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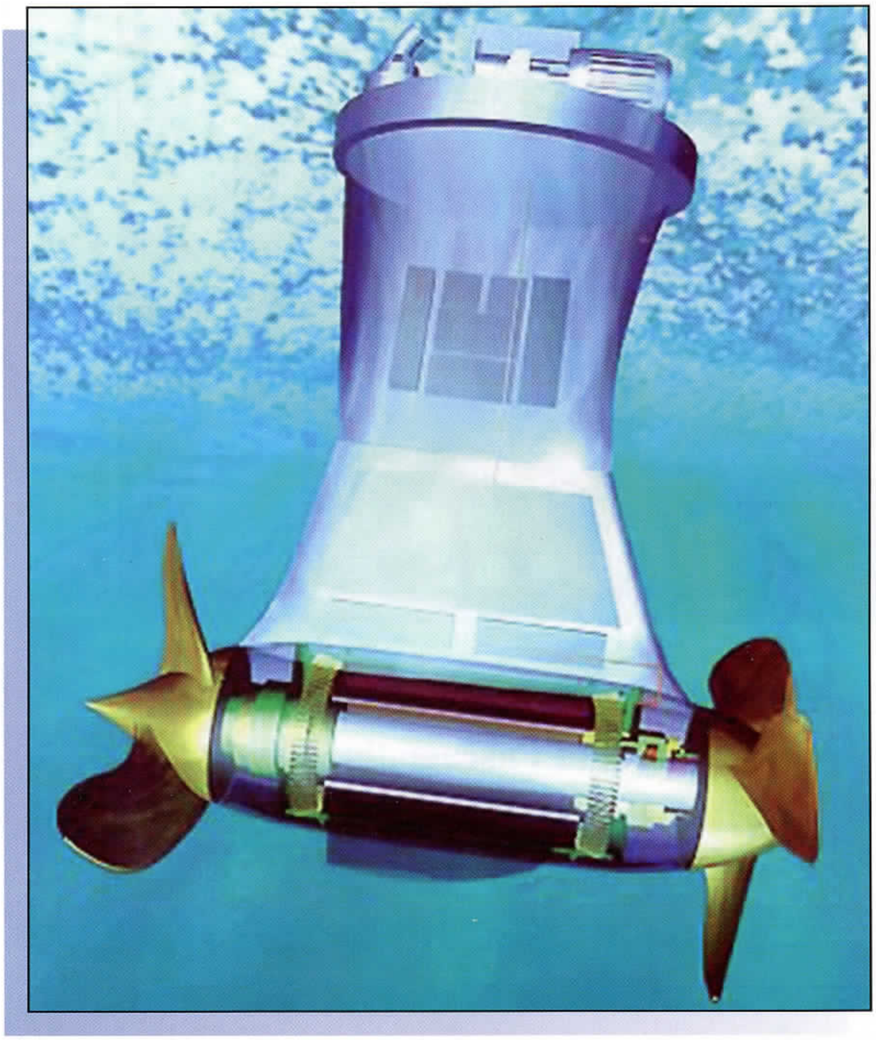
Maritime Engineering Journal

CANADA'S NAVAL TECHNICAL FORUM

Fall 2001/Winter 2002

CNTHA News Inside!



Also in this Issue:

- *ON EXCHANGE: Building DDG-51 Destroyers with the USN*
- *GREENSPACE: An Innovative Waste Treatment Facility that Saves the Environment — and Money!*
- *CNTHA NEWS: The DDH-280 Design Challenge*

Pod Propulsion: A Viable Option for the Canadian Navy

Canada

On Exchange:

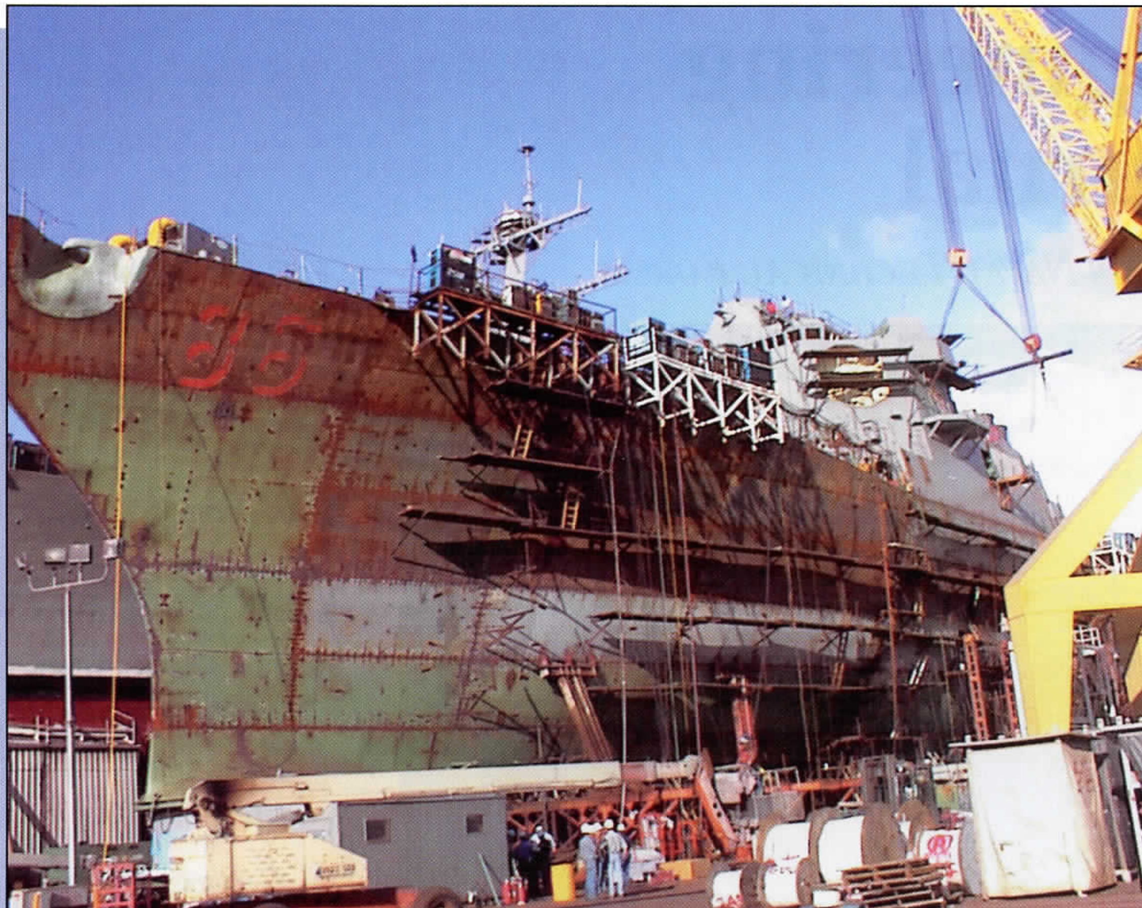


Photo courtesy Ingalls Shipbuilding

A Canadian MARE's story of exchange duty with the USN in Pascagoula, Mississippi
— page 14

Maritime Engineering Journal

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DEPARTMENTS

FEATURES

Cover:
The Siemens-Schottel SSP Propulsor is just one type of pod unit that offers a simpler and more economical system of propulsion over conventional diesel-electric designs. *(Cover photo courtesy Siemens-Schottel)*

The *Maritime Engineering Journal* (ISSN 0713-0058) is an unofficial publication of the Maritime Engineers of the Canadian Forces, produced three times a year by the Director General Maritime Equipment Program Management. Views expressed are those of the writers and do not necessarily reflect official opinion or policy. Mail can be sent to: **The Editor, Maritime Engineering Journal, DMMS (6 LSTL), NDHQ, 101 Colonel By Drive, Ottawa, Ontario Canada K1A 0K2**. The editor reserves the right to reject or edit any editorial material. While every effort is made to return artwork and photos in good condition, the *Journal* assumes no responsibility for this. Unless otherwise stated, *Journal* articles may be reprinted with proper credit. A courtesy copy of the reprinted article would be appreciated.

Guest Editorial

Working Together with a Formidable Sense of Purpose

By Captain(N) Rick Payne
Assistant Chief of Staff for Naval Engineering and Maintenance
Maritime Forces Atlantic

Within hours of the terrorist attacks on September 11th the MARLANT battle staff was at action stations, participating with central staffs in what became known as Contingency Operation Chinook. The operation examined all feasible options for Canada's possible involvement in a coalition against terrorism. The call soon came, with a warning order on Sunday, October 7th for the deployment of MARLANT's high-readiness task force as part of Operation Apollo. Ten days later — on Wednesday, October 17th — the Canadian task force sailed from Halifax, mission-ready; a proud moment witnessed by Canadians coast to coast thanks to live media coverage.

From a personal perspective, the days surrounding the task force's departure felt almost surreal. For example, the day before, the decommissioned *Nipigon* had been towed gracefully out of harbour, nearly unnoticed, destined for one final duty — as a reef off Rimouski, Quebec. And two days after the ships sailed, Haligonians witnessed more history with the homecoming of HMCS *Windsor*, the second of Canada's four new submarines. Throughout these extraordinary events the Second World War corvette HMCS *Sackville* stood on the synchrolift, quite dignified it seemed, as if sagely presiding over "our" bit of history.

The symbolism was palpable, to say the least. The departing task force of HMC ships *Iroquois*, *Charlottetown* and *Preserver* represented the full range of our modern naval capability. *Nipigon*, having accomplished her duty throughout the decades of the Cold War, was now proceeding to her place of rest. And HMCS *Windsor*, entering harbour as the "new kid" in the fleet, signalled Canada's clear intent toward maintaining a strong and flexible navy. You get the picture.

Against this fantastic backdrop the naval technical community was visibly centre stage. Military personnel, civilians and contractors — a dedicated corps of engineers, technicians, tradespersons and logisticians — all worked together with a formidable sense of purpose in the intensive 24/7 preparations for Op Apollo. In every instance their individual and collective accomplishments bore the trademarks of teamwork and professionalism. As current events are proving once again: the prelude to action is never over. Well done!

To our shipmates and colleagues now deployed…we wish you every success in your mission, and a safe passage home.

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.

Commodore's Corner

Operation Apollo — Material Response and the Challenges Ahead

By Commodore J.R. Sylvester, CD
Director General Maritime Equipment Program Management

All of you are well aware of the events of Sept. 11th, and the government's decision to initiate Operation Apollo to contribute forces in support of the US-led coalition against terrorism. I would like to take this opportunity to discuss the response of the maritime engineering and material support community to these events.

Shortly after the terrorist attacks, contingency planning commenced for various response options. The maritime engineering community was heavily involved in this early planning and preparation, a factor which made our future success possible. On Oct. 7th the government announced that the Canadian Forces would join the coalition effort against terrorism. This included the commitment of six warships, with the high-readiness task force sailing in 10 days. Although the task force was already in a high state of readiness, there was still a significant amount of preparation to be completed before the ships sailed. The effort required to accomplish this in 10 days was enormous; the corresponding response was nothing short of humbling.

