kept to an absolute minimum. Incorrectly or inaccurately defined requirements can lead to a faulty design which in turn can lead to a program that doesn't perform as required. Accurate requirements that are not properly conveyed to the contractor can also lead to a faulty design. So the onus is on the project team to properly identify the requirements and ensure the contractor fully comprehends what is needed.

Assuming that the requirements have been accurately defined and the contractor fully understands them and has translated them into a proper design, there still remains the problem of coding errors. In general, as the size of a software program increases, so does the probability of error. The way to minimize the impact of coding errors is to try to detect them as early in the project as possible. When errors are detected late in a project, requirements have to be revalidated, designs adjusted, software amended and retested, and documentation rewritten.

Rapid prototyping is a process that is used to validate user interface requirements and to prove concepts. The process allows the customer to become actively involved in evaluating a product as early as possible, and facilitates the early detection of requirement errors.

In rapid prototyping the contractor is tasked to deliver non-production prototype software at various stages of development so that the customer can try it out, refine his requirements and suggest improvements. From the contractor's point of view, the earlier the customer becomes involved in evaluating the product, the greater the likelihood the customer will be happy with the finished product and accept it. From the customer's point of view, being involved at every stage of product development helps keep the contractor on the right track, aids in identifying problems early and helps to reduce risk.

Maintenance Support

In the Request for Proposals, it is important to ask bidders to provide an additional quote on their cost to maintain the software over a specified period. This gives the project team a good indication of how much confidence the developers have in their own programming capabilities. It also commits them to supporting the software for a reasonable period of time, and serves as an incentive for the developers to aim for high-quality, reliable code since anything less will eat away at their profit margin. However, the customer needs to know what he wants for maintenance. Otherwise, there is a risk of spending a lot without achieving anything significant.

Contract Payments

Most contractors like to be paid up front and deliver the goods later. At the very least, they prefer to receive milestone payments. However, poorly managed software projects tend to quickly ramp up to the 90-percent completed stage, then stay there seemingly forever. If a contractor says that the code has been completed, and the project is therefore 90 to 95 percent finished, the reality is that completion of the code only constitutes about 30 to 40 percent of the total effort. The work that remains to debug the software and test the system will still occupy a lot of time and resources. If the contractor is paid the majority of the funds when only the code has been completed, there is a real danger the project will incur overruns.

Project payment schedules should be designed to place financial risk on the contractor if all aspects of the project are not delivered fully completed. Some

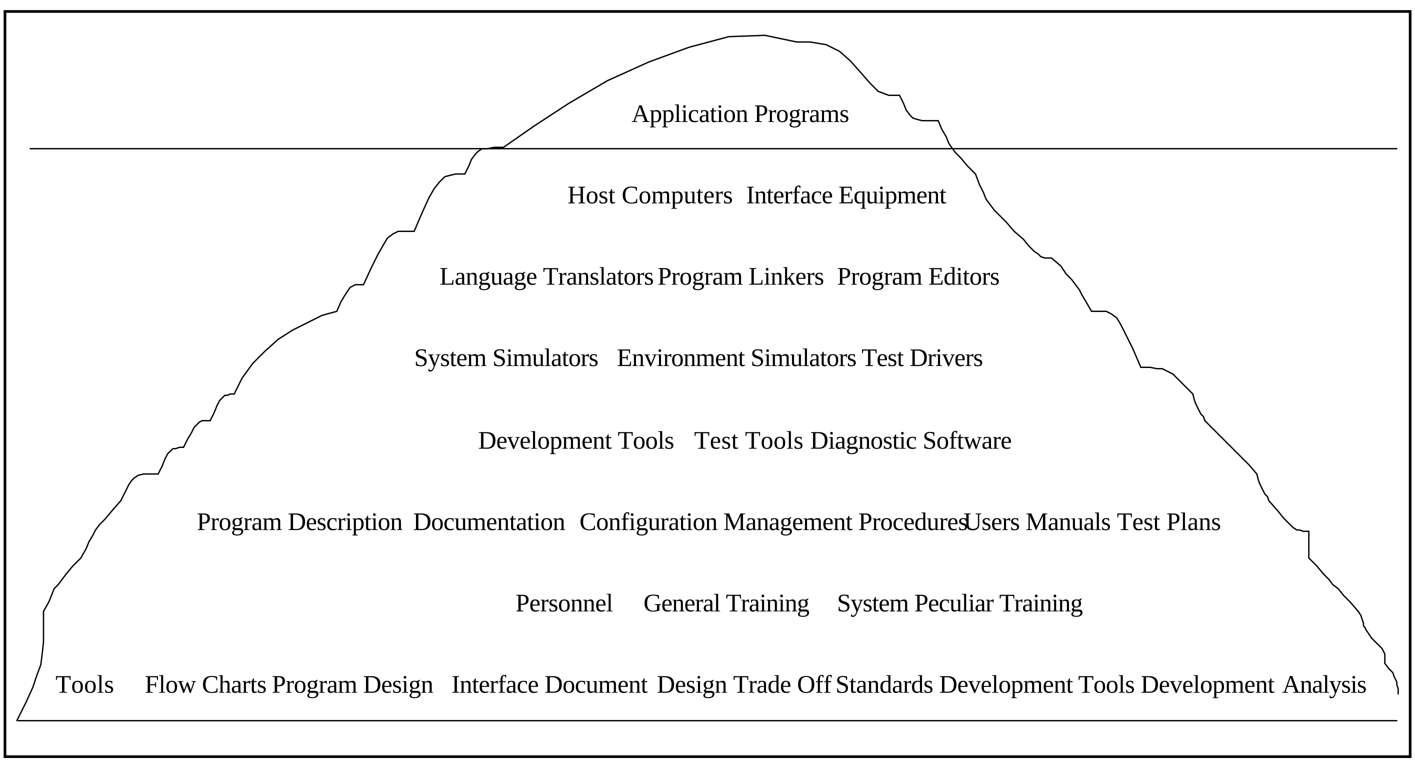


Fig. 1. The Software Iceberg

people recommend milestone payments tied to incremental builds for complex software development.

Testing, Problem Reporting and Configuration Control

A well-organized project team will do its best to arrange for software to be tested in its intended application as soon as possible after delivery, and continue to monitor its performance through integration. The project team should also implement a problem reporting procedure. If problems are reported and it is evident that changes need to be made, it is essential that some form of control be placed on how the contractor rectifies problems. (This is normally tied to the contractor's development process, which should be evaluated carefully during bids. Quality objectives would have to have been identified in advance.) Otherwise, software configuration control can be quickly lost if the contractor locates and fixes a fault without first carrying out an impact analysis, testing the change and amending the documentation properly. It is the project team's responsibility to establish a configuration management system to correct problems that develop.

Conclusions

The key to getting a software project started in the right direction is to keep the requirements under control — define them accurately and in sufficient detail to avoid any misunderstanding with the contractor. The time spent on this phase can go a long way toward ensuring the success of a project.

The project team must also carry out a risk analysis for each aspect of the project and develop contingency plans for dealing with undesirable events. The RFP must be designed to allow the user to become actively involved in evaluating the contractor's product at every stage of development. Ensuring the program is thoroughly tested in its intended application as soon as possible after delivery is always recommended.

Consider also the requirement for software maintenance. Estimate the level of effort and cost, and add these to your life-cycle cost estimates. Arrange the contract payments to fit the level of effort and make the contractor responsible for the software's maintenance support. Finally, implement a problem reporting procedure, enforce software configuration management, and ensure that the contractor analyzes, tests and documents any changes.

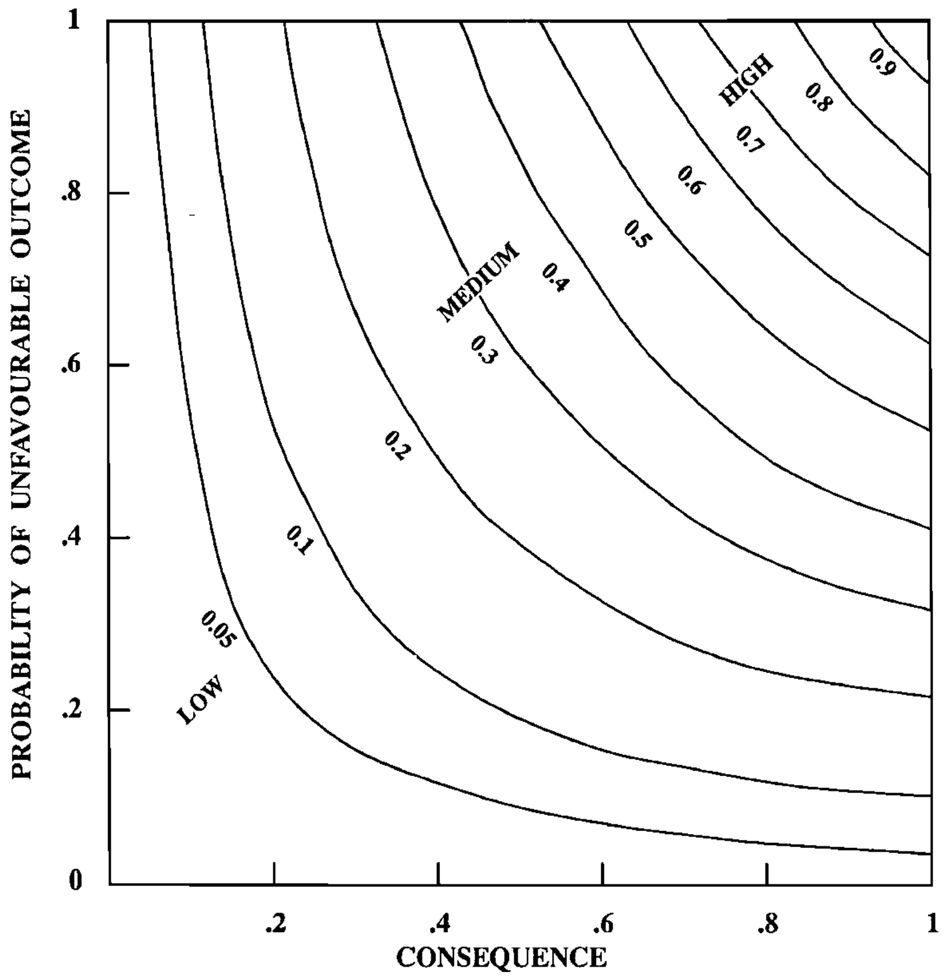


Fig. 2. "Isorisk Contour Map — Probability of Unfavourable Outcome

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[1] Brooks, F.P. Jr., The Mythical Man-Month, Software Engineering Project Management Tutorial, Computer Society Press of the IEEE Editorial Board, 1988.