On the coasts, in excess of 450 work items were progressed on the ships. This involved a great deal of overtime, with many organizations going to a 24/7 operation. Outstanding and arising maintenance tasks were completed, engineering changes (ECs) were installed, on-site engineering was done as required, and tests and trials were conducted. Shore units and ships that were not sailing helped out by providing technicians to join the maintenance and watchkeeping efforts. In DGMEPM, design, financial and sole-source approvals were fast-tracked for the ECs. Range support was provided, critical spares and immediate operational requirements were satisfied, national spares were checked and the "bins topped up," contracts were established, refits advanced, and key personnel were deployed to the coast. And this is by no means an exhaustive list of the effort made by the material community. It is also recognized that none of this would have been possible without the dedicated effort of the operator community.

What impressed me most was the level of teamwork displayed across the entire material community. It was clear from the start that you had a common goal and that each of you was committed to doing your part in supporting each other. Your open communication resulted in a synergy that allowed you to complete what at first may have seemed an insurmountable task.

The challenges ahead are no less daunting. Although a pat on the back is well-deserved, as usual we cannot stop long to enjoy it. Now that the ships have sailed, we must sustain them for an extended period a long way from their home ports. We must also prepare other ships to replace those that have deployed, and at the same time continue to meet existing commitments and progress projects important to the future of the navy. I am confident that, even in this climate of fiscal prudence and personnel shortages, the material community will continue to meet these challenges and "make it work."

This is also a time to reflect on our response to Op Apollo. Yes, we got the ships ready in time, but only after a significant maintenance effort, hurried additional sparing and a fast transfer of needed equipment from ships that weren't sailing. We need to examine if existing processes or policies made the task of meeting readiness levels more challenging. Does the current readiness and sustainment policy provide the navy the capability to respond quickly to national taskings? If the policy is correct, do we lack the resources to properly implement it? Do we have the correct maintenance policies? Are different maintenance policies required for peacetime and conflict? Do we have the right sparing profile for the ships? If the processes and policies are right, are we using them correctly? This is a valuable opportunity for the navy to validate its material support policies.

I wish to take this opportunity to express how deeply proud I am of the way in which you pulled together, worked hard and met this challenge head-on. You have once again demonstrated superior service to the public and to the fleet. Although recognition of your efforts may not always be visible, rest assured that your dedication, professionalism and efforts are appreciated. Well done and "Bravo Zulu."

Letters

Unmanned aerial vehicle article sparks interest

I am a Naval Electronic Sensor Operator (NESOP) working in MARLANT HQ (N34), and I was reading the cover story of the Spring 2001 issue (*"A Potential Unmanned Aerial Vehicle for Canadian Navy Electronic Warfare"*).

EW is a subject that we NESOPs take seriously, and the article sparked my interest. I must say, it provided an interesting topic for discussion here in the office. I intend to forward a copy of the article to my colleagues who do not have access to the *Journal* on a regular basis. Thank you. — **CPO2 Dan Myers, Maritime Forces Atlantic HQ, LN 34-82, Staff Officer Above Water Warfare – Operational Requirements Analysis Cell (East).**

Many years ago I was a civilian engineer in naval headquarters, after which I finished my career in government working with industry in the promotion of Canadian defence products. Thus it was I felt disappointed that the authors of the article, *"A Potential Unmanned Aerial Vehicle...."* did not seem to be aware, in their brief rundown of early efforts in the UAV field, of a uniquely Canadian system which had been trialled by the US Navy with Canadian observers.

The "Flying Peanut" in flight. ***(Photo copyright Canadair)***

The Canadair CL-227 Sentinel, or "Flying Peanut" as we nicknamed it, was developed as a UAV by Canadair in its pre-Bombardier days. It flew using counterrotating propellers powered, if memory serves, by a Williams Research engine. I do not recall what sort of electronics suite was able to be fitted on this small device, but at the time it was certainly at the state of the art. The CL-227 was developed by the same team at Canadair that developed and produced the AN/USD-501 and longer range AN/USD-502 drones for the British and German armies. — **Alan Rackow, Ottawa.**

I can understand Alan Rackow's disappointment that we did not mention the CL-227 Sentinel since the Sentinel and the Eager have some similarities (e.g., shape, rotors). Plus the Sentinel was Canadian. However, the general UAV introduction in our article was purposely kept very brief as we wished to concentrate our write-up on the benefits of a UAV able to receive an unlimited supply of power from the ship through its tether. The Sentinel carried its own limited power supply. For the ESM/ECM application suggested in the article, the long endurance of a ship-powered UAV platform is seen as highly desirable. — **Barbara Ford, Defence Research Establishment Ottawa.**

Forum

Educating a Marine Engineer — A Sequel

Article by Gordon F. Smith

I would like to present a sequel to the Spring 2001 article: "*Educating a Marine Engineer — The UCL Experience!*" Reading this article took me back some 40 years to when I attended the Dagger course, which at that time was given at the Royal Naval College in Greenwich, England.

The "Dagger" designation comes from the Royal Navy list of officers. Any officer who completed the Advanced Marine Engineering course had a small dagger (†) placed beside his name on the list. I have been able to find the names of 63 Canadians who completed the course, including four who took the course as RN officers before joining the Canadian navy. Twenty-one of these officers took the course at Greenwich, 29 at Manadon, and 13 at University College London. The first Canadian officer on the Dagger course was the late RAdm Jack Caldwell in1938-39, and the second was VAdm Bob Stephens who attended Greenwich in 1946-48. At present, Lt(N) Rob McColl is attending UCL.

In my time, we also took a ship design course, and I imagine it was similar to today's UCL course. However, we did not have computers. To do a simulation of a power plant, for example, we had to design and build our own computer using hard wire, resistors and capacitors. No doubt in this respect things have really changed. In my case, the postgraduate course certainly was a "...learning tool and a means of applying what we had learned.…"

On my return to Canada in 1963 I joined the Preliminary Design (PD) section of Director General Ships in Naval Headquarters, Ottawa. I was the marine engineer on a team of about six people responsible for designing ships to satisfy the various staff requirements. The General Purpose Frigate had just been cancelled and PD was given the task of designing a destroyer of roughly the same size, but with many changes to the GP Frigate design. To give more deck space it was decided to lengthen the Tribal destroyer design by adding 30 feet (~ nine metres) at the bulkhead between the boiler-room and engine-room. However, because of the increased draft (among other things), the 30,000-shp power plant would be unable to meet the speed requirements. We needed more shaft horsepower. The only developed steamplant design I could find was a US Navy propulsion system of 75,000 shp. This design operated at very high temperatures and pressures, with all the inherent problems, and the power was too high. So I thought, why not go for a gas turbine propulsion system of about 50,000 shp, which was the power the naval architects wanted.

The Directorate of Marine and Electrical Engineering (DMEE), the Naval Engineering Design Investigation Team (NEDIT) and others looked at the various arrangements of combined diesel, steam and gas turbines. The most logical choice appeared to be the all-gas-turbine arrangement. From my Dagger course, and being in the UK, I knew the RN was designing the COSAG, CODAG and COGAG systems. Furthermore, HMS *Nubian* was at sea with a COSAG G-6 "industrial" gas-turbine propulsion system, and the aeroderivative gas turbine was being developed for marine use.

After many changes to our ship design (e.g., two helicopters instead of one) the final DDH-280 destroyer design went to the Naval Board for approval. It was decided to build four destroyers, using all gas turbines for main propulsion. I think here is a case where the knowledge and experience gained taking the Dagger course came in use immediately on completion of the course.

After two years in the Preliminary Design section, I left headquarters to join HMCS *Provider* as Engineer Officer. I returned to the DDH-280 program in 1967 as Senior Staff Officer (Engineering), preparing the working drawings in the Naval Central Drawing Office at Canadian Vickers, Montreal. I left the navy in 1969, and was brought back under contract as a civilian to be the first chief engineer of *Iroquois* and *Huron* for set-to-work and trials. My association with the DDH-280s continued ten years later when I became Litton's resident overseer for the Pratt & Whitney Aircraft portion of the Tribal-class Update and Modernization Project (TRUMP) contract. I hope I am still around for the decommissioning of the DDH-280s!

I strongly agree with the UCL article that "The Canadian Forces can only benefit by sending its officers on programs such as [the Dagger course], as the rewards will continue to show for years afterward." In my case, they certainly did.

Gordon Smith is retired and makes his home in Ottawa and Vermont.

Canadian Dagger List

RAdm Jack Caldwell	G 1938-39
VAdm R.St.G. (Bob) Stephens	G 1946-48
Cdr Pat Nash	G 1948-49
Capt(N) EJ (Derry) Dawson	G 1951-53
Capt(N) SE (Stan) Hopkins	G 1953-55
Capt(N) DH (Doug) Benn	G 1953-55
Capt(N) J (Jim) Knox	G 1955-57
Cdr VG (Gary) Ernst	G 1958-60
LCdr BF (Bryan) Allen	G 1958-60
Capt(N) GM (George) Bolt	G 1959-61
LCdr GF (Gord) Smith	G 1961-63
Cdr Keith Davies	G 1962-64
LCdr PHD (Peter) MacArthur	G 1964-66
Cdr JM (Jack) Littlefair	G 1964-66
Cdr KG (Ken) Harrison	G 1964-66
Cdr DH (Don) Smith	G 1965-66
Cdr RA (Bob) Douglas	G 1967-69
Cmdre Eion Lawder	G 1967-68
Cdr M (Mike) Brett	G 1967-69
Cdr JRF (Dick) Hodgson	G 1968-70
RAdm M (Mike) Saker	G 1970-71
Cdr LT Taylor	G 1971-72
Cdr John Pirquet	M 1972-73
Cdr George Godwin	M 1973-74
Capt(N) DW (Dave) Riis	M 1973-74
Capt(N) S (Sandy) Sutherland	M 1974-75
Capt(N) Bruce Baxter	M 1974-75
Cdr R (Ron) Rhodenizer	M 1976-77
LCdr Peter Ross	M 1976-77
Cdr R (Bob) Weaver	M 1976-77
RAdm ID (Ian) Mack	M 1977-78
Cdr DH (Darryl) Hansen	M 1978-79
LCdr Larry L'Ecuyer	M 1978-79
LCdr Karel Heemskerk	M 1978-79
Capt(N) SB(Sherm) Embree	M 1979-80
Cdr PJ (Peter) MacGillivray	M 1981-82
Capt(N) Dave Marshall	M 1982-83
LCdr RA (Richard) Wall	M 1982-83
Cdr Glen Trueman	M 1982-83
Capt(N) Doug Dubowski	M 1983-84
Cdr K (Ken) Winch	M 1983-84
LCdr C (Carr) Hallett	M 1984-85
Cdr Gilles Hainse	M 1985-86
Cdr R (Rick) Sylvestre	M 1986-87
Cdr R (Rob) Gair	M 1987-88
Cdr N (Nick) Leak	M 1987-88
LCdr R (Bob) Dunlop	M 1988-89
Cdr J (Jim) Jollymore	M 1989-90
LCdr R (Bob) Jones	M 1989-90
LCdr KQ (Kam) Fong	M 1989-91
LCdr Andrew Finlay	M 1989-91
LCdr RES (Rob) English	L 1992-93
LCdr D (Don) Demers	L 1993-94
LCdr M (Mike) Campbell	L 1993-94
LT(N) C (Cliff) Wardle	L 1993-94
LCdr Brian Murray	L 1995-96
LCdr R (Rick) Perks	L 1995-96
LCdr Glenn Walters	L 1995-96
LCdr Pierre Demers	L 1998-99
LCdr Derek Hughes	L 1998-99
LT(N) Dan Riis	L 1998-99
LT(N) Kirby McBurney	L 1999-00
LT(N) R (Rob) McColl	L 2000-01

G = Greenwich
M = Manadon
L = UCL

Pod Propulsion:
A Viable Option for the Canadian Navy

Article by Cdr Marc Batsford
Images courtesy the author, except where noted

The Canadian navy's AOR oiler replenishment vessels and *Iroquois*-class anti-air-warfare and command and control destroyers are nearing the end of their technical life expectancies. If the Canadian navy is to sail effectively into the 21st century, new ship-building programs will have to produce ships that meet or exceed current naval standards in speed, manoeuvrability, noise and magnetic profiles, survivability and maintenance. However, limited fiscal resources demand that innovative and economical means of putting new ships to sea be found. Emerging maritime technology such as pod propulsion may provide some workable solutions.