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[3] Boehm, Barry W., *Software Engineering Economics,* Prentice Hall, 1981.

LCdr Tinney is a DMSS 5 project engineer at NDHQ.

HMCS Fredericton: A CSE's Advice on Predeployment Preparations

Article by Lt(N) Jim McDonald

Ever go camping without a pivotal piece of equipment? Like your tent? Or your matches? Not unless you're asking for trouble.

All good campers know that before you go on a trip you should plan your route and pack the essential equipment, then travel only with the best people. The same goes for any major naval deployment, including that of HMCS *Fredericton* (FFH-337) to the Adriatic on Operation Sharpguard in late 1995.

Tops on our trip's "to do" list was arranging to have the appropriate number of qualified personnel on board to maintain our equipment. We then checked the equipment to ensure operability and made sure that we had all the possible spares we could get. Before stocking up we did a walk-through with our supply technicians to muster the stores. Going out green was not an option. Personnel and equipment were put through their paces in work-ups and trials about a month beforehand.

Like any campers heading for an extreme location we had to be self-reliant and carry with us all the necessary equipment. After adding mission fits during a short-work period (an essential preparation, during which we also performed corrective and preventive maintenance) it was time for a test drive, better known as a shakedown. This was a one-day trip to sea to reacquaint personnel with sea routine and to iron out some of the bugs. We also grabbed this opportunity to conduct a full-power trial which proved to be very beneficial because, with trials staff and fleet FSRs on board, we were able to fine-tune and calibrate our equipment and systems.

There were a couple of important things to consider before heading out on a five-month deployment:

• We were facing a 5,000-nautical-mile logistic span, which meant that spare parts wouldn't exactly be available at the nearest corner store — we had to ensure our onboard spares entitlement was up to date;

• We were deploying to an operational theatre where our systems would have to be maintained at a high state of readiness — we knew we had to get ahead of our planned maintenance, especially the six-month routines, because we would have virtually no time to do anything like that while deployed. The only possible time for conducting PM would be during transit, while the ship was engaged in less demanding operations, or during one of our foreign port stops (and we all knew what we'd rather be doing then). And something we discovered. The Integrated Maintenance Administration and Supply System (IMASS) used by ship's maintainers to produce maintenance action forms, unsatisfactory condition reports (UCRs) and, to a lesser extent, to generate equipment health monitoring reports, does not adequately spread out six-monthly routines. So a word of caution. Don't trust IMASS to split up your preventive maintenance routines into manageable chunks.

Obstacles Along the Way

Like any typical outing, the problems started early. On Dec. 9, 1995 as we were getting ready to leave our first port of call (Gibraltar) for the Op area, a naval weapons technician was injured while loading a charged torpedo flask. The end of the flask accidentally came into contact with the lever of the securing mechanism and discharged its high-pressure air. The flask took the path of least resistance and struck the man above the knee. It took 11 stitches to close the wound.

With their injured mate in good hands, the naval weapons technicians turned their attention to the torpedo equipment. The crux of the problem was that the securing mechanism did not clamp onto the exhaust port of the warshot torpedo tube. The techs sorted this out by using a rubber mallet to make the mechanism take proper hold of the torpedo exhaust-port nipple. Ship's staff then devised a test experiment using high-pressure nitrogen from the hangar and a variety of hoses and couplings to ensure the securing mechanism would release at the specified pressure.

Following proper procedure we communicated the problem and solution via

OPDEF and UCR to our shore authority — who promptly advised us not to use a mallet on the securing mechanisms unless operationally necessary. (They believed the problem was likely not with the securing mechanisms, but with the warshot nipples.) As we were heading for a potentially hostile environment and our experiment was successful, we put the mallet to the remaining securing mechanisms.

About two months later we were alongside in Valencia, Spain, tied up beside the USS *Simpson* (FFG-56) which also carries Mk 46 torpedoes. Ship's staff came up with the idea of trying our securing mechanisms on their torpedoes. When they didn't fit we knew it was the mechanisms that were at fault. A message to our command/shore support brought us new securing mechanisms via our forward logistic support unit, FLS Grottaglie, Italy. The new mechanisms fit like a charm.

Our next hurdle involved intermittent faults with the modem chassis of our Link-11 data terminal set (DTS). Here we were, headed toward an operational area, and we could neither receive nor transmit a tactical picture. This came as a surprise since the DTS had worked during a recent exercise and also for its six-monthly routine during the short work period. It had even passed a programmed operational functional appraisal (POFA) on the transatlantic trip.

We ordered a new DTS, which was sent to the ship as an immediate operational requirement (IOR). We had to order a complete DTS because some of the circuit card assemblies — the ones that appeared to have failed — are not issued as spares. When it arrived we found it had been configured for a steamer, not for a *Halifax*-class ship! A repair party arriving later in Athens with some needed test equipment told us that a correctly configured DTS was on the way.

The repair team narrowed the problem down to poor soldering throughout the back plane of the DTS chassis. In the meanwhile, they reconfigured the (IOR) steamer modem and performed the POFA test. Successful Link-11 operations ensued! Both repair party and ship's staff celebrated with tours of Rome and Pompeii!

Innovation and Resourcefulness

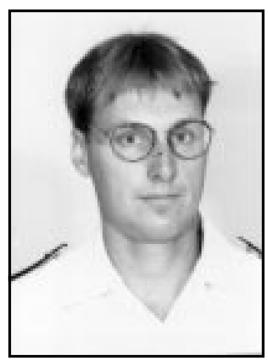
Innovation and resourcefulness were the order of the day during this deployment. When a defective gland rendered a ROD plant unserviceable, the stokers looked for a quick fix to ensure our supply of fresh water. They ended up bargaining with the cooks for a Teflon cutting board from which they machined the replacement gaskets they needed to return the plant to operational service.

Another smart fix resolved a potentially risky situation surrounding the accuracy of the 57-mm gun at close range. A limitation in the fire-control software meant we could not accurately predict the fall of shot, which would have left us "shooting in the dark," so to speak, if we had to fire any warning shots during boarding operations in the Adriatic. If we were to fire a shot across a ship's bow, we simply couldn't be sure of the results. We worked around the problem by tracking pre-action calibration rounds with the STIR radar until we could predict the initial velocity we needed to get a hit within given parameters. We forwarded the results to shore command for their perusal.

In-bound missiles weren't the only threat out there. Rough weather conditions (par for the course) also played a role. On one occasion seawater ingress threatened the effective functioning of the gun — first, the end caps for the barrel wouldn't stay secure (the boatswains created a vinyl cover), then water showed up inside the cupola, the forward section base and the 57-mm magazine (via the hoists).

For Your Next Trip...

Be prepared for problems; they will occur. Despite the problems we faced, HMCS *Fredericton* had a very successful deployment, conducting 52 boardings (34 in a 12-day period while acting as flagship). The ship functioned exceptionally well, especially when compared to other countries' naval vessels. The most important factor contributing to our success was our talented, resourceful and willing personnel. If you are planning your own deployment, don't head out without picking up *Fredericton*'s handy-dandy post-deployment report for a description of the rest of the problems and challenges of our mission.



Lt(N) McDonald is the assistant combat systems engineering officer on board HMCS Fredericton.

The Top 10 Predeployment Checklist

1. Perform inspection of naval ordnance (INO)
2. Calibrate test equipment
3. Get ahead of your planned maintenance schedule
4. Verify entitlement of onboard spares
5. Contact a former unit and read previous deployment reports
6. Take care of all personnel matters
7. Perform critical performance trials
8. Discuss deployment with other department heads
9. Start planning approximately two months in advance
10. Function as a team

Seminar Report:

Central Region Naval Support Seminar

Article by Cdr Don Flemming

The second annual Central Region Naval Support Seminar was held at the National Archives building in Ottawa on April 14. The seminar has evolved from the MARE and naval engineering seminars of the past to its present format to reflect a broadening of the participant base. The seminar is now designed for all defence team members in the National Capital Region who work toward satisfying the navy's engineering, maintenance and integrated logistics requirements.

The theme of this year's seminar was "Partnerships in Support of the Fleet," with emphasis on the word "partnerships." The aim was to take a look at how Maritime Command (Chief of Maritime Staff), DGMEPM and the fleet maintenance facilities work together to support the fleet. This relationship is still being developed and so must remain a dynamic process until the full impact of the standing-up of the Chief of Maritime Staff (CMS) organization in Ottawa is felt later this year.

In his opening address, **Cmdre Wayne Gibson** (Director General Maritime Equipment Program Management) stressed that good progress has been made in exploring and developing the relationship between ADM(Mat) and CMS, but there is much more to be accomplished. We must continue to improve how we take resources and turn them into the greatest possible amount of short-, intermediate- and long-term support to the fleet. The purpose of the seminar was not to find solutions to the problems. Rather, it was intended to serve as a forum through which members of the defence team in the National Capital Region could be informed of the changes that have taken place, and of the challenges that must still be addressed. It was hoped the seminar would also act as a catalyst in improving partnerships.

Speakers were chosen to reflect the broad spectrum of interests and needs that characterize the defence team partnership. **Capt(N) Dan Murphy** (Director of Naval Requirements) led off by addressing the key element of managing expectations as they pertain to defining requirements. The definition and prioritization of fleet requirements are the first steps in determining the kind and amount of support that is to be provided. Since we live in a world of budget-driven requirements and not requirement-driven budgets, naval requirements must be prioritized and costed as a totality, not just within the traditional stove-pipes of Capital, National Procurement, Operations & Maintenance, etc. Once a way ahead is approved, the satisfaction of a requirement must be pursued until final implementation is attained.

Next, **Capt(N) Sherm Embree** (Director of Maritime Management and Support) examined the Fleet Support Plan — the glue that holds the MARCOM/ADM(Mat) relationship together. Co-operation and a common focus on fleet support are required by both organizations if the fleet is to receive the support it needs. DGMEPM must be responsive to MARCOM requirements within resource constraints and regulations, and it is necessary at all levels to fully reveal the support that MARCOM and ADM(Mat) bring to the fleet, including the costs of that support. The framework that enables these requirements to be met is the Fleet Support Plan.

Presentations were also made by **Cdr Larry Olsen** (representing FMF *Cape Breton*) and **Capt(N) Gerry Humby** (Commanding Officer FMF *Cape Scott*). These officers provided an overview of the changes their organizations have undergone in the recent past, the challenges that lie ahead, and the way in which the FMFs have "moved the yardsticks" in improving their performance as service providers to the fleet. As a concrete example, **Mr. Les Boudreau** and **Mr. Norm Kempt** (FMF *Cape Scott*) briefed the audience on the move to self-directed teams within that organization. On a somewhat lighter note **Ms. Sandra Wardell** (Directorate of Soldier Systems Program Management) narrated, "A Modern DND Clothing Tale," her humorous look at recent changes to the procurement process.