Pod propulsion is a relatively new and growing maritime propulsion technology that has been successfully used in commercial applications. Based on an electrical generation and distribution system, pod technology offers unique advantages over conventional electric propulsion plants which use internally mounted electrical motors, shaft lines, steering gear and rudder systems. Pod propulsion uses an electric motor encapsulated in a hydrodynamic pod that is strut-mounted on the ship's external hull (*Fig. 1*). A propeller is mechanically connected to the motor, which is powered by the ship's electrical system. At present, pod units are available from one to 30 megawatts (MW) to satisfy varying power requirements dictated by hull form, propeller size and propeller configuration. This technology offers a viable and economical alternative propulsion option for the Canadian navy.

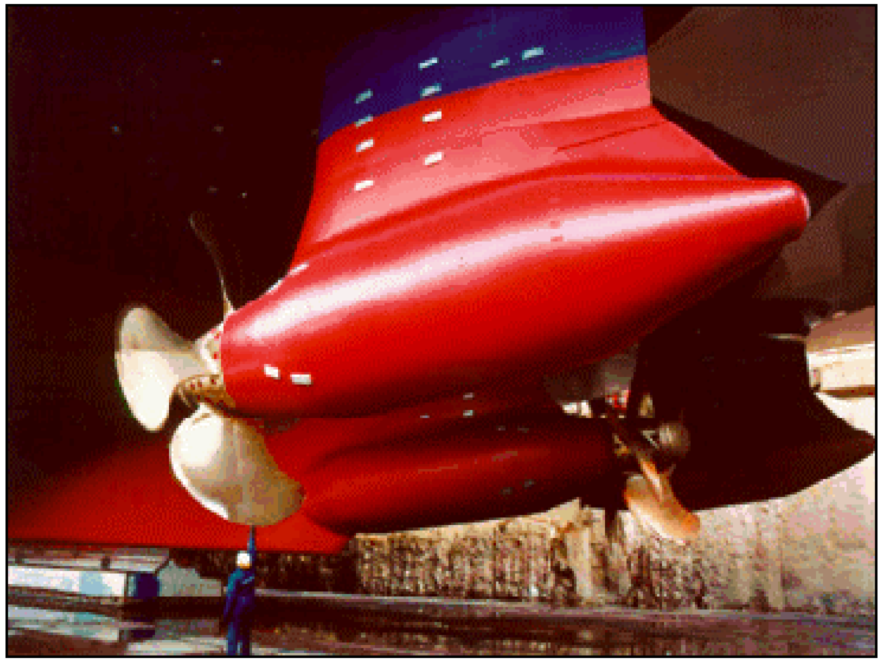

Fig. 1. An electrically powered pod propulsion system, such as the three ABB Azipod® units installed on the Royal Caribbean cruise ship *Voyager of the Seas*, offers unique advantages in the simplicity of its design. In this configuration, the port and starboard units are fully azimuthing, while the centre unit is fixed. *(Copyright 2002 ABB)*

Design Benefits

The pod propulsion system is unique in its simplicity of design. It is an electrically powered propulsion unit that can be installed on any size naval, commercial or service vessel. The pod, which is strut-mounted on the ship's external underwater hull, is usually located in the vicinity of the stern or "after-cut" of the ship. Within the pod is a single- or double-wound AC electric motor mechanically connected to a hydrodynamic fixed-pitch propeller. An AC motor is used because of its smaller size and weight compared to the DC variant. The motor is powered by any electrical generation source (e.g. diesel, steam or gas-turbine generators), controlled by a frequency converter, and has full torque available to it in either direction, from stop to maximum design speed. The propeller may be installed either in front of or behind the electrical motor, which determines whether the ship is pushed or pulled through the water.

Pod propulsion units require relatively few support systems compared to conventional diesel-electric propulsion plants. Pod systems have their cooling, motor and hydraulic controls all contained within a single hull compartment directly above the unit. An oil seal and bilge pumps ensure watertight integrity. Steering through 360 degrees is achieved by rotating or "azimuthing" the entire pod. The pod control station, normally located on the bridge, uses wheel and joystick controls. A backup, or secondary, control posi-

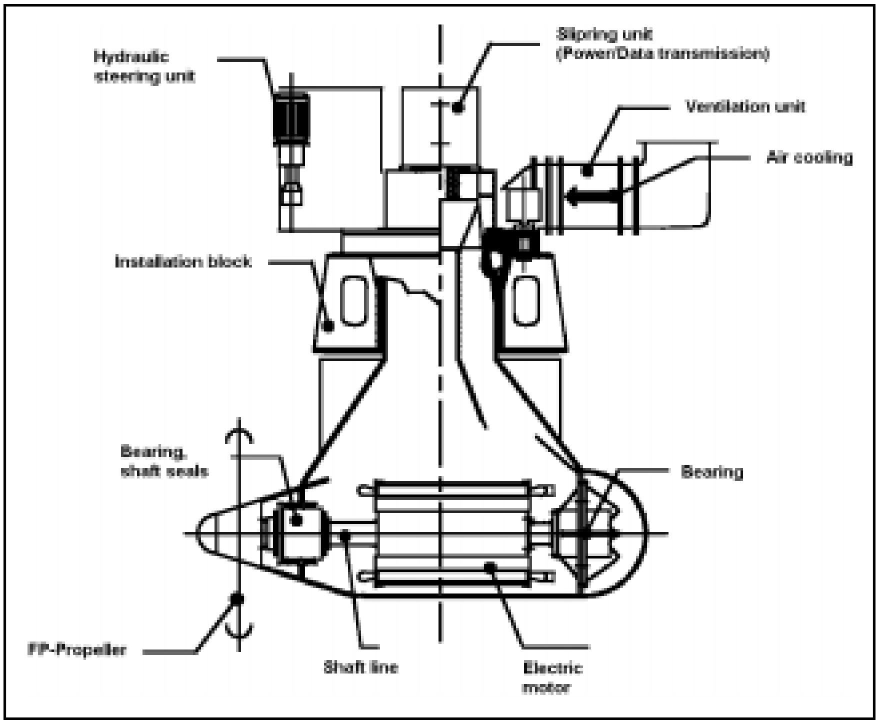

Fig. 2. Cross-section of ABB's Azimuthing Podded Drive (Azipod®). The unit incorporates an electric AC motor which directly drives a fixed-pitch propeller. *(Copyright 2002 ABB)*

tion is provided in a location specified by the ship's owner, while a third control position is situated in the pod compartment along with the ancillary equipment. Finally, each pod is provided with an independent multi-pump pack in the pod compartment as a final means of pod control.

Conventional electrical propulsion systems use an internally mounted electrical motor, which eliminates the need for lube oil systems, complex gearing, associated clutches and long shaft lines. Pod propulsion systems continue this simplification by precluding all shaft lines, thrust bearings, stern thrusters, stern tubes and seals, rudders and steering gear. This reduction in main and ancillary machinery allows increased payload, better crew accommodation and room for future operational growth. Between the conventional diesel-electric, diesel-direct, and pod-propulsion/diesel-electric choices, the option with the smallest space requirement is pod propulsion. Because the equipment is not centred on the hull or restricted to set shaft lines, the ship designer has the flexibility to locate machinery components throughout the ship, facilitating redundancy and maintenance. (See *Fig. 2*.)

Although not unique to pod propulsion, redundancy is realized by the decentralized location of the ship's prime movers and electrical distribution systems throughout the ship, improving system availability during battle damage. In terms of maintenance, electrical pods are ideally suited for the Canadian navy's repair-by-replacement philosophy. The prime movers can be located within reach of a weatherdeck soft patch to facilitate access for maintenance, and the pods themselves are designed so that pod or propeller alone can be replaced while the ship is still in the water, obviating costly and unscheduled docking procedures. Pod propulsion offers the potential to optimize the number of different prime movers, thereby generating economies in personnel training, maintenance and spare parts requirements. Finally, this technology provides for significant operational growth if sufficient electrical generation capacity is considered during construction or mid-life refit. The advantage of having electrical generators of varying power capacities offers the ship's staff the opportunity to load the ship's electrical generation and distribution system in a more flexible and efficient manner. The result is greater operational flexibility, while maximizing system performance and fuel economy.

Shiphandling Characteristics

A pod system's exceptional manoeuvrability is due to the unit's ability to rotate through 360 degrees about the vertical axis (i.e. azimuth), and to the torque available in both forward and reverse. Pod speed is controlled through a frequency converter, which allows the operator full power in either direction. Electrical pod propulsion has demonstrated excellent torque characteristics throughout its power range, which ensures rapid speed response and acceleration which are essential during poor weather or restricted manoeuvring. Because the pod can be rotated, manoeuvrability is improved at low speeds and during critical ship operations such as replenishment at sea, restricted navigation passages, and leaving or coming alongside a jetty.

A pod-propelled ship can be stopped almost immediately by reversing the direction of the propeller, or by rotating the pod 180 degrees. Reversing the propeller to maximum thrust in the opposite direction requires only 10 to 20 seconds. The net reverse thrust generated by a fixed-pitch-propeller pod is approximately 60 percent to 80 percent of the thrust generated in the forward direction. However, 100-percent thrust in reverse is available by rotating the pod 180 degrees — a quick manoeuvre that does not impede steering capability. This leads to greater safety and easier vessel handling, while eliminating the need for a more complex controllable reverse-pitch propeller, or a reversing clutch system.