The final portion of the day was devoted to an open forum in which the audience was given an opportunity to raise questions and concerns. Cmdre Gibson, his directors and the seminar speakers took to the stage to field questions. This was perhaps the most interesting part of the seminar and, not surprisingly, time did not allow all questions to be answered. Nevertheless, there was ample opportunity to continue discussions at a mixed reception held that evening in the NDHQ combined WOs & Sgts/CPOs & POs Mess.

Cdr Flemming is the DGMEPM Special Projects Officer.

Test and Demonstration of a High Energy Density Aluminum Power Source in Unmanned Underwater Vehicles

Article by J.H. Stannard[1] and LCdr. L.D. Clarkin[2]
([1] Fuel Cell Technologies Ltd., Kingston, Ont.; [2] Dept. of National Defence, Ottawa, Ont.)

Introduction

A multi-year program to develop an aluminum semi-fuel cell power source for unmanned underwater vehicles has recently been completed by Fuel Cell Technologies Ltd. for the Canadian Department of National Defence (DND). In the final phase of the work a 2.3-kW power source for the ARCS (Autonomous Remote Control Submersible) vehicle has been constructed and bench tested, and sea trials in the Vancouver area were conducted in January and February this year. The power source operated for more than 50 hours under water at a nominal output of 2 kW, resulting in a gross energy capacity of approximately 80 kWh.

The system is mounted in a dedicated aluminum hull section 175 cm in length and 68.6 cm in diameter. With all reactants the system is neutrally buoyant. An energy density of 250 Wh/kg has been achieved, and simple incremental improvements will extend this to 330 Wh/kg in the near term. An exhaustive series of bench tests carried out at Fuel Cell Technologies included testing for the effect of pitch and roll on performance. At the R&D level, in-house funded research at FCT is resulting in greatly increased power capability, with small stacks of cells operating at the equivalent of up to 6.0 kW in the same size cell stack as used on ARCS. This is a result of improvements to the oxygen breathing cathode.

In this paper, an approach to improving underwater endurance of a UUV is described using the aluminum-oxygen semi-fuel cell. This technology has been developed over a period of several years by Fuel Cell Technologies Ltd. on behalf of DND[1]. The result of this program is a 2.0-kW system capable of powering the ARCS UUV for up to 50 hours. Test results from the program are described in this paper.

Background

Since the 1980s, DND has completed a series of studies of promising technologies that could be employed to provide electrical power for both land-based and shipboard use into the next century. The attributes that were being sought included atmosphere independence, improved system efficiency, greater energy density, a reduction in environmental emissions and a reduction in both acoustic and infra-red signatures. The technologies considered included:

- new battery concepts
- closed-cycle heat engines (diesel, Stirling)
- fuel cells

The conclusion of these studies indicated that the best technology to meet the stated requirements with the least technical risk and the widest application was the fuel cell.

Unlike a battery, which is an energy storage device, a fuel cell is an energy conversion device. The fuel cell takes external feeds of a fuel (hydrogen) and an oxidant (oxygen) and converts the chemical energy directly into electrical energy. The direct conversion from chemical to electrical energy means significantly lower emissions, plus system efficiencies in excess of 50 percent, which are better than those possible with an equivalent generator set driven by heat engines. This technology was considered ideal for the underwater application; such a unit would have lower acoustic and heat signatures, and the lower mechanical and heat stresses could potentially offer lower maintenance costs.

These attributes provide an attractive option that could be the heart of an environmentally friendly energy source for both fixed and mobile power units, while offering the possibility of a lower cost of ownership. Consequently, DND's Chief of Research and Development (CRAD) has been involved in the development of a Canadian fuel-cell technology that has shown the best potential to fulfil these diverse requirements. That technology is

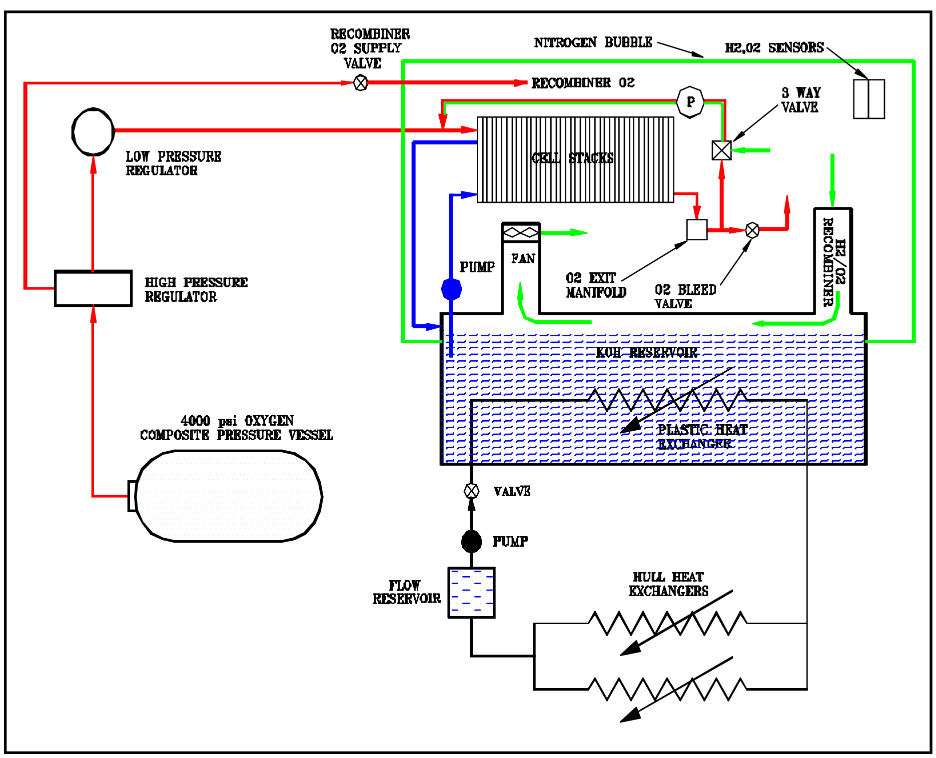


Fig. 1. Simplified Schematic of an Aluminum-oxygen Power Source

the aluminum-oxygen semi-fuel cell (Al/O_2 SFC)

Aluminum-oxygen Semi-fuel Cell

Since this is not a true fuel cell, the technology is referred to as a semi-fuel cell. It is, in effect, part battery and part fuel cell. Like a battery, one component, the fuel, is consumed within the cell. The fuel element is the anode made from a proprietary aluminum alloy and is immersed in a liquid electrolyte (potassium hydroxide). Like a fuel cell, the oxidant is stored outside the cell and is fed to the cathode as required. Electricity is produced because of two chemical reactions, the first being between the oxygen and electrolyte that consumes electrons to produce hydroxyl ions and the second between the hydroxyl ions and the aluminum anode to release electrons. The main by-product of this latter reaction is alumina trihydrate which is carried away by the circulating electrolyte.

Exploiting the significantly higher power densities possible with the Al/O_2 system, Fuel Cell Technology Ltd. (FCT) is developing advanced atmosphere-independent power sources aimed at undersea applications. In the UUV application, the company has shown that is possible to achieve significant improvements in energy densities over conventional secondary batteries (tenfold over lead-acid batteries and up to fivefold over silver-zinc batteries)[2,3].

Power Source System Description

A simplified schematic of a generic aluminum-oxygen power source is shown in *Fig. 1*. Essentially there are six major subsystems to consider. The overall system is comprised of a stack of energy producing cells containing solid aluminum anodes, a volume of potassium hydroxide electrolyte which is pumped through these cells, the means of storing and regulating the supply of oxygen to the cell stack, a hydrogen management system, a thermal control system and an electronic control system.

The cell stack consists of one or more sets of cells, generally between 12 and 150, wired in series or parallel to achieve the desired combination of power and stack voltage. Each individual cell is equipped with inlet and outlet passages for electrolyte and oxygen.

Manifolds are formed by openings in the cells, and the whole assembly is sealed with O-rings when clamped between rigid end plates. The anode area in the monopolar configuration used is approximately 500 cm^2, and in all production designs to date has not varied outside the range of 350 to 1,000 cm^2. Operating current densities at nominal power output are usually selected to be in the range between 20 and 100 mA/cm^2. The ARCS system has 44 cells of 590 cm^2 area.

A detailed trade-off study performed under contract to the DND ARCS program[4], led to the selection of high-pressure oxygen at 4,000 psig in a composite wrapped pressure vessel as the means of oxidant storage for the ARCS system under construction. A high-pressure regulator, followed by an electronically controlled proportional valve, supplies the stack at a constant pressure of a few inches of water. The selected system is extremely mass-efficient, comparable in volume to 50-percent hydrogen peroxide and chlorate candle systems, and much simpler to operate than LOX. The overall design is compatible with any oxygen storage means, which may vary with the intended application.

The electrolyte management system consists of a stainless steel reservoir to contain the electrolyte, and a circulation pump. This relatively simple system is generally designed to be conformal to the vehicle hull. In general, the electrolyte reservoir forms up to 40 percent of the volume of the total system and also provides the mechanical structure integrating the other subsystems.

A small amount of hydrogen is produced at the anode by a corrosion reaction between the aluminum and the aqueous electrolyte. This is continuously removed by a recombiner system and a recirculating atmosphere of nitrogen. A small amount of oxygen is added to recombine with the hydrogen, forming water that is returned to the electrolyte reservoir. The nitrogen-containing enclosure around the cell stack, recombiner components and circulating loop are generally all designed to be conformal to the vehicle hull, thus increasing packing density[5,6].

The thermal management system controls electrolyte temperature, typically at 60°C, by means of an electrolyte-to-coolant heat-exchanger, a recirculating loop of water-based coolant, and conformal aluminum heat-exchanger panels bonded to the inside of the hull.

The electronic control system and the software is generic and based on the use of industrial PCs and off-the-shelf electronic components such as power supplies and sensors. Typically, up to 48 channels of data and control are used, but this will be reduced as the need for engineering development data reduces.

The complete system developed for ARCS weighs 388 kg and occupies a hull volume of approximately 425 L.

ARCS Test Program

This just completed R&D project started in November 1994 with a series of four bench tests that were completed in December 1996. These were followed by the West Coast sea trial program which was completed in February 1997. The test program was developed through a series of levels of increasing complexity as described following.

Subsystem Development

A series of subsystem development tests were carried out on all major subsystems. An objective of the program was to

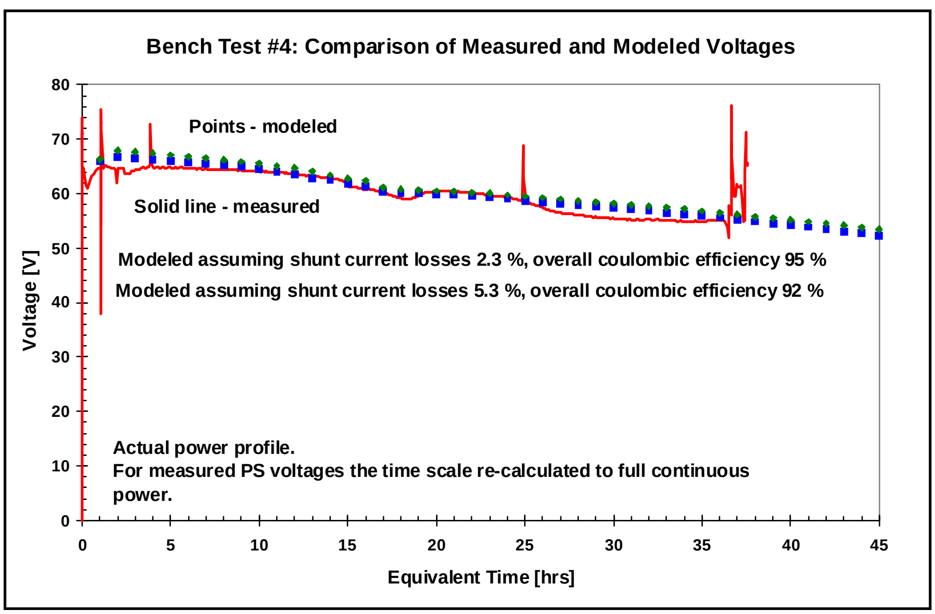


Fig. 2. Comparison of Modeled and Actual Voltage of Bench Test No. 4

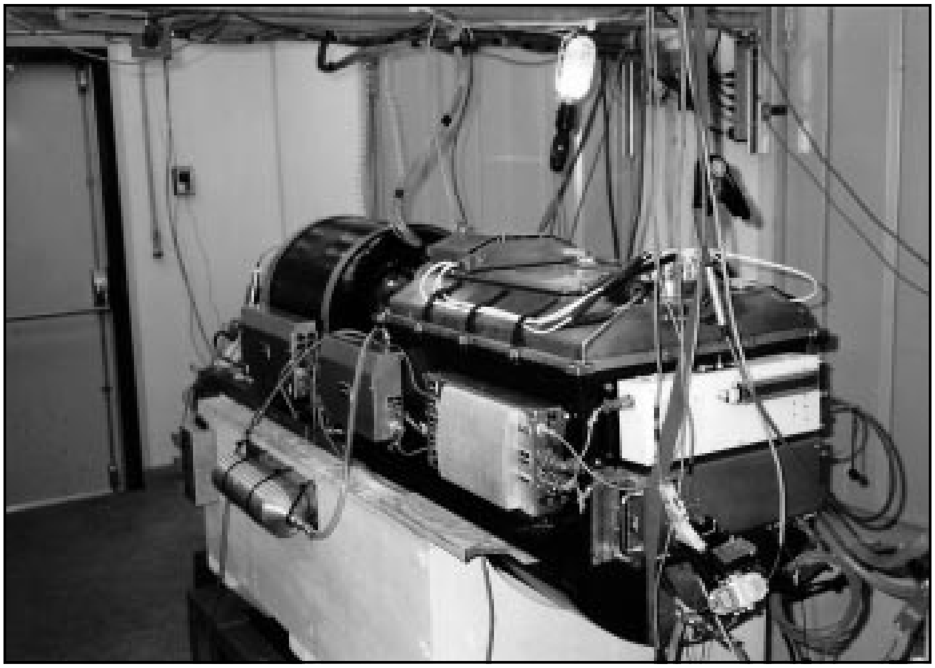


Fig. 3. Fuel Cell Power Source (FCPS) Undergoing Final Bench Test

obtain increased levels of reliability and maintainability for the aluminum-oxygen system with an initial target of 90 percent probability of successfully completing a 50-hour mission under water. A reliability test rig was built and up to twenty-one complete 48-hour cycles were achieved on many of the key components such as pumps and valves. Sensor development was also carried out, as this had been found to be a major reliability problem area in earlier sea trials.

Bench Tests

The bench test program included four tests of increasing complexity. The first test was a shakedown whereby all the subsystems were operated together for the first time. By the time bench test no. 4 was carried out, the effects of pitch and roll and a realistic mission profile were included. The net result of all the improvements was a radically improved performance during bench test no. 4, with a long unbroken period of autonomous operation. The following results were obtained:

Total Energy (Gross) :	88.0 kWh
Total Energy (Net) :	80 kWh
Total Run Duration :	47.0 H
Time to Full Power :	50 minutes

Anodes were generally flat after the discharge and average coulombic efficiencies were much improved at 87.2 percent. A comparison of modeled and actual voltage is shown in *Fig. 2*. Another feature of the test was the excellent performance of the cell stack purge system and uniform cell voltages.

A number of improvements resulted from analysis of the results. The balance of flows between the stack and recirculation loops was changed. This was based on the observation that the cell stack electrolyte had too great a concentration of solids, causing some cell plugging after 40 hours and loss of several cells at 43 hours. The other major improvement was implementation of a hydrogen sensor offset correction scheme which compensated the sensor readings based upon the stability of the recombiner temperature.

The tilt and roll tests were largely successful and in general all subsystems including the seed mechanism were satisfactory. The result of the bench test program was a system qualified for sea trials. *Figure 3* shows the fuel cell power source (FCPS) undergoing its final bench test (no. 4) at FCTL facilities in Kingston, Ontario prior to ARCS vessel integration in Vancouver.

Three sea trials of the system — one of 30-hours' and two of 50-hours' duration — were conducted at Indian Arm Inlet near Vancouver in January and February 1997. These trials were conducted in conjunction with I.S.E. Research Ltd., using their test vessel, *Researcher.* The DND-owned ARCS vehicle was operated in an autonomous manner, but was monitored from the surface via a low-rate acoustic telemetry link.

Vehicle Integration

After a series of bench tests was performed with the FCPS, the entire system was shipped to ISER, where a joint team of FCT and ISER personnel performed the mechanical and electrical integration of the system with the ARCS vehicle. This involved the following tasks:

- Setting up facilities to store and mix electrolyte, as well as a means to transport the electrolyte to and from the research vessel;
- Final adaptation of the FCPS removal cradle, and trial fitting the FCPS into its custom hull section;
- Final assembly of the FCPS, including assembly of the high-pressure oxygen system on the FCPS tank;
- Installation and assembly of the FCPS cooling system;
- Installation of nitrogen purge plumbing on the ARCS vehicle to provide both vehicle and FCPS purging with the vehicle either open or closed;
- Design and assembly of a liquid nitrogen purge system on board *Researcher*;
- Weighing and ballasting of the ARCS vehicle to provide neutral buoyancy;
- Developing procedures for handling the vehicle, FCPS and support equipment during all phases of sea trials.

The work of mechanically integrating the FCPS with the vehicle and setting up the necessary ground support equipment was carried out without incident. Integration of FCPS electronics and electrical equipment consisted of the following:

- *Main power cable:* This cable supplied power to the ARCS vehicle from the fuel cell DC mains output bus. It was plug-compatible with the existing NiCd battery packs;
- *Shore power connection:* A cable was run from an existing ARCS hull penetrator to the FCPS mains bus. This allowed the vehicle and FCPS electronics to be powered at any time from a shore power supply, eliminating the danger of depleting the emergency batteries during extended periods of storage or debugging;
- *Reserve batteries:* Five 12-V lead-acid batteries were installed within the FCPS hull section;
- *Serial communication cable:* Cable interface between the ARCS vehicle computer and the FCPS main computer.
- *FCPS Health and Safety Signal Cable:* Cable interface between the ARCS vehicle computer and the FCPS main computer.

The electrical integration of the FCPS went smoothly with no technical problems.

Sea Trial No. 3 — "Second Free Swim"

The test objectives for sea trial no. 3 were to operate the FCPS within a free-swimming autonomous ARCS vehicle in solids managed mode for a minimum of

PARAMETER	REQUIREMENT	ACHIEVED	COMMENT
Mass	400 kg	384 kg	Several improvements made in detail design.
Volume (Length specified)	1.8 m Maximum	1.75 m	Still requires ballast. Packing density of 75% could be improved on.
Running Time	50 Hours	50 Hours (Sea Trial No. 2)	Longest unbroken autonomous operation was 37 hrs. (Bench Test No. 4)
Power	2.0 kW Continuous 2.3 kW Peak	2.0 kW 4.5 kW	30+ hrs. (Sea Trial No. 2); 37 hrs. (Bench Test No. 4) Momentary during Bench Test No. 1. (3.0 kW routinely achieved.)
Energy Capacity	100 kWh	75.0 kWh (Sea Trial No. 2) 80.0 kWh (Bench Test No. 4)	Compromised by hot shut-downs (anticipated to be extremely rare in a mature system).
Energy Density	250 Wh/kg	195 Wh/kg 208 Wh/kg	Sea Trial No. 2 Bench Test No. 4
Refuel Time	2 Hours	16 Hours	Removing slurry from tank is still time-consuming.

Table 1. Comparison of Achieved Performance versus Project Goals

50 hours. On February 17, 1997 the FCPS was started and the vehicle was launched successfully. After approximately nine hours of operation the vehicle experienced problems controlling a manoeuvring plane. At hour 12.7 the vehicle was brought back on board *Researcher* and the plane control was fixed while the FCPS was still on-line. At hour 14.3 the vehicle was again launched and ran until the electrolyte pump motor failed at hour 23.7. The motor was replaced and the vehicle was relaunched.

The performance of the FCPS was reduced significantly after the motor failure. The failure of the motor stopped the flow of the electrolyte through the cell stack suddenly. This flow is the only cooling mechanism of the cell stack, and once the flow is removed under running conditions the stack generally overheats and causes an adverse affect to the cathodes. At hour 32 the weather deteriorated and a decision to recover the vehicle was made for safety reasons. The vehicle was recovered and the FCPS was kept on-line with the vehicle ready to launch once the weather had settled. At hour 36.9 the vehicle was launched and the test was run until the FCPS could not sustain the minimum system voltage at the minimum practical vehicle speed.