Using the pod system for steering significantly improves a ship's manoeuvrability compared to using conventional steering gear and rudder systems, especially at low speeds. A podded ship's turning circle performance is better because maximum thrust is possible in any direction. A 180-degree rotation of the pod unit takes just 20 to 25 seconds, similar to the time required for a *Halifax*-class frigate rudder to go from full port to full starboard.

Performance Characteristics

Pod propulsion offers attractive performance benefits over more conventional propulsion systems, especially in the areas of ship noise, hydrodynamic efficiency and fuel economy. The elimination of long shaft lines, support bearings, stern tubes, cooling water bays and other underwater protrusions — typical with conventional systems — creates a smoother laminar flow over the hull and propellers. Not only does this result in reduced drag and improved propeller efficiency, which translate into better fuel economy (as confirmed through tests at the Carderock Division of the US Naval Surface Warfare Center in Bethesda, Maryland), it allows the ship to achieve a significantly higher speed before the onset of cavitation. At the same time, the cleaner underwater hull profile and the pod's fewer mechanical ancillary support systems located within the hull reduce the ship's external/internal noise and vibration profiles. Together, these attributes greatly enhance the operational efficiency of a pod-propelled ship in an antisubmarine warfare role over that of a conventionally propelled ship.

Propeller size and configuration have a significant impact on the performance characteristics of a pod unit. Manufacturers produce a variety of systems, both with the propellers mounted on the front of the pod (known as a "pulling" variant) and on the rear (the "pushing" variant). The "pulling" type pod has displayed certain advantages over its counterpart. Tests conducted by the US Naval Surface Warfare Center revealed that, depending on hull form, two "pulling" type pods with forward-mounted counterrotating propellers can potentially increase cavitation inception speed by up to seven knots and provide a 28-percent reduction in power consumption. These improvements are attributed to there being no shaft or strut bearings in front of the propeller, which allows a consistent and undisrupted flow of water over the leading edge of each propeller blade.

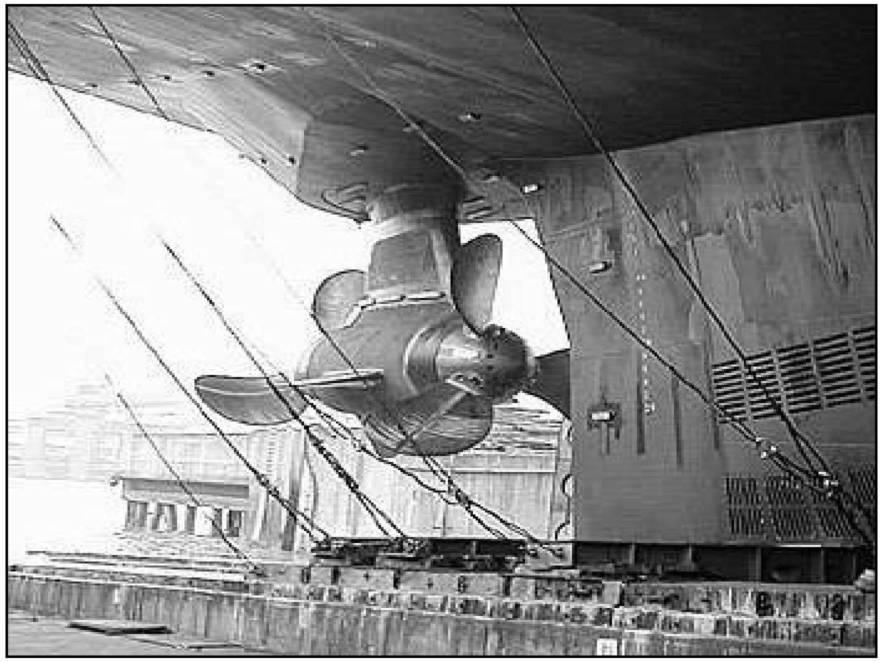

Fig. 3. The double-ended Siemens-Schottel SSP Propulsor pod unit mounted on this bulk carrier may make a strange sight with propellers mounted at each end of the pod, but the unit has demonstrated a 10-percent reduction in energy consumption over conventional diesel-electric propulsion systems. *(Courtesy Siemens-Schottel)*

Pods are normally located outside of the hull wake, which further ensures the uniformity of hydrodynamic flow through the propeller. A pod that utilizes a double propeller configuration (*Fig. 3*), with one propeller mounted in front of the motor and the other mounted behind, has undergone both tank tests and full-scale testing. Energy consumption by the pod was found to be 10 percent lower than that of conventional diesel-electric plants, which may translate into greater fuel savings or greater available speeds. Although the cavitation and energy savings data will vary from one hull form to another, pod units show significant improvements over conventional electric-propulsion systems.

Internal noise reduction is another advantage of pod propulsion. Without main reduction gearing, shaft lines and stern thrusters, there are significant reductions in internal noise and vibration. The pod propulsion system is powered by an electrical generation and distribution system that can be installed on an acoustic double-raft mount system within an acoustic enclosure. This raft system is acoustically isolated from the ship's hull, thereby minimizing hull-borne machinery noises. It can potentially be mounted high up within the ship's structure and away from the waterline so that internal hull noise transmitted into the water is minimized. The acoustic enclosure/double-raft mounting is proven technology that has been successfully applied to many classes of warships; notably, the Canadian patrol frigates.

POD Propulsion Proven in Use

There are a number of companies producing pod systems. While manufacturers are quick to point

Carnival's MS *Elation*: Several cruise lines have chosen pod propulsion for their newest ships. *(Photo by Andy Newman, Carnival Cruise Lines)*

out that ship's speed is proportional to pod size, performance also depends on hull form, hull displacement, propeller design and diameter, propeller location (pushing or pulling variants) and configuration (whether there are one or two propellers, and whether they rotate in the same direction or counterrotate).

ABB Azipod, an affiliate of Kvaerner Masa Yards in Finland, manufactures the Azipod®, or Azimuthing Podded Drive. The ABB Azipod system has been used in commercial shipping, roll-on/roll-off ferries and cruise liners. Carnival Cruise Lines Inc. recently contracted for the construction of eight *Fantasy*-class passenger cruise liners. The first six were equipped with conventional diesel-electric machinery with standard shafting arrangements, but the last two ships were delivered with pod propulsion systems. The twin 170-ton, 14-MW Azipod units installed on the 70,000-ton ships (MS *Elation* pictured above) provide a speed of 22 knots. Had 25-MW Azipod units been chosen, it is estimated that the maximum ship speed would have been 27 knots.

German shipbuilder Meyer Werft has been consigned by Royal Caribbean International (RCI) Cruise Lines to build two podded cruise ships for delivery in 2001 and 2002. At 324 metres in length and displacing 136,000 gross tons (gt), these will be the largest cruise ships ever built. Each will be equipped with three ABB Azipod units.

The SSP Propulsor, designed, engineered and produced by Siemens AG Marine Engineering and Schottel-Werft Josef Becker GmbH & Co., features a permanently excited motor and a second fixed-pitch propeller located at the other end of the pod (*Fig. 3*). The second propeller shares the load equally, thereby maximizing the productivity of both propellers. The permanently excited motor makes use of permanent magnets that replace conventional rotor poles. This allows for an increase in propulsion efficiency over conventional electrically excited synchronous motors, and allows the pod's electric motor to be smaller and more compact. The magnets are also more efficient as there is no requirement for an exciter to provide power to the rotor. The SSP propulsor is available from five MW to 30 MW per unit.

Propulsion tests of two 14-MW SSP propulsors were carried out in tank tests at the SVA Tank Tests Institute in Potsdam, Germany. The 70,000-gt cruise vessel *Century*, built in 1995 by Meyer Werft, was used as the reference vessel for the these tests. *Century* has a conventional diesel-electric propulsion plant of two 14-MW shaft lines and a design speed of 22 knots. The test results indicated that the SSP pod propulsion unit's power consumption was 10 percent less than that of *Century's* power plant, implying a potential fuel saving of 10 percent, or an increase in speed of 0.5 knots.

American Superconductor Corporation of Westborough, Massachusetts has made a significant development in the superconductor motor which will have significant benefits for pod technology. The new motors are more efficient and smaller in design and weight than conventional electric motors. Superconductor motors will be available in both AC and DC variants, and will most certainly be seen as potential replacements for the larger pod motors used today.

One risk associated with pod propulsion was recently identified when one of the Carnival Cruise Line ships equipped with pod propulsors was docked because of a lip-seal defect which caused salt-water contamination and failure of the pod electric motor. ABB Azipod is studying the defect to determine the cause and correct the problem.

For the Canadian navy, a further risk is the lack of information on how an electrical pod would affect a ship's magnetic signature. Although considerable research has been conducted on such aspects as cavitation, efficiency and noise characteristics of pod propulsion technology, very little work has been done on the magnetic signature effects of pods.

Conclusion

Pod propulsion is an attractive propulsion system due to its flexible design, shiphandling and performance characteristics. It is emerging as a proven technology that facilitates greater design flexibility by distributing the electrical generation and distribution system throughout the ship. This decentralized machinery layout enhances redundancy in the case of a naval ship experiencing battle damage. Further, the design of the ship is not focused on traditional shaft lines. The elimination of lengthy and technically complex shaft lines, rudders, steering gear equipment, stern tubes, gearboxes and supporting ancillary systems reduces machinery space requirements and maintenance envelopes. From a maintenance perspective, a pod unit can be replaced while the ship is in the water, thereby making it ideal for the repair-by-replacement philosophy of the Canadian navy. Steering and manoeuvrability capabilities are greater than those of conventional systems as the pods will rotate in 360 degrees, providing thrust in any direction.

Pod systems have demonstrated a reduced external noise profile due to fewer external hull appendages. Internal noise and vibration reduction are achieved by housing fewer moving components within the ship. Power generation for the pods may be acoustically mounted and enclosed. Such a naval platform is ideally suited to all naval operations and particularly antisubmarine warfare functions.

Pod technology has already made significant inroads in the commercial shipbuilding industry. This new technology offers many unique advantages not offered by conventional electric propulsion systems. Pod propulsion is undoubtedly a viable option for future shipbuilding programs for the Canadian navy.

Cdr Batsford is a graduate of Command and Staff Course 27 at the Canadian Forces College in Toronto. His paper was written to fulfil one of the curriculum course requirements. Cdr Batsford is now working as a member in the Department of National Strategic Studies at the College.

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Risk Management for Project Managers

Article by M.F. Dervin

The concepts of risk management apply to virtually all planned activities, from organizing a little league baseball tournament to mounting a NASA space mission. Project managers are risk managers. Thus, they must prepare for and deal with risk. As an introduction to the broad topic of risk management, this paper discusses a simple process for identifying and dealing with risk from a project management perspective.

The criticality and complexity of a project and its associated dollar value determine the formality and level of detail needed in a risk management plan. Direct cost and schedule risks typically are what come to mind regarding project risks. However, other types of risk must also be considered and evaluated in terms of their interrelationships and implications. For example:

• *Project achievability* encompasses scope, quality and performance issues in light of constraints and the desire to be innovative by taking advantage of new or developing technology. (Remember, the flip side of risk is opportunity.)

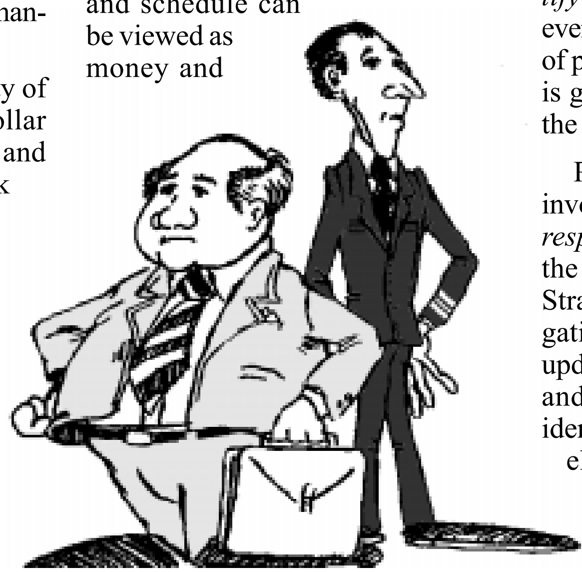
• *Availability of resources* addresses materials and equipment, facilities, in-house expertise and the engineering tools/means to check a contractor's proposal/work/product, the availability of qualified contractor personnel, Canadian content requirements, etc.

• *Organizational issues* for both DND and the contractor would cover such possibilities as multiple competing demands on personnel, changes of priorities, personnel morale, the likelihood of a strike, physical or philosophical reorganization, and, for the contractor/subcontractors — bankruptcy.

• *Process selection* addresses the ramifications of different strategies for design, manufacturing, procurement, contracting, in-service support, etc.

• *External factors* include changing regulations, a change of government, or an environmental catastrophe.

Although all of these will directly or indirectly affect a project's cost and schedule, in a broader sense, cost and schedule can be viewed as money and time resources that fall under "availability of resources." As a project manager, this broader perspective is necessary if for no other reason than to identify sources of risk to a project's cost and schedule. All risks associated with the project should receive due attention, including potential risks to the organization and the implications for DND, industry and the country. This is not to say that all risks should be treated equally. An assessment of the likelihood and ramifications of each risk will combine to determine the appropriate level of attention.



There are many formal definitions of risk management available from such organizations as Treasury Board, the Project Management Institute and the Software Engineering Institute. Common to all of them, however, is the concept that risk should first be assessed, and that a risk containment plan should then be developed and implemented.

Risk assessment normally involves *identifying* the risks which are likely to affect a project (and documenting their characteristics); and then *quantifying* or evaluating the risks and event interactions to assess the range of possible outcomes. Consideration is given to both the probability and the implications of each risk.

Preparing a risk containment plan involves developing a set of planned *responses* to the occurrence, or even the threat of an undesirable event. Strategies for preventing and mitigating risk must be developed and updated, with contingencies built in and possible workaround options identified. The plan also involves an element of *response control* to respond to events that could elevate risk over the course of the project. By monitoring trigger points (indirect or direct warning signs) of an impending risk, the project team can follow through on response strategies to prevent, block, mitigate or work around the risk. Being flexible, willing to compromise and seize opportunities is key to effective risk response control.

An effective way of managing and documenting risk management activities is to develop a risk matrix, database or book. This is a living document that should be evaluated periodically and updated to reflect changing circumstances and ensure that new risks are identified. Within the matrix, identified risks are listed by category, with each risk quantified and response actions spelled out. Unforeseen risks, which are

Identification	Quantification			Response		
(Descriptive Information)	Probability Rating	Impact Rating	Risk Index (Ranking)	Preventive Measures	Trigger Points	Resolution Actions

Fig. 1. Suggested risk matrix format

documented as they occur, are typically dealt with through technical margins and contingencies in the form of unallocated slack in the schedule and reserve funds.

In developing a risk matrix the project manager has to consider the interrelationships of various elements within the scope of the project and the organization, and factors external to both. Although the project manager has little if any control over organizational and external factors, they can present real risks that must be anticipated and planned for. A suggested heading format for a simple risk matrix is illustrated in *Fig. 1*. Naturally, this can be expanded as required to include columns/fields for each risk to identify timing implications, assigned responsibility, status, date last reviewed, date of next review, and so on.

Identifying Risk

The first step in building a risk matrix is identifying potential risks. Brainstorming sessions among the project team, interviewing subject matter experts and reviewing lessons learned from past projects are good techniques for identifying sources of risk. Brainstorming by risk categories is a useful technique to force one to look at the problem from different perspectives. With the risks identified, they can then be grouped as desired to best facilitate prioritization, classification, control and reporting. One possible grouping with example risks is illustrated in *Fig. 2*.

An alternative grouping is suggested in the *Defence Management System Manual* as follows:

• External risk factors — those that project management cannot control, including externally imposed deadlines, currency fluctuations, co-operative development obligations, and statutory requirements; and

• Internal risk factors — those that project management can control, including the allocation of adequate resources, performance risk, the reliability of cost estimates, and schedule and technical risk.

The project manager must also address "strategic" risks that directly threaten the entire project rather than limited aspects of it. One example of this would be a technology revolution that either obviates the need for the product, or antiquates the implementation method.

Quantifying Risk

Risk quantification can be done several ways and usually accounts for both probability of occurrence and the seriousness of consequences. A rating of low, medium or high may be sufficient to determine the degree of attention to be paid to a particular risk. More sophisticated approaches essentially add complexity, but offer greater visibility of how the rating was derived, and facilitate mathematical analysis.

For example, a risk index value could be calculated by assigning a probability rating (from 0 = unlikely, to 1 = very likely), and multiplying it by an impact rating (from 0 = insignificant, to 1 = catastrophic). This could be enhanced to also factor in a time frame (imminent to distant) to help develop containment strategies.

One variation that links the risk directly to cost is the *expected monetary value*, where EMV = cost x probability. However, EMV considers the impact only in terms of money and ignores schedule, quality, performance, morale, etc., unless these can be quantified in dollar terms. Where justified for large or complex projects, computational tools that include statistical analysis algorithms are available to assist the project manager in quantifying, analyzing and combining risks to determine overall project risk.

The project manager also has to recognize that multiple individual risks tend to compound, which significantly adds to the likelihood and seriousness of a negative outcome. For example, it is not difficult to imagine the potential for mayhem if multiple new technologies were being introduced in a fixed-schedule project that was also facing the risk of staff shortages.

Response to Assessed Risks

Preventive measures typically take the form of research and development to address unknowns. This can be as simple as making a phone call to verify something, or as complex as conducting extensive engineering analyses, model tests and full-scale mock-up simulations.

A list of trigger points in the matrix gives the project manager focus and helps indicate when action is required. Possible trigger points might be reached when margins are used up quicker than planned, key personnel indicate they are leaving, or NATO proposes new interoperability requirements. Trigger points can even be set up as a "fault trees," so that instead of a single event prompting a risk response action, the trigger is actually a sequence of events which, if left unchecked, would result in an undesirable outcome.

Response actions normally include mitigation and workaround strategies — typically, identifying ways of reducing the probability of a specific risk occurring in the first place, identifying options in the event of a risk presenting itself, and adjusting the schedule wherever possible after the fact to minimize the impact of any risk on the project. Transferring risk, although a strategy, does not resolve the problem. Passing the risk along to a contractor will not remove the consequences of the risk to the project. Insurance policies and litigation may compen-

Project Achievability – Goal/Scope/Quantity/Feasibility

- Possibility of unknowingly specifying unachievable performance requirements within the specified physical constraints (size, deck area, arrangement, etc.).
- Requirement changes, or design, system or equipment change not totally compatible with original configuration.
- Weight growth margins (stability or strength) used up.

Availability of Resources – Time/Money/People/Facilities

- Retention of key personnel within the organization.
- Adequate funding early in the project for option analysis.
- Insufficient lead time for project planning.

Organizational Issues – Priorities/Morale/Reorganization

- Competing demands on DND personnel.
- Reorganization/relocation of DND units.

Process Selection – Strategies/Methodologies

- Fixed price vs. cost-plus contract.
- Commercial off-the-shelf product, but imposing some military standards.
- Contracting-out engineering support.

External Factors – Regulations/Environment/Third Party

- Regulation change.
- Intended equipment no longer available.
- New NATO requirement for interoperability.

Fig. 2. One way of grouping a project's risks

sate for loss, but they do little to keep a project on track.

Risk Management Techniques

In terms of factors internal to the project, the project manager has several management tools and techniques that build on and feed into the risk matrix. Gantt task scheduling charts and PERT task network flowcharts can be used extensively to:

- identify and organize tasks (the work breakdown structure), including milestone and decision points;
- indicate assigned responsibility for each task;
- show the anticipated and actual time needed to complete each task;
- construct/determine the connectivity or relationship between tasks (the critical path being of greatest significance);
- develop schedules and budgets for the total project, or by various levels of task/activity groupings to aid personnel and financial resource loading and levelling; and
- generate charts and reports disclosing project progress and forecasts.

For engineering projects in particular, there are several formal analysis processes that can be used to help identify and evaluate risks. Some of the more common ones include failure modes and effects analysis, criticality analysis, fault tree analysis, mistake proofing, safety hazard analysis, threat and risk assessment, and failure reporting and corrective action systems.

All of these activities can be viewed as part of risk management. Developing the work breakdown structure and determining the critical path is a means of identifying what and where something might go wrong and its implications for the project. The risk analysis will help set expected, optimistic and pessimistic predictions of time and cost estimates, which in turn will help quantify schedule float and budgetary contingency. Sophisticated software programs designed for this purpose (e.g., *ProAct, RiskTrack, RISKMAN,* and Microsoft Project's *Risk+*) allow the project manager to play out various "What if?" scenarios supported by statistical and probability analyses to better identify trigger points and develop risk mitigation and workaround strategies.

Current project management philosophies stress the value of risk management to improve product quality, use of resources and the likelihood that the project will be completed on time and on budget. In the federal government all projects in excess of $100 million are classified as major Crown projects. Treasury Board assesses these projects as high risk and requires formal and elaborate evaluations of project-associated risks. However, there is risk in even the smallest projects, and project managers must consider risk as part of every project plan.

As a closing comment, it is important to facilitate effective communication among project team members and management to ensure that risk information flows freely without fear of blame, and without pressure from team members or management to downgrade a risk issue. In addition, the project manager charged with overall responsibility for conducting risk management, and the individuals who are assigned responsibility for specific risks must have access to the necessary resources of time, personnel, tools and funds to effectively assess and respond to the risks inherent in their project.

Acknowledgement

The author wishes to thank Bernard F. Hough, an executive scientist with Computer Sciences Canada Inc., and a respected author and lecturer on risk management. His comments and advice were most helpful in the preparation of this paper.