A comparison of operation before and after the shutdown due to the pump failure shows that stack voltage at 34 amps had been reduced from an extremely healthy 64 volts to only 56.5 volts (*Fig. 4*). This indicates quite widespread damage to cathodes. The final result of 82.5 kWh (gross) is only 75 percent of the target. It is noteworthy that, of the seven vehicle stops during this test, only two were as a result of the FCPS. The other five were due to operational or vehicle related problems. It is FCT's belief that, based on the proven stack performance up to the 23.7 hour point, the target 100 kWh (net) performance would have been achieved.

Discussion of Results

It is an unfortunate feature of most development programs that are constrained by budget and schedule, that the system being developed is only beginning to achieve some level of maturity near the end of the program when both budget and time are rapidly running out. In an ideal world the FCPS would be run for twenty repeat trials to wring out all the reliability and operational issues and result in an accurate assessment of capability and performance. Within the limited scope of the actual sea trials program, important data was gathered and the FCPS and ARCS began to operate well, with long periods of autonomous operation.

Table 1 summarizes a comparison of the FCPS performance to the program goals and identifies the major reason for any shortfall. Clearly the main problem impacting performance measurements was continued unreliability. Many improvements were made during the bench test program, and problems identified early in the sea trials were addressed. It is ironic that the one major failure during the final sea trial was the main electrolyte pump. This unit had been replaced with a new one that had been run-in carefully on the bench as recommended by the reliability program, but still failed in a random manner during underwater operation. Test data and analysis show that this would be an extremely rare occurrence. Test data also shows that virtually all the other improvements to sensors, recirculation flows, cell stack sealing, etc., worked as expected causing no problems on the final test.

The following subsystems worked flawlessly on the final sea trial:

- Electronic Control System
- Thermal Management System
- Hydrogen Management System
- Emergency Battery System
- Structural System
- Oxygen Storage and Supply System
- Launch and Recovery
- Start-up and Shut-down

The project team is therefore convinced that given sufficient operational time the 100-kWh (250-Wh/kg) target would have been met.

Conclusions and Recommendations

Considerable information and practical experience were gained by performing the bench tests and sea trials. Overall performance was close to this CRAD-sponsored R&D project goals and virtually all subsystems performed flawlessly on the final sea trial, confirming that the aluminum-oxygen semi-fuel cell is a viable technology for use as an underwater power source. Time and budget constraints at the end of the program were the only limitations on achieving a complete 100-kW-hour autonomous discharge within an operating ARCS vehicle.

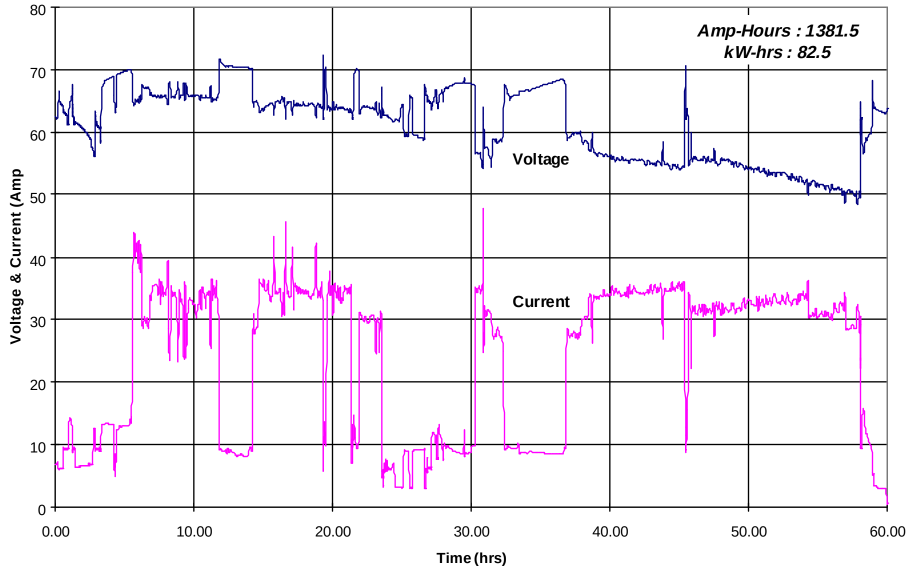


Fig. 4. Sea Trials "Second Free Swim" Voltage and Current Plot

The following summarizes the changes that could be made to the system to make it more user-friendly and reliable in a production version:

• Investigate and replace the electrolyte pump with one that is more efficient. The current pump accounts for more than half the total auxiliary load of the FCPS, and although the pump is rugged, the motor proved unreliable in the final test;

• Make the system easier and less labour-intensive to refuel by means of a pre packaged electrolyte and sludge container;

• Further development in the gas sensor area is required to provide increased reliability in measuring the oxygen concentration within the bubble and refine the thermal conductivity hydrogen sensors;

• A faster controller for the oxygen supply should be incorporated to improve response to transients; and

• An improved cathode with higher performance has been developed and tested with internal FCT R&D funds. Adoption of this cathode would improve performance of the FCPS by a further 20 to 25 percent. Any future project should incorporate this improvement.

All of these actions should take place in a program whose main aim is to perform a much longer period of sea trials with a more reliable and cost-effective power source that meets the end-user's requirements. As the tasks of mechanically and electrically integrating the FCPS with the ARCS vehicle have been successfully completed, further sea trials with a more reliable and user-friendly product could be carried out with much less technical risk and overall cost.

Further R&D Initiatives

The Canadian ARCS test program has demonstrated a successful progression of advancing air-independent semi-fuel cell energy storage for electric propulsion. Not only is this a highly energetic energy storage device, but it is also an affordable and environmentally friendly and safe alternative, and offers the possibility of greatly reduced cost of ownership.

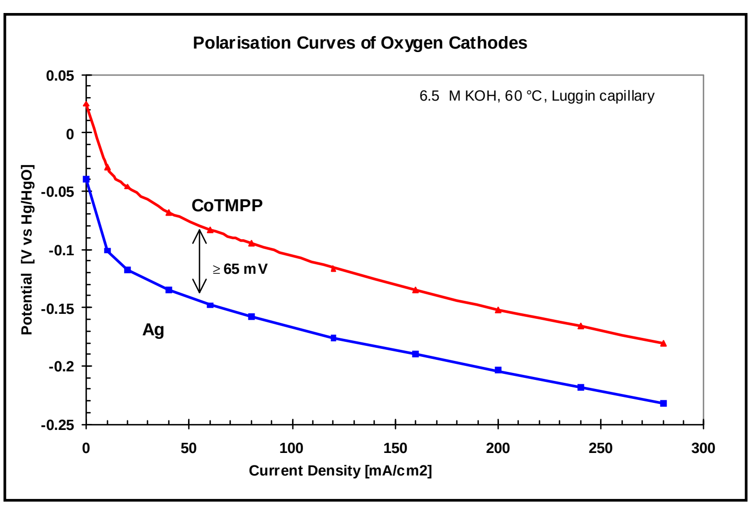


Fig. 5. Improved Cathode Performance utilizing CoTMPP

FCT internally funded research on improved oxygen cathodes has resulted in significantly improved cell voltage as shown in *Fig. 5*. Four-cell stacks tested with this technology have given the equivalent performance of 6.0 kW from a cell stack configured the same as the ARCS system. System improvements currently under development will enable an energy density of between 400 and 500 Wh/kg within three years.

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First Solid Waste Handling Systems at Sea with the Canadian Navy

Article by LCdr S.K. Dewar
Photographs courtesy of Mario Gingras

The first installation of solid waste handling equipment provided under the Maritime Environmental Protection Project (MEPP) recently sailed on Westploy aboard the fleet replenishment ship HMCS *Protecteur* (AOR-509). The ship received a ruggedized compactor made by Strachan and Henshaw (the U.K. torpedo tube maker), and a solid waste pulper, manufactured by Hobart. The ship was also fitted for, but not with, a USN-designed plastics processor which will arrive in mid-1997.

The equipment is being fitted to ensure that Canadian warships can comply with environmental regulations such as MARPOL 73/78 and the Canada Shipping Act in an environmentally and sailor-friendly manner. The equipment was chosen to deal with the waste streams found on board ship and has all been proven through use in other navies.

The ruggedized compactor is designed to overcome the deficiencies that existing commercial systems have experienced at sea. This machine can reduce the volume of waste fed into it by a factor of about 15 (as opposed to a factor of three for most commercial equivalents). During its initial period of operation on board *Protecteur*, it processed paint and aerosol cans, 4x4s, rat guards and wire-reinforced steam hose without complaint, all of which would have defeated other types of machines. Processed waste is stored in 20-litre pails which are sealable to prevent leakage of liquid or odours. Numerous safety features have been incorporated to prevent the machine from "accidentally" processing incompatible items (XOs come readily to mind!).

Strachan and Henshaw FSRs Dave Richards (left) and Dave Sigrist set *Protecteur*'s ruggedized compactor to work at the end of March. The machine, seen here with its front cover removed, eats everything from 4x4s to rat guards, reducing the volume of waste by a factor of 15.

The Burning Question — Why not incineration?

The question is often asked why incineration was not selected for use at sea, particularly given the positive experience of the three *Halifax*-class ships. It is worth briefly explaining the reasoning behind the decision to move away from incineration, as it illustrates the complexity of the situation surrounding environmental regulations.

It has been known for some time that the international maritime community is considering bringing in regulations to control air emissions. Emissions of nitrogen oxides, sulfur oxides, volatile organic compounds and particulates are all serious environmental concerns. Many individual nations have already introduced regulatory legislation, as have subnational jurisdictions such as California. All these regulations are constantly evolving, however, and as yet no international consensus has emerged as to how these concerns can be met. Under draft regulations for MARPOL Annex VI, serious restrictions on the use of incinerators were proposed. These are being challenged by many nations, but it is not yet clear what will result.

The Canadian navy requires equipment which will allow its ships access to ports and operating areas without undue restriction. Quite simply, the long-term viability of conventional incineration is uncertain and, for that reason alone, technology that will meet our long-term needs was selected for use by the MEPP. A good case can be made that it is much more environmentally sound than incineration, which in the end simply discharges waste into the air rather than the water (and burns good fuel to boot). **— S.K.D.**

***Protecteur*'s new waste pulper. This and other waste handling equipment is being fitted throughout the Canadian fleet as part of the Maritime Environmental Protection Project.**

The pulper is designed to handle waste which is mostly organic in nature, such as food, paper and cardboard. It works by grinding the waste into very small particles that may be discharged overboard as a seawater slurry in most areas of naval operation. By effectively dealing with organic waste which can contribute up to 60 percent of the total daily waste generated by a ship at sea, other types of waste can be dealt with more simply and effectively. Pulpers are in widespread use in cruise ships and ferries, and have been selected by the USN for use in all their major surface combatants.

The plastics processor is the first machine of its kind and is now in widespread use in the United States where there is a national law that they be fitted in naval ships before 1998. The processor works by melting and compacting plastic into one-metre-diameter "bricks," reducing it from its original volume by about 30:1. Plastic waste which is heavily food-contaminated can also be processed, and trials have shown that such waste remains sanitary and odour-free as long as two years after processing. The USN even has a program to recycle the processed plastic into marine dock pilings (recycling programs are being considered by Canada).

Perhaps as important as the equipment itself is the compartment housing the equipment. On board *Protecteur*, a dedicated compartment specifically designed to aid waste processing was constructed in the starboard after corner of the dispersal area. It allows waste to be sorted, stored and handled easily. Considerations for ease of cleaning, ventilation and drainage were given utmost attention in the design.

Installation of solid waste handling equipment in other ships of the fleet will begin this summer. The equipment should greatly ease the burden of complying with environmental rules, and place the Canadian navy at the forefront of the world's navies in our commitment to environmental stewardship.

Update : Ozone Depleting Substances

The Montreal Protocol and the Canadian Environmental Protection Act (CEPA) have banned the production and importation of CFCs. This means that the supply of refrigerants and halon for our ships is restricted to what is currently available. Apart from our commitment to responsible environmental stewardship, from a logistics point of view the navy has no choice but to convert its ships to accept environmentally friendly alternatives.

New federal halocarbon regulations are in third draft and are expected to become law by the end of the year. These regulations will force *all* federal departments and agencies to comply with CEPA. MARCORD G-19 is being updated to reflect these new regulations. The most significant change will be the requirement to report ODS releases to Environment Canada. In addition, freon and halon releases will have to be dealt with within seven days of detection.

Freon

New high-efficiency purge units have been purchased for the 75-ton chillers currently in service. Use of these new purge units is legally required by Jan. 1, 1999. After this date the maximum allowable discharge of R11 from a purge unit will be 0.1 kg freon/kg air.

New chillers are being installed in HMCS *Preserver* during the current refit, and are planned to be fitted in *Algonquin* during her refit. Not only will these chillers be environmentally friendly, but they should be easier to support as well.

The conversion of the domestic refrigeration system in the Canadian patrol frigates should start this summer. The existing compressors were built to accept R134a, the environmentally friendly refrigerant, so most of the system will be unchanged. Development is under way to replace the domestic refrigeration compressors in the *Iroquois* class with compressors of the same series as those fitted in CPF.

Halon

Federal regulations require that all work on halon systems be done in accordance with ULC requirements. To comply with this requirement, all personnel maintaining halon systems should be trained in the correct practices. Future training courses will be ULC approved. It is intended that two courses will be given on each coast during the next year.

Most halon first-aid extinguishers have been replaced with either CO_2 or dry chemical extinguishers. The only halon extinguishers being retained will be on board aircraft and submarines.

A fire risk analysis of CPF has confirmed that they are overprotected with halon. In electronic spaces, a fire in a cabinet will not produce enough heat to activate the heat detector, so no automatic release is possible. A smoke alarm would have to be investigated and first-aid action would extinguish any fire. Work is being done to improve the smoke detection system and make it easier to get CO_2 into the cabinet.

The first batch of modified halon release control (HRC) cards has been received and is being installed. This modification eliminates the risk of an accidental halon release from a double ground fault condition.

It is planned to replace the halon protecting the CPF machinery enclosures with a fine waterspray system that uses fresh water and air to form very fine water droplets in the enclosure to extinguish fires. It is effective, environmentally friendly and easily recharged by ship's staff. This system will also be used to protect the 1,000-kilowatt diesel generator on board the *Iroquois* class. **— LCdr Tom Shirriff, DMSS 4, NDHQ.**

Project Mermaid: The Canadian Sea Sparrow Missile Program

Article by Phil R. Munro
This article was sponsored by the Canadian Naval Technical History Association.

The Canadian Sea Sparrow missile initiative developed around the DDH-280 program following the demise of the general-purpose frigate program in November 1963. The general-purpose frigate had been designed to accommodate the medium-range Tarter surface-to-air missile system along with, in all likelihood, the close-range Sea Mauler, a USN adaptation of the Mauler missile used by the U.S. Marine Corps. As things turned out, Sea Mauler died in infancy almost concurrent with the cancellation of the general-purpose frigate.

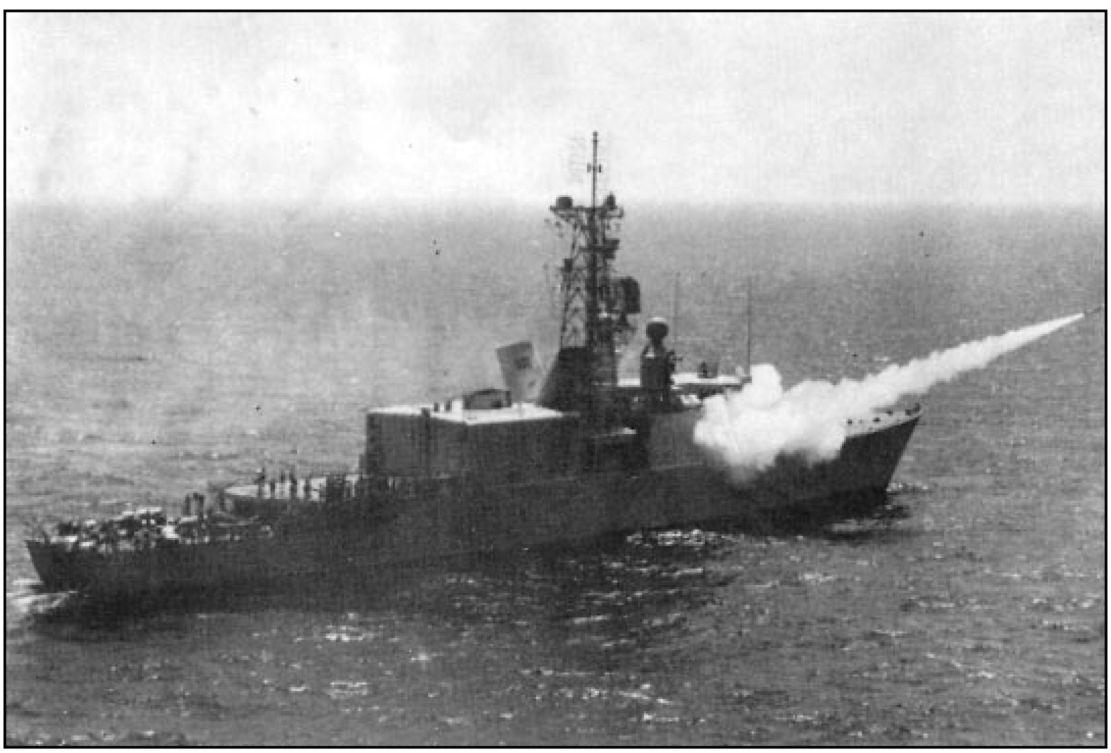
As the DDH-280 Tribal-class destroyer program took shape, the Director of Naval Requirements expressed a need for a point-defence missile system. Unfortunately, the DDH-280 had been authorized as a gunned vessel only. Essentially, its weapons fit was constrained to off-the-shelf equipment, and there was no close-range missile system available.

As far as a gunfire-control system went, consideration was being given to the Mk 87 anti-aircraft system then under manufacture by Ford Instruments (later Sperry) for the United States Navy. The Mk 87 was actually a modification of the Dutch M22 fire-control system being manufactured to U.S. standards (which led to significant difficulties when U.S.-standard replacements for the metric-standard antenna bearings upset the balance of the combined antenna system). Ford produced only two development sets, both of which eventually made their way into service.

About this time (February 1965), Hollandse Signaalapparaten was demonstrating its M22 combined anti-surface/anti-air fire-control system, using a search antenna for both target acquisition and anti-surface tracking while scanning. Anti-air tracking was accomplished by a dedicated track antenna mounted on the same yoke, all within a radar dome. A significant plus for the M22 was that the system had a simultaneous anti-air and anti-surface capability using only two operators to carry the process through from detection to weapon firing and kill assessment. Other systems required more personnel.

My involvement in the program began by taking a Canadian team to visit the Dutch naval base in Den Helder to see what the M22 was all about. The demonstration was most impressive and we took the opportunity to visit the factory in Hengelo for detailed discussions. We learned that the parameters of the system were identical to those of the Mk 87 system, yet the M22 cost considerably less. We were thus confronted with the attraction of a proven system at a good price, versus the advantage of North American logistics (particularly, the supply of spare parts in a wartime environment). Another topic of interest was a moving target indication (MTI) feature. MTI did not exist in either the M22 or Mk 87, but Signaal informed us that it could be incorporated at extra cost.

The final decision favoured the M22. We really wanted a missile control system, but had no mandate. Naval staff had placed the requirement for simultaneous attack on two air targets, predicating two tracking systems per ship, and so we set about costing and justifying the four-ship requirement.



HMCS *Athabaskan*: When the four DDH-280s entered service in the 1970s, these “Sisters of the Space Age” gave Canada its first naval missile capability. *(Canadian Forces photo)*

Meanwhile, in September 1965, the newly promoted Cdr E.R. (Ray) Ross became the Assistant/Director Weapon Systems (Surface and Air) [A/DWS(SA)] and spearheaded the attempt to obtain authority for missile defence. At this time the USN was working on a basic point-defence missile system in which an eight-cell launcher could be reloaded by hand (an estimated 30 minutes per missile). Since the Canadian staff requirement dictated a greater tactical payload, DWS(SA) was given $200,000 to award study contracts to Sperry Canada and Raytheon Canada to determine the viability of a reloadable Sparrow missile system and to cost a subsequent development program.

Owing to a 30-month lead time, an order for a single M22 gun-control system was placed and arrangements were made with Signaal to cut the lead time to 24 months by "borrowing" a system from the production line intended for Sweden. The contract was placed in mid-1966 (project M22-18CA) and was immediately followed by a contract for three additional systems (M22-19CA) on the basis of the mandated gun ship. This order got the program under way.

The study, Project Mermaid, started in late 1965 and lasted the better part of a year. Signaal supplied a model of the M22 system which was used as the central theme in a marketing film made by naval photographers. We visited the Sperry and Raytheon factories, took movies and compiled a ten-minute film which was used in briefings to higher authority. Cdr Ross developed a one-hour brief which was presented to Director General Maritime Systems, to Chief of Technical Services and then to Director General Requirements.