Mr. Dervin is a project manager, naval architect and marine engineer working in MEPM/DMSS2 (Ship Systems Engineering) as the department's Hydrodynamics Systems Engineer.

On Exchange:

Building DDG-51 *Arleigh Burke*-Class Destroyers with the USN

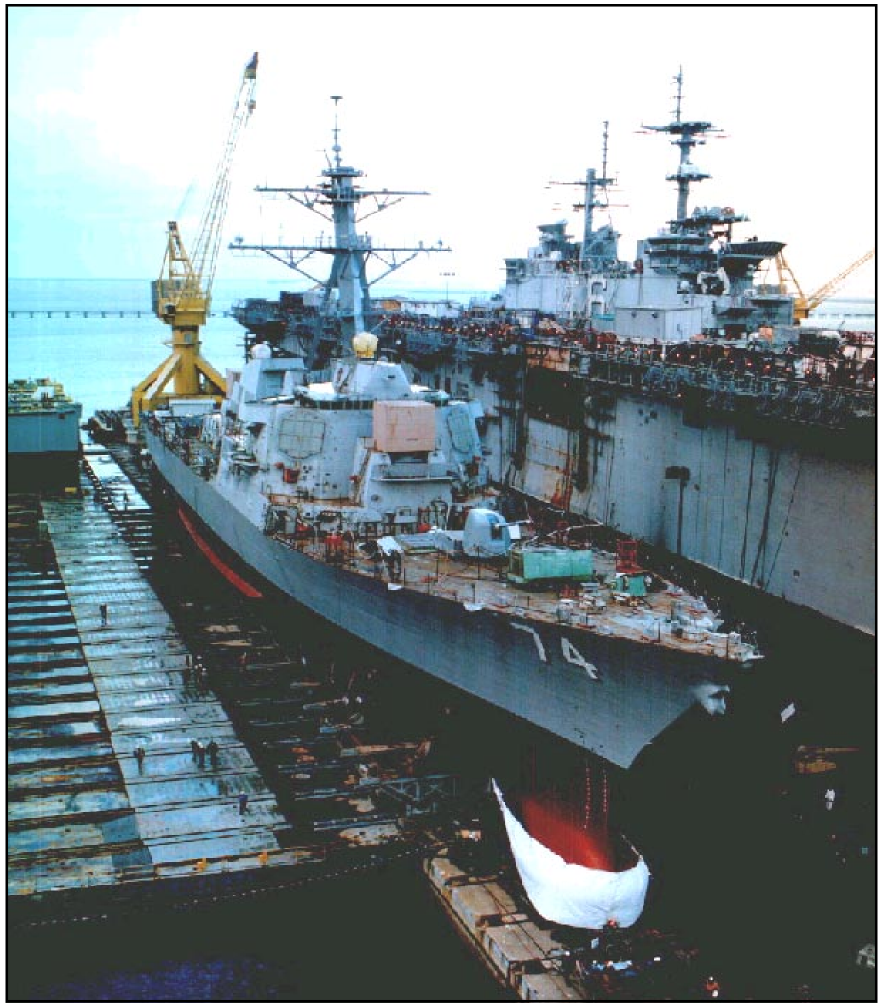
Article by Cdr Paul Catsburg

In classical Greek mythology the aegis was the impenetrable shield of Zeus. In modern day US naval parlance, "Aegis" refers to the overall weapon system of the CG-47 *Ticonderoga*-class cruisers and DDG-51 *Arleigh Burke*-class destroyers — primary defenders of the US Navy's carrier battle groups.

The 8,900-ton DDG-51 destroyer is the USN's latest surface combatant. It has all the capabilities of its parent CG-47 *Ticonderoga*-class, but with less displacement and a minimized topside deckhouse volume. The finished product is impressive: a warship that will project naval sea power with excellent seakeeping, low detectability and high survivability. What's more, the DDG-51 project is providing a unique and invaluable exchange opportunity for the Canadian navy to participate in a world class ship engineering and construction effort.

The exchange duty, which is located in Pascagoula, Mississippi, presents a challenging assignment for a Canadian naval engineer. The position calls for a LCdr MARE Marine Systems officer with head of department experience to oversee the contract administration, waterfront construction, validation and crew activation of *Arleigh Burke*-class destroyers for the United States Navy. For a MARE with an affinity for industrial work, becoming an integral part of a major project team involved in engineering, building, testing and delivering state-of-the-art ships is as good as it gets.

Canada got involved in this project by virtue of a longstanding exchange of officers between the Canadian and US navies. In July 1996 the exchange position was moved from the downsized US naval shipyard in Philadelphia, Pennsylvania, to the Northrop Grumman Ingalls Shipbuilding facility in Pascagoula, situated on Mississippi's Gulf coast. Pascagoula has a proud history of naval production that includes numerous classes of submarines and surface ships, including the DDG-51 *Arleigh Burke* class.



USS *McFaul* (DDG-74) in the Ingalls Shipbuilding floating drydock at Pascagoula, Mississippi. *(Photo by Peter Christman, courtesy Ingalls Shipbuilding)*

Supervisor of Shipbuilding — A Different Perspective

The Aegis destroyer program is headquartered in Washington, DC, with lead yard at the Bath Iron Works in Maine. The Northrop Grumman Ingalls Shipbuilding facility in Pascagoula is the follow yard and has so far delivered 14 of the 25 ships of the DDG-51 class. The program manager in Washington has an on-site representative in Pascagoula, a USN

The ship construction cradle for the USS *McFaul* rests on a series of electric trolleys that will eventually transport the fully assembled DDG into the floating drydock for launch and final outfitting (see photo on previous page). *(Photo courtesy Ingalls Shipbuilding)*

commander charged with the day-to-day responsibility for getting the ships built to the navy's specifications. The Canadian exchange officer reports to this USN on-site representative.

As a Canadian naval officer I brought a different perspective to the Aegis program, but soon discovered that special treatment for me would not be part of the experience. From the start I was treated as an equal and given the responsibilities of ship superintendent, which were commensurate with my training and experience. In Canadian terms, the job equated to that of a naval overseer/project officer for a particular vessel. The ship superintendent is directly responsible to the program manager's representative for the construction, sea trials, delivery and sailaway of an Aegis destroyer — in my case, the USS *McFaul* (DDG-74).

My primary responsibility was to act as the central point of contact for all production and engineering matters relating to the vessel. This required establishing and maintaining excellent relations with the contractor, program office staff from Washington, on-site project team personnel, a multitude of support subcontractors, and the vessel's precommissioning crew. The on-site naval project team is a closely knit group of military and civilian professionals who work at the waterfront from the start of fabrication until the vessel leaves the contractor's facility. Nominally, it is their job to oversee all activities during the two-and-a-half-years and roughly three million labour hours of vessel construction and activation.

As the ship superintendent I was specifically responsible for monitoring and reporting production status, and for ensuring that a quality product was built in accordance with contract specifications. In practical terms I had to identify potential technical problems, assess their criticality and propose co-ordinated solutions. A fundamental aspect of the job involved incorporating approved engineering changes in a timely and cost-effective manner. The superintendent's position is not unlike that of the football quarterback, where in the shipbuiding context you are charged with ensuring that the defence/contractor team works together to deliver the best possible product on time and preferably under budget. The end result is a $950M (US) state-of-the art guided missile destroyer ready to join the US naval fleet.

The Construction Process

The overall DDG-51-class construction process is similar to that used to build the Canadian patrol frigates — modular construction with initial outfitting and equipment installation early in the building process. In the same way that the CPF program benefited, the Aegis program takes advantage of pre-outfitting to maximize manpower employment and facilitate material handling during the assembly sequence. Again, in a process reminiscent of the CPF construction, the assemblies are integrated into grand blocks which are then erected and joined. One significant difference is that, where the CPF assemblies were lowered into a drydock to be joined, the Aegis ships are built in a cradle on a shore-level "transfer facility" and transported fully assembled into a floating drydock for launch and final outfitting. The cradle actually rests on a series of electric trolley cars which move synchronously along a shipyard-wide railway grid system to transport the ship into the floating dock. The entire transfer process takes 12 to16 hours.

The ship, which is roughly 70 percent complete at this point, is floated-up within a day or two and named during a traditional christening ceremony. Sea trials are now about one year away. As final outfitting continues, systems integration and testing move into full swing, while the propulsion system alignment and engineering support systems are readied for initial startup or "light off." Combat systems testing, particularly with respect to the Aegis system, begins approximately six months prior to the first sea trial because of the complexity of the systems and the certification requirements. After a rigorous set of sea trials, the supervisor of shipbuilding accepts delivery of the ship for the navy and transfers custody to the ship's first captain. The crew has by now been trained in shipboard operations, examined by a separate USN examining body, and certified for sailaway and commissioning.

On the Waterfront

After successfully completing the USS *McFaul* in April 1998 I was "fleeted-up" to the position of Aegis production officer, making me responsible for overseeing up to six destroyers at once in various stages of production. The move was partially due to personnel shortages, but primarily based on my experience in the superintendent's chair. The challenge now was to use my recently acquired knowledge to lead other ship superintendents and production teams through construction and activation of their respective hulls.

A typical summer workday started early, at 6:00 a.m. After a 20-minute drive from my residence in nearby Ocean Springs, I would arrive at my trailer office in the shipyard to begin the day's work by reading the e-mail and sorting out the workday schedules. This was followed by a short meeting with my senior production staff to discuss any significant events or challenges for the day. From that meeting I would move into a production meeting with the contractor and ship's crew, and a tour of associated production areas to monitor progress and resolve any immediate issues.

After lunch I would be involved with such activities as crew liaison, reviewing proposed engineering change requests, co-ordinating on-site field engineering solutions, negotiating contract modifications with the contractor's staff, working the quality assurance reviews, and getting prepared for the weekly and quarterly production updates to senior management. The days in the shipyard were never the same, and the volume and diversity of work ensured that all personnel were actively engaged in the shipbuilding process. My best day at the shipyard was during the final phases of the contractor's sea trials for the USS *Roosevelt* (DDG-80). With senators, congressmen and admirals on board, the ship's excellent performance confirmed all the hard work we had put into it and gave us a tremendous sense of satisfaction and pride.

In many ways the USN DDG-51 build program was reminiscent of our own patrol frigate program. Downhand construction and extensive pre-outfitting were very much the order of the day. ***(Photo by Robert Cole, courtesy Ingalls Shipbuilding)***

Official work hours ended at 3:00 p.m. due to the daytime heat build-up, although overtime was occasionally required to ensure that events on second or third shift were properly overseen. Where complex systems and sophisticated equipment are involved, nothing can be taken for granted. And then there were the forces of nature to contend with.

From June to November there is an everpresent threat of hurricanes. In September 1998 Pascagoula experienced a full-blown category two hurricane, *Georges*, that devastated the Caribbean and made landfall on the US Gulf Coast. Fortunately, there was sufficient warning to mount a successful evacuation, and damage to our neighbourhood and rental housing was slight. The decision to evacuate is always highly subjective due to the unpredictability of landfall. In this case, however, a very large area was potentially affected — from Lafayette, Louisiana to Pensacola, Florida. Approximately 500,000 people were on the move in a 24-hour period, and my family was fortunate to secure hotel accommodation in Beaumont, Texas. Due to extensive flooding and infrastructure damage on the coast we were kept out of our neighbourhood for five days, and the shipyard remained shut down for two weeks for various repairs and a major cleanup.

Life on the Gulf Coast

Exchange duty offered an excellent opportunity to learn from another navy, increase my professional experience, and also enjoy different surroundings and culture. Southern hospitality is definitely alive and well on the Gulf Coast, and the warm climate is something you acclimatize to after an initial transition period. Summers are very hot, with daytime highs in the mid-thirties Celsius with correspondingly high humidity. Winters are much cooler, with infrequent freezing spells. For golfing enthusiasts the courses are open year-round.

Life on the Gulf Coast is a cultural experience second to none. During the last five years Mississippi has seen an influx of major casino and resort developments, and right on the beach in neighbouring Biloxi you can enjoy outstanding world-class entertainment and food. New Orleans, a two-hour drive away, is an easy destination for fun and exploration. The annual Mardi Gras parades and parties that are an integral part of life on the Gulf Coast are celebrated from Mobile, Alabama through to Louisiana. Travel eastward leads to the beautiful beaches of Alabama and western Florida, and you can get to Orlando-area attractions in about 10 hours by road.

The coast also boasts a fine array of seafood, from jumbo shrimp to redfish, sharks, crayfish also known as "mudbugs," tuna, catfish and other Gulf Coast sea fare. For the sportsman, half the fun is getting out and chasing your own dinner while remaining vigilantly aware of weather, in particular the frequent thunderstorms. The outdoorsman must also be keenly aware of natural hazards such as alligators, poisonous snakes and spiders. These are all part of the rich landscape of the southern states and we taught ourselves to be aware when visiting the bayous. Fortunately our encounters with alligators and cottonmouth snakes were all from a distance.

Exchange duty offered an excellent opportunity to learn from another navy. The SUPSHIP mil/civ team at the Ingalls Shipbuilding facility in Pascagoula, Mississippi was a dedicated group of professionals, and it was a privilege to join them as an integral player. To my left are: LCdr Mark Vandroff, USN; Cdr Steve Metz, USN; Pete Christman; P1 Richard Collins, USN; Robert Cole; CPO John Mitchell, USN; P1 Jeffrey Young, USN; Cathy Turner; Senior Chief Nathan Hale, USN; and Buddy Arnold. ***(Photo courtesy Ingalls Shipbuilding)***

Community involvement and support are a large part of the USN's good neighbour policy. The variety of extracurricular activities available included charity events and fundraising for the community, leading cub scouts, coaching minor sports and conducting tours for school and interest groups. These activities enhance the local community and promote the USN as an integral and valuable member of the community. My entire family was involved in these community activities which resulted in many strong and lasting friendships.

Summary

The opportunity for this three-year posting came from my career manager. Having had experience in Canadian shipyards, particularly in Saint John, this job was right up my alley and was right in line with my annual requests via the career management system. In the end, I was asked to stay with the project for an additional year as production officer. This allowed the USN to capitalize on my experience as we completed the design integration of the twin helicopter hangar and helicopter handling capability in USS *Roosevelt*, another highly demanding but rewarding venture that tested us all.

Working for the United States Navy's Supervisor of Shipbuilding at the Northrop Grumman Ingalls Shipbuilding facility in Pascagoula, Mississippi was professionally challenging and highly rewarding. The government contractor team I joined was a dedicated group of individuals who worked hard at delivering the very finest warships in the world to the USN. Having the privilege of working in this environment as an integral player on the team was more than I hoped for from the exchange program. When combined with the intrigue of the Gulf Coast and the wonderful people of Mississippi, I can honestly say that going to work each day was a pleasure and an experience to be remembered with great fondness. If you get the call from your chain of command, I am sure that a tour of duty "down south" would be well worth your while.

Acknowledgements

The author wishes to acknowledge the help and experience of the numerous individuals, along with the Aegis Test Team and waterfront "Trailer People," who contributed directly or indirectly in the writing of this article. Specifically, Captain Harry Rucker, USN; Commander Steve Metz, USN; Commander (ret.) Kurt Oberhoffer, USN; Commander John Day, USN; Lieutenant Commander Mike Smith, USN; Lieutenant Commander Mark Vandroff, USN; Mr. Pete Christman; Mr. Steve Baxter; Senior Chief Petty Officer (ret.) Nathan Hale; and Chief Petty Officer (ret.) John Mitchell.

Cdr Catsburg is the business manager of Fleet Maintenance Facility Cape Scott *in Halifax.*

An Innovative Waste Treatment Facility that Saves the Environment — and Money!

Article by Gordon Hardy

So the question is…How do you turn an industrial electroplating shop that churns out streams of nasty waste water into a "poster facility" for environmental stewardship — and save gobs of money at the same time?

That is exactly what Fleet Maintenance Facility *Cape Breton*'s (FMFCB) Industrial Engineering section was determined to figure out when it set out to design and build a waste treatment facility to process wastewater from its Esquimalt dockyard electroplating shop (*Fig. 1*). The shop performs metal plating and steam and chemical cleaning, all of which generate hazardous wastes that require treatment, or expensive disposal by a registered waste hauler (in the order of \$2-3 million a year).

Fig. 1. The waste treatment facility at FMF *Cape Breton's* dockyard electroplating shop. (*DND photo.*)

In 1992 FMFCB commissioned a baseline environmental study to get a clear picture of the magnitude of the problem it faced in dealing with the various waste streams more economically in-house. There was a serious challenge ahead of us, no question, but the problems were not insurmountable. We would just have to take care in designing our in-house waste treatment facility.

The bottom line was that the waste treatment facility would have to comply with all federal, provincial and municipal environmental legislation (*Fig. 2*) during the estimated 20-year lifespan of the equipment…and for a price we could afford. The process would therefore have to be based on a proven design and be robust enough to handle a large and changing variety of chemicals. Furthermore, since the shop could not spare many person-hours, the process had to be automated!

This was no small order in itself, but there was one other important requirement. Because of the extreme health hazard, the waste treatment process had to ensure that cyanides could never mix with other waste streams. Mixed with acid, cyanide produces deadly hydrogen cyanide gas. (Clearly this was to be avoided.)

Four of the five wastewater streams coming out of the electroplating shop presented a different treatment challenge. The major source of waste water is rinse water. For plating and surface preparation a metal part is typically dipped in acids and concentrated solutions, and rinsed between each dip in continuously flowing rinse tanks to prevent cross-contamination. The waste rinse stream thus collects concentrated solutions that drip off the parts after each "drag-out" (tank dip). The challenge in treating this is the high volume of the stream and the high concentration of metals.

The second wastewater stream is the particularly hazardous cyanide rinse water which must be kept separate from all other acids, as already noted.

A third wastewater stream is made up of the spent acid and alkali baths that are dumped about every

(Text continues p. 20)

The Numbers Tell the Story:

Substance	Tightest Legal Limit ppm	Influent ppm (Weighted average)	Effluent ppm	Factor of Safety [Limit (ppm) divided by Effluent (ppm)]
Metals				
Aluminum	2	21	0.02	100
Barium	2.5	1.3	0.001	1875
Boron	15	0.4	0.021	722
Cadmium	0.1	31	$5x10^{-4}$	214
Calcium	NS	92	1.50	NS
Chromium	1	779	0.014	71
Chromium Hex.	0.2	121	0.036	6
Cobalt	0.3	0.36	$4x10^{-4}$	675
Copper	0.3	57	0.043	7
Iron	50	320	0.039	1275
Lead	0.3	13	0.002	135
Magnesium	NS	17	0.3	NS
Manganese	1	3	0.002	443
Mercury	0.01	NS	$7x10^{-5}$	150
Molybdenum	1	1.2	0.002	450
Nickel	1	6.9	0.002	429
Phosphorus	NS	69	0.042	NS
Potassium	NS	9.6	0.089	NS
Silicon	NS	22.6	0.467	NS
Sodium	NS	160	0.91	NS
Strontium	NS	0.76	0.006	NS
Sulphur	NS	84	0.39	NS
Tin	1	0.29	0.007	138
Titanium	NS	0.56	$4x10^{-4}$	NS
Vanadium	NS	0.44	$9x10^{-4}$	NS
Zinc	0.5	91	0.009	53
Hydrocarbons				
Total Oil & Grease	15		1.03	15
Mineral Oil & Grease	NS	77	0.78	NS
Total Polycyclic Aromatic Hydrocarbons	0.05	NS	$2x10^{-4}$	NS
Benzene	0.1	NS	0.002	56
Ethyl Benzene	0.2	NS	$3x10^{-4}$	635
Toluene	0.2	NS	0.004	49
Other				
pH	6 - 9.5	0.5 - 14	7.7	NS
Total Suspended Solids	30	459	5.6	5
Total Dissolved Solids	NS	2123	NS	NS
Biochemical Oxygen Demand	500	657	38.4	13
Chemical Oxygen Demand	1000	NS	28	36
Cyanide	0.2	4.2	0.01	21
Chloride Total	1500	238	2.71	553
Sulphate	NS	67	0.85	NS

Legal limits according to municipal sewer bylaws, the *British Columbia Waste Management Act* "Special Waste Regulation," and the *Fisheries Act* "Metal Finishing Liquid Effluent Guidelines." (NS – not specified). (NA – not applicable)

Influent and effluent test results derived from studies by Northwest Environmental Group Ltd., Zenon Environmental Inc., and ENKON Environmental Inc.

Fig. 2. A quick comparison of the influent/effluent chemical content of the waste stream speaks volumes for the effectiveness of the waste treatment facility, especially when held up against the tightest legal limits.

six months. Being concentrated, and having a wide pH range, this waste stream is a unique challenge to treat.

The fourth waste stream comes from steam cleaning and paint-stripping operations. Painted, oily and greasy parts are sprayed with high-pressure hot water, chemically treated if necessary, and sprayed with hot water again. The resulting waste water contains dirt, paint chips, emulsified oil and paint strippers.

The fifth waste stream is generated by a scrubber that removes harmful contaminants from the air that is vented from the chrome-plating tanks. As this meets current sewer bylaws it does not require treatment.

Gradually, the design for the waste treatment facility began to take shape. Key pieces of equipment were purchased, and in 1997 West Bay Mechanical and JCR Construction began work on the $1.3-million waste treatment facility. The facility was commissioned just over a year later in May 1998.

Handling the Waste Stream

Rinse waste water

Anything that falls to the shop floor drains to one of two underground storage tanks. All non-cyanide rinse tanks are dumped to the floor and flow into a tank that holds about 1½ days' worth of flow to guarantee that the electroplating facility can continue operations in the event of a catastrophic power failure of the waste treatment equipment. In normal circumstances the holding tanks and underground storage tanks have enough capacity to permit cleaning and plating operations for eight days.