An intended prop to the briefing was supposed to be the shell of a practice missile. What Raytheon delivered was a full practice missile nearly two metres long, weighing well in excess of 250 kg. We manoeuvred this beast up two flights of stairs and around the corners of the stairwell and then had to remove the door of the briefing room to get the missile into place for the first two briefings. (The prop was abandoned for later briefings.)

Not surprisingly, the briefing got shorter and shorter the farther we went up the line to the vice-chief and the chief of the defence staff. By the time we finally briefed Defence Minister Paul Hellyer, it was down to a ten-minute presentation, *including* a much condensed two-minute movie. Each briefing was introduced by Cdr Ross referring to Project Mermaid as the latest thing in bilingualism — "*Mer*" being French for "sea," and "*maid*" standing for "missile air intercept defence." A bit corny perhaps, but it set a good tone for the briefing.

Commodore Ray Ross spearheaded the Canadian Sea Sparrow missile program as a CSE commander in the mid-sixties and went on to become the navy's DGMEM engineer-in-chief (1977-80). He died in retirement in 1987 at age 56. *(Canadian Forces photo)*

In August 1966 the minister approved a $2.5-million missile development program, the cost to include one prototype launcher. Approval was given concurrently for the purchase of nine production launchers, a suitable number of Sparrow missiles and an additional six M22 fire-control systems. Distribution for the total production was intended as follows:

- Eight M22-19CA production systems for four DDH-280 destroyers (dual launchers);
- One M22-18CA prototype and one M22-19CA production system to be fitted in the support ships as single-launcher systems. (These were never fitted, but went instead to the fleet schools in Halifax (18CA) and Esquimalt (19CA) for training.)

Project Mermaid Results

The Sperry Solution

Sperry proposed an eight-canister launcher (four over four) that would be fixed to the deck and could be trained and elevated. A load position was established in the fore-and-aft line, about 30 degrees from the deck plane. The deck behind the launcher would be opened up using a motorized sliding panel, making an opening large enough to thrust four missiles from the underdeck magazine into the launcher.

A second load of four could follow the first, with the loader positioned higher to match the upper set of canisters. Vertical positioning was achieved by a "barber chair" hydraulic lift. The principal objection to this method was the possibility of sea water ingress in heavy weather. The loading time was reasonable, but the maximum tactical payload was 16 missiles.

The Raytheon Solution

Raytheon put forward a design for an eight-canister launcher that would be situated on deck immediately forward of the magazine. The front of the magazine bulkhead would open and four missiles would be lifted from stowage by a horizontal arm fitted with grabbers. The missiles would then be thrust into the launcher as the whole arm could be moved forward for loading. The loading arm could be moved in both the deck plane (athwartships) and vertical plane for missile capture, and in the deck plane (fore and aft) for delivery.

Once delivered of its load, the arm was free to pick up a second load and repeat the process, this time at a higher level. Raytheon had designed the arm to pick up a designated load (up to four missiles) to meet specific loading needs. The system was considered to be the better of the two offered, but was cumbersome.

The Navy Solution

Cdr Ross suggested it would be ideal if the launcher and loader were combined into one vehicle, reducing weight and complexity. This approach reduced the ready payload to four missiles, so Raytheon offered the possibility of two loaders side by side, each situated in front of the magazine and looking forward. Cdr Ross immediately picked up on this theme and conceived the configuration of four missiles per side, each launcher being a loader, with each launcher controlled by its own M22 fire-control system. Thus, the distinctive DDH-280 Sea Sparrow arrangement was born.

The accepted configuration contained 12 missiles on each side — four on the launcher, four stowed with wings and fins

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R 131241Z Jun 74
FM ATHABASKAN
TO NDHQ OTTAWA
MARCOM HQ HALIFAX

BT
UNCLAS
SUBJECT: CANADIAN SEA SPARROW CLOSE
RANGE MISSILE SYSTEM FIRING TESTS
1.  CANADA'S FIRST SEA SPARROW GUIDED
FLIGHT OCCURRED AGAINST AS TARGET TOWED
BY BQM-36A DRONE ON 12 JUN ON ATLANTIC
FLEET WEAPONS RANGE PUERTO RICO.  THE
FLIGHT WAS PERFECT IN ALL RESPECTS
2.  SPECIAL ACKNOWLEDGEMENT IS MADE TO
ALL ADDRESSEES FOR THEIR CONTRIBUTIONS
AND ASSISTANCE IN THIS SIGNIFICANT
ACCOMPLISHMENT
BT
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fitted for ready pick-up, and four stowed beneath these ready to be winged and finned as the top layer was removed. In a tactical situation the ship had the capability of firing up to 24 missiles. No other navy had that capability until the advent of the vertical launch system a decade later. An additional eight missiles were stowed vertically in the magazine, capable of being hand-moved into position for a final engagement. It was not anticipated that these would be active except in unusual circumstances.

From approval in 1966, liaison with Raytheon Canada and Holland Signaal comprised the heart of the program. As production of the fire-control system paralleled the development program, alterable parameters were limited to the launch system and its interface with a known fire-control system. Since the Sparrow was a semiactive homing missile requiring target continuous wave illumination, it became necessary to add an illuminating horn concentric with the monopulse tracking antenna, along with a rear reference horn for missile selection and tuning. To enhance radar acquisition and tracking a deal was struck whereby Signaal would develop the MTI and a pulse doppler tracking system (PDT) using Canadian government money which would be repaid from world sales of the product.

This was somewhat unusual. Under normal circumstances the Canadian government would provide specifications and technical monitoring, and so would retain the rights to any development it paid for. But in this case the RCN had no technical input and Signaal (partially controlled by the Dutch government) was producing the specification for the Dutch navy. Hence the deal was made so that Signaal could retain the rights to the product. By 1968 both MTI and PDT were operational and were incorporated into the M22 production systems. Signaal made sufficient world sales to meet the set target and the money was repaid as agreed.

Development included the magazine/handling/launcher system and certain modifications to the fire-control system, notably inclusion of the illumination horn in the tracking antenna. This addition proved to be somewhat complex as the weight and balance of the antenna were critical to the servo drives and some reengineering had to be undertaken. As well, horns for the rear reference signal required for missile tuning had to be mounted on each side of the superstructure abaft the launchers (the missiles were tuned with the launchers in the extended position).

Retaining the missile umbilical cord posed another problem. In the USN system the connection was sheared on firing, and a new cord was fitted, but this procedure was incompatible with quick reloading. Raytheon solved the problem with a quick disconnect system.

The first M22/5-18CA fire-control system was shipped to Raytheon Canada at Waterloo, Ontario via Canadian military transport in the spring of 1968. It remained there as a test bed until completion of the development program.

My direct connection with the Canadian Sea Sparrow ended with my retirement on Dec. 31, 1967 as the program moved into production, trials, fitting and finally sea trials. The message at left indicated the culmination of a successful Canadian development program.

Phil Munro joined the RCNVR as a wireless telegraphist in 1942, and served as an electrical officer from 1949 until his retirement in 1968. From 1963 to 1967 he worked on the Canadian Sea Sparrow program, serving as program manager for the last two years.

Book Review

Liberation—The Canadians in Europe

Reviewed by LCdr Robert Jones

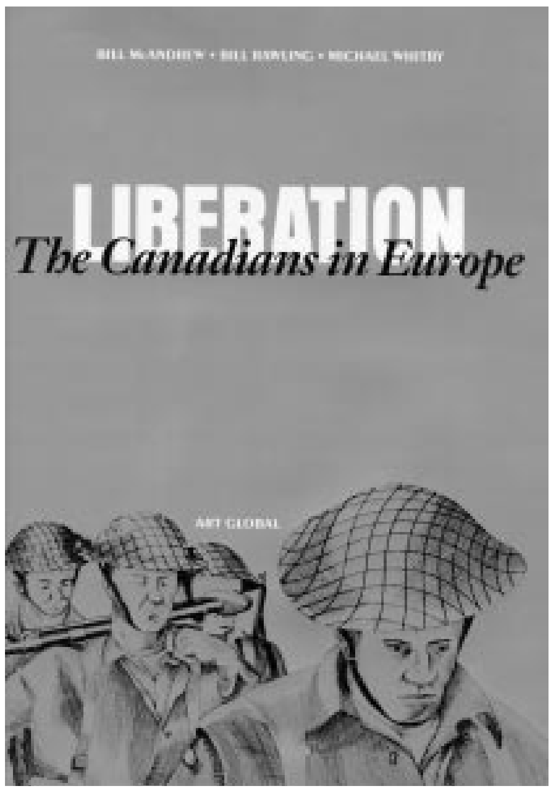
Liberation — The Canadians in Europe by Bill McAndrew, Bill Rawlings and Michael Whitby.
Montreal: Éditions Art Global Inc., in co-operation with the Department of National Defence, 1995.
Hardcover, illustrated, 170 pages.
ISBN 2-920718-59-2

Over the course of my career I have experienced, on a number of occasions, immense pride (mixed, I'll admit, with a tinge of embarrassment) at being singled out by grateful British and Dutch citizens because of the "CANADA" flashes on my uniform. But while the spontaneous outpourings of praise and thanks for the sacrifices my father's generation made on their behalf during the Second World War have been heartwarming, they have been sobering as well.

More than 100,000 Canadians in this century paid the ultimate price for freedom. Throughout many Commonwealth cemeteries in Europe, row upon row of plain white headstones, marked by a simple maple leaf, bear witness to the terrible cost war brought to Canadian families.

We should never forget their sacrifice, and in keeping with that sacred trust the Directorate of History and Heritage of the Department of National Defence has recently released three new books covering Canada's role in the European Theatre of Operations in World War II: the Italian campaign, the D-day invasion and breakout of Normandy, and the liberation of Northwest Europe. All three books, based on coffee table/scrap book format, use photographs and personal anecdotes to bring to life the sweeping historic events of World War II.

Liberation — The Canadians in Europe, written by Bill McAndrew, Bill Rawlings and Michael Whitby, covers Canada's role in the period of the war from the decimation of the German Seventh Army in Normandy in late August



1944 to VE day in May 1945. The book focuses primarily on the Canadian army's role in the pursuit of the German Fifteenth Army to the Dutch-German frontier, the unenviable task of clearing the Scheldt Estuary in the fall of 1944 (which opened up the vital port of Antwerp), the winter stagnation filled with chilling rains, snow and mud, and finally the liberation of Holland and the thrust into Germany in the late spring of 1945.

Not forgotten are the significant roles played by the Royal Canadian Navy and Royal Canadian Air Force. The personal anecdotes of the infantrymen, sappers, armoured troopers, artillerymen, nurses, service corp personnel, sailors and airmen put into context the history that was being written at that time. The book provides the reader with vivid accounts of the full range of experiences of Northwest Europe — everything from assaults under fire, to augmenting infantry units with untrained service troops, artillery duels, night actions in MTBs, air combat against Me-262s, and rotating out of the line for some well deserved leave in Brussels.

Minor irritants of the book were the small size of the photographs and the lack of technical drawings and performance specifications for the various equipment discussed in the book. Perhaps the editor felt these items would detract from the coffee-table/scrapbook look of the publication.

In any event, *Liberation* does a very credible job of portraying the events of the time, and I highly recommend it. Above all, it reminds us of the sacrifices made by many Canadians in the prime of their lives and gives us pause to reflect on the legacy they helped shape for our generation to enjoy.

LCdr Jones is a Marine Systems Engineer with DQA in Ottawa. His article, "Titanic's *Engineers — Heroes of a Disaster," appeared in the October 1996 issue.*

News Briefs

CFAV Quest *mid-life refit*

The biggest news in the auxiliary fleet is the modernization of the scientific research vessel CFAV *Quest*. For over 20 years this vessel has been a main player in underwater acoustic research. To promote this role, the ship was designed with many interesting quietening features. For example, the main machinery is mounted on a 100-tonne raft which is itself flexibly mounted off the hull. Below the waterline, every compartment is internally clad with mass damping acoustic tiles.

This project is being progressed as a "design and build" contract with industry, whereby a single contractor progresses the design and then carries design responsibility forward into the actual refit phase. The contract for the work, valued at nearly $43 million, was awarded to Marystown Shipyard Ltd. of the Burin Peninsula, Newfoundland in June 1996.

Marystown elected to set up offices in Bedford, Nova Scotia for the design phase. This has afforded them a prime location for access to their major design subcontractors. Among these are: Lockheed Martin Canada (communications and navigation); Bolt, Beranek and Newman (acoustics); Donelad Hydronautics (the principal designer); and Westinghouse Canada Inc. (machinery control system).

With the design phase drawing to a close, the ship was scheduled to arrive in Marystown on June 16 for commencement of the refit implementation. The refit is expected to be completed in August 1998. **— Malcolm P. Wall, Project Manager *Quest*, NDHQ.**

Journal *articles "write" stuff*

A number of *Maritime Engineering Journal* articles have been selected for reprinting by other agencies.

"*Requirements Influencing the Design of Canadian Naval Gearing*," written by Don Nicholson (April 1988 issue) was scheduled for reprinting in the April 1997 issue of the *CSME Bulletin.*

"*Incident at Sea: Oxygen System Explosion in HMCS* Cormorant," written by LCdr Jim Muzzerall, Stephen Dauphinee and LCdr Kevin Woodhouse (June 1995 issue) is being used as a case study by the American Society of Test Materials at the NASA White Sands facility in New Mexico.

"*Truth Versus Loyalty*," written by CPO1 Bob Steeb (Oct. 1996 issue) was reprinted in the Jan. 1997 issue of the NATO Maintenance and Supply Agency's *Lucana News*.

"*In Defence of the Canadian Court-martial System*," written by Capt(N) Dave Jacobson (Feb. 1997 issue) is slated for reprinting in the *JAG Journal*, as well as in the Defence Association *National Network News*.

Bravo Zulu to all concerned.

Mack Lynch Memorial Award

SLt Dave St. Cyr received the 1996 Mack Lynch Memorial Award for achieving a high scholastic average and demonstrating, in the eyes of his peers, superior officer-like qualities on completion of the MARE 44C theory course at Dal-Tech (ex-Technical University of N.S.). Ms. Jennifer Lynch, QC presented the award, a copy of the book *Orion*, *Mighty Warrior*, in memory of her father, Captain Mack Lynch, RCN, a radar officer on board HMS *Orion* during World War II. *(Awards news arranged by Lt(N) R.A. Duff. CFB Halifax Photo by MCpl L. Morin.)*

Northrop-Grumman Canada Awards

Since 1973, the Northrop-Grumman Canada Award has been presented to the candidate who displays a high level of engineering excellence, academic standing and officer-like qualities on the MARE 44C applications course. The standing is based on peer assessment. The 1996 recipients of this award were Lt(N) Alain Dupuis (serial 9601), and SLt Peter Angel (serial 9602). Mr. John Murray of Northrop-Grumman Canada presented the awards, which consisted of a plaque and a set of binoculars for each winner. ***(CFB Halifax Photos by MCpl L. Morin)***

ROUTP '72 silver anniversary West Coast reunion, Aug. 1-4, 1997

The West Coast boys have made good on their promise to host the 25th anniversary reunion of the Reserve Officer University Training Plan class of '72.

The family-oriented weekend kicks off in Esquimalt with a 7:00 p.m. meet and greet at the Naden Wardroom on Friday, August 1. Organizers are in the process of arranging harbour tours and visits to an MCDV and HMCS *Cape Breton* ("The Fred!").

On Sunday, August 3 the venue shifts to the mainland. The plan is to take the afternoon ferry to Vancouver (buffet dinner on board), then enjoy a free evening in the big city. Monday will begin with breakfast and a Vancouver Harbour and Approaches boat cruise. After that, the reunion winds down with an afternoon barbecue at HMCS *Discovery* and dinner in town for those who can stay on.

Contact King Wan and let him know your plans for attending. If you can't make it to the reunion, consider sending a video greeting. (Please pass the word to any of our classmates whose whereabouts might be known to you.)

King can be reached at (604) 222-1788 (home), (604) 432-3806 (work), or by e-mail: king_wan@bctel.com. He can give you all the details, including accommodation arrangements. **— Brian McCullough (ROUTP Class of '72), Production Editor,** ***Maritime Engineering Journal,*** **DMMS, NDHQ.**

IMLA conference on maritime education, Sept. 7-11, 1997

The International Maritime Lecturers' Association (IMLA) will be holding its conference, "*The New World of Maritime Education: Meeting Challenges, Seizing Opportunities, Managing Change,*" Sept. 7-11, 1997 in St. John's, Newfoundland.

The conference is being hosted by the Fisheries and Marine Institute of Memorial University and is one of several "Summit of the Sea" conferences marking the 500th anniversary of John Cabot's landfall in Newfoundland. The colloquium will address the challenges and opportunities facing maritime education and training in the next rnillenium.

For more information, contact: **Philip Bulman, Conference Chair, Fisheries and Marine Institute of Memorial University of Newfoundland, P.O. Box 4920, St. John's, Nfld., A1B 5R3. (Telephone: 709-778-0648; Fax: 709-778-0659; e-mail: imla97@gill.ifmt.nf.ca URL: http://www.ifmt.nf.ca/~imla97)**

Firmware configuration management

Imagine jamming on your car brakes to avoid a collision and the horn sounds, or turning on your stereo and the microwave oven starts. The times when simple mechanics controlled the items in our lives are gone forever. Computers, computers, computers — every aspect of life is touched by a computer or computer enhanced device. This makes configuration management of the software on these devices critical. This is especially true with firmware based systems where the software is stored on integrated circuits called electrical programmable read only memory (EPROM).

With firmware it can be difficult to determine the exact configuration of the software. The configuration as seen by the user is defined by the system operation. However, configuration from the manufacturer's perspective is complex. The executable software is installed or "burned" onto the EPROM using an EPROM burner with special software to control the burn. Keeping tight control of the resulting product is critical. Simple burn verification checks do nothing to ensure that the right software is installed onto the right hardware.

The Department of National Defence has been faced with some demanding challenges with the firmware configuration management and logistics supporting the integrated machinery control systems (IMCS) installed on the *Iroquois*- and *Halifax*-class ships. The IMCS is a distributed control system, used to monitor and control the ship's auxiliary, ancillary and propulsion systems.

The IMCS application firmware is housed on several different circuit card types. It is possible to have several different types of firmware for a particular circuit card. The circuit card hardware is compatible between different IMCS subsystems, but with the software installed the circuit card function becomes unique to the subsystem. The software to be installed on each circuit card is thus dictated by the intended location of the circuit card. There are four different software suites on the *Halifax* class and five different software suites on the *Iroquois* class. The combination of these suites makes up the overall IMCS software version. Currently there are three different IMCS software versions; two *Halifax* class and one *Iroquois* class. However, through the support life of the ships it is feasible for many more versions to evolve. Clearly, ensuring that the right software is burned onto the right circuit card and is placed in the right subsystem on the right ship is a logistics challenge.

DMSS 5, the DND IMCS design authority, has developed procedures and systems which allow this unique logistic support requirement to be satisfied within a support infrastructure that is oriented toward simple repair by replacement. In this new system the replacement of failed circuit cards is accomplished using onboard spares, and the replenishment of the spares is performed through shore-based firmware support stations located at each fleet maintenance facility (FMF) on the west and east coasts. The ship requests a desired circuit card through the DND supply system. The FMF firmware stations select the circuit card type and firmware suite to be loaded onto the circuit card, and deliver the programmed card to the ship, complete with identifier labels indicating its system applicability. This allows circuit cards in the supply pipeline to be treated as blanks (just as any other hardware item) until they are programmed at the firmware stations. When a change in the IMCS design is required (e.g. due to a machinery upgrade), a new version of software is developed at a third-line support facility. When the new software is released, each firmware station master computer is upgraded and all the circuit cards on the affected ship are upgraded to incorporate the new version.

As the IMCS support facility contractor, GasTOPS Ltd. of Gloucester, Ont. is supporting DMSS 5 in the development of firmware maintenance plans and procedures used to govern the software configuration identification and release process. Hopefully, with these new procedures, the so-called unexpected "computer error" will not occur. **— W.J. Rogers, reprinted from GasTOPS Ltd. *CaseFILE*, Vol. 6, No. 1, March, 1997**.

MacDonald-Dettwiler Award

Lt(N) Warren Prokopiw has received the MacDonald-Dettwiler Award for 1996. The award is presented to the best overall Combat Systems or Marine Systems Engineer having completed head of department training in the previous calendar year. Four finalists appeared before a selection board consisting of Capt(N) Ian Mack (Chair) and three other senior officers. Mr. Logan Duffield made the presentation of a naval sword on behalf of MacDonald-Dettwiler. *(CFB Halifax photo by MCpl L. Morin)*

Lockheed-Martin Award

The winner of the 1996 Lockheed-Martin award was Lt(N) Rob Gray. This is the ninth year that Lockheed-Martin has presented a naval sword to the top Combat Systems Engineering candidate successfully completing the MARE/CS 44C qualification in the previous calendar year. Four finalists appeared before a selection board consisting of Capt(N) Yvon De Blois (Chair) and four other senior MARE 44C officers. Mr Bruce Baxter made the presentation on behalf of Lockheed-Martin Canada. *(CFB Halifax photo by MCpl L. Morin)*