Our first step was to reduce the overall flow of rinse water. By dumping the tanks weekly rather than leaving them to flow continuously, the rinse flow was reduced from 44,000 to 3,100 litres per day.

Fig. 3. The pH neutralizer

To begin the waste treatment process, the rinse waste water is pumped to a holding tank and sent in batches to a vacuum evaporator to remove the water component. Before the rinse waste water even reaches the vacuum evaporator, however, the stream is approximately neutralized by the addition of sulphuric acid or sodium hydroxide. Chemically, the hydroxide radical (OH-) attaches to the metal ions, producing a metal hydroxide precipitate. To achieve maximum precipitation of all metal hydroxides present, the two-stage automatic pH neutralizer (*Fig. 3)* is set so that the potential of hydrogen (pH) of the solution after evaporation will be slightly alkaline at pH 9. (On the 0-14 acid-to-alkaline pH scale, a reading of seven is neutral.) The neutralizer has built-in redundancy to ensure that this pH value of the solution is always achieved.

The vacuum evaporator (*Fig. 4*) reduces the volume of the rinse water by a factor of about 40. The evaporated water is condensed, pumped through an activated carbon filter to remove any volatile compounds, stored in a tank, and pumped back to the shop for reuse as non-potable water. To reduce the chance of algae growth, the tank stores only about half a day's production. Excess water drains to the sanitary sewer.

Fig. 4. Vacuum evaporator

As the vacuum evaporator extracts water, the concentration of the remaining solution goes up by a factor of 40, which causes more metal hydroxides to precipitate. This concentrate is sent to a conical sludge tank and then pumped to a filter press (*Fig. 5)* to reduce the volume by a factor of two. Weekly, the filter cake is scraped from the press and collected in a hopper underneath. The liquid is fed back to the holding tank. The filter cake (visible in the photo) is itself reduced in volume by another factor of three in a sludge dryer (*Fig. 6)*, after which the dried cake is shovelled into drums for disposal as hazardous waste by commercial haulers.


Fig. 5. Filter press

Overall, the plant reduces the rinse water volume from 3,100 litres per day to 20 litres per day, which significantly reduces waste disposal costs.

Cyanide rinse waste water

A cyanide oxidizer (*Fig. 7)* was chosen to preprocess cyanide over the conventional method of changing pH and adding chemicals in a multistage process. The oxidizer was found to be altogether a more reliable, simple, cost-effective and labour-saving system. Since cyanide cannot be permitted to mix with other chemicals, a second underground storage tank is used to collect and store about three weeks' worth of cyanide rinse waste water. An operator manually activates a pump to transfer 1,000 litres into the oxidizer. The oxidizer circulates ozone (produced from air) into the solution to oxidize cyanide (CN) into relatively harmless carbon dioxide (CO_2) and nitrogen oxides (NO_x). After a few days the operator tests the solution for cyanides and, when it is safe to do so, sends the batch to the aboveground holding tank for processing with the normal rinse waste stream.

Acid and alkaline waste water

Every three months, the spent acids and alkaline solutions are dumped into a tank where they are approximately neutralized by mixing in a quantity of sodium


Fig. 6. Sludge dryer

hydroxide. They follow the same processing path as the rinse waters, but are dealt with separately. In this case the vacuum evaporator reduces the volume by only a factor of two.

Steam cleaning wastewater

Steam cleaning operations present a dirty emulsified oily water solution that requires pretreatment. At first, a grease interceptor and strainers were used to remove the dirt, paint chips and some hydrocarbons, but the emulsified oil in the solution coated the pH sensors and plugged the filter press. Consequently, in April 2000, a special bentonite clay prefilter was introduced to remove even emulsified oil. The filter automatically adds clay powder to absorb the oil, then uses a self-cleaning filter to remove the clay. The system reduces the oil and grease concentration in this waste stream from 270 ppm to 3 ppm, then adds it to the normal rinsewater stream for processing.

Scrubber waste water

The scrubber runs 24 hours a day. Since the scrubber waste water meets the current sewer bylaws, it is drained to the sanitary sewer and its contaminant levels are checked monthly by contractor staff. If it ever becomes a problem, a valve can be turned to divert it to the waste treatment facility to follow the same process as for rinse water.

The Waste Treatment Facility

The equipment and tanks in the waste treatment facility are mounted within a spill-containment


Fig. 7. Cyanide oxidizer

curb large enough to contain the contents of the largest tank plus 10 percent. The equipment is mounted along the perimeter and higher than the curb to permit processing even when the containment area is flooded. The cyanide processing equipment has a separate containment area.

Special ventilation is located where acids and alkalis mix, and at the cyanide oxidizer to remove any ozone that may escape. General ventilation is laid out so that the labourers who scrape the filter press and shovel out the hoppers receive fresh air.

Fig. 8. Waste before treatment (left) and after (two beakers at right). ***(DND photo.)***

The whole plant is controlled by a direct digital controller (DDC), specified after a fault analysis was conducted on every sensor, piece of equipment and tank. It is designed to safely operate the facility while the facility is unattended over a long weekend. The DDC reads sensors, controls pumps and equipment, triggers alarms and shuts down problem areas automatically. The labour needed to operate and maintain the plant is only 10 hours per week.

If a failure occurs, a light on the panel indicates where the problem is, and an appropriate level of alarm is activated. For example, if the pH of the final water tank exceeds a specified level, two things happen: first, the pH neutralizer and the vacuum evaporator are shut down (effectively shutting down water production); and second, a yellow LED (light-emitting diode) on the process flow schematic lights up, informing the operator of the alarm location. The DDC also acts as an alarm system for the entire shop. If a spill occurs, the liquid flows to the under-

		Alternatives	
		Hazardous Waste Disposal	**Waste Treatment Facility**
Costs			
Capital outlay	Equipment and building	$0	$1,315,000
Annual costs	Labour	$0	$30,000
	Waste disposal*	$2,340,563	$20,203
	Consumable materials*	$0	$3,796
	Electricity*	$0	$213,881
	Equipment depreciation and repair	$0	$40,000
Annual operating costs		**$2,340,563**	**$307,880**
• First year costs (capital outlay plus operating cost)		$2,340,563	$1,622,880
• Annual costs after the first year		$2,340,563	$307,880
Savings (waste treatment facility vs. hazardous waste disposal)			
• First year ($2,340,563 - $1,622,880)			**$717,683**
• Subsequent years ($2,340,563 - $307,880)			**$2,032,683**

** Calculations are based on operating the waste treatment facility at the present 50-percent capacity and hazardous waste shipping costs at $2.25 per litre.*

Fig. 9. Cost Benefit Summary*

ground tanks which act as a secondary containment area. In the event of overflow, the water supply to the building shuts off automatically. If the spill continues, or if an equipment failure is detected, the DDC triggers audible and visual alarms in the facility, the shop office and, if necessary, at the nearby fire hall.

Performance

Results as of June 2000 indicate that the effluent quality exceeds the most stringent legislation by at least a factor of five for all substances. *Fig. 8* shows the actual influent and effluent. *Fig. 2* summarizes the plant's chemical performance over the first two years of operation. The effluent is clean enough that water is recycled by the electroplating shop. We have found that some metals such as hexavalent chrome do not precipitate as well as other metal hydroxides, and accumulate in the holding tank. At present about 2,500 litres of the concentrated liquid is sent away as hazardous waste every year.

Overall, the plant reduces the wastewater volume by a factor of 120, significantly reducing waste disposal costs. *Fig. 9* compares the cost to build and operate the plant running at its present 50-percent capacity, versus the cost to ship away the waste streams as hazardous waste. It shows that the plant's annual cost, including labour, electricity and even equipment depreciation is more than $2 million less expensive than the alternative we would have had to go to. This represents an annual return of 155 percent on the initial investment of $1.3 million.

This waste treatment facility, based on a vacuum evaporator, was designed and built to treat a large variety of waste from the electroplating shop in Fleet Maintenance Facility *Cape Breton* at CFB Esquimalt. After two years of operation, measurements indicate that the concentration of substances in the effluent is five times below the most stringent sewer legislation. Additionally, records show that the plant has saved over $2 million annually on the initial $1.3 million investment due to reduced disposal costs.

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Gordon Hardy is the development officer for the Industrial Engineering section of Fleet Maintenance Facility Cape Breton *in Esquimalt.*

News Briefs

East Coast engineering community honours top achiever

RAdm Bruce MacLean, Commander Maritime Forces Atlantic, honoured **SLt Mark Keneford** in a ceremony at the CF Maritime Warfare Centre in Halifax following the maritime engineering community's town hall meeting Nov. 30, 2001. Five months earlier, SLt Keneford had been awarded the Governor General's Academic Medal during convocation ceremonies at the Nova Scotia Community College (NSCC).

The medal, instituted in 1873 by the Governor General the Earl of Dufferin to recognize scholastic achievement, is today given to the student with the highest mark for the entire college. SLt Keneford achieved an overall average of 98 percent for the two years he attended NSCC in the mechanical engineering technologist program.

SLt Keneford was commissioned from the ranks in 1999 and is presently undergoing training as a marine systems engineering officer on board HMCS *Toronto*.

RAdm MacLean and SLt Mark Keneford

Congratulations, Mark! — **Contributed by Lt(N) Dave Benoit**

Steiner Regatta 2001

Captain Mike Booth, RN, *left*, (Naval & Air Adviser, British High Commission, Ottawa) presents the 2001 Steiner Regatta trophy to Cdr Eric Bramwell (PM Afloat Logistics and Sealift Capability Project). Ottawa area naval families enjoyed a fun day of Canada/UK "internavy" racing last July at Ottawa's Britannia Yacht Club. A contingent of Royal Canadian Sea Cadets oversaw events on the Ottawa River. *(Photo by CE Carnie)*

Last summer's annual internavy Steiner Regatta once again drew a number of Ottawa-area naval families out for a fun day of racing and socializing. About 50 people enjoyed the day's events at the Britannia Yacht Club on the shores of the Ottawa River.

The annual race day competition between Canadian navy families and their Royal Navy counterparts in Ottawa originated in 1962 when Captain O. St. J. Steiner, RN, then Naval Adviser to the British High Commission, conceived it as a means of further cementing the close ties between the Canadian and Royal navies. The competition was expanded in 1986 with the addition of the Manfield Plate Challenge whaler race between serving officers of the Canadian navy and members of the Naval Officers Association of Canada. In 1990, RAdm Steiner, RN (ret.), recognized the family aspect of the regatta by presenting a Steiner Mark II trophy for the children's activities. The regatta is now organized by the HMCS *Bytown* Naval Officers Mess.

During last year's regatta Canada won both the Steiner and Steiner Mk II (kids) trophies. The event also raised $200 for the Easter Seals children's charity. — **Lt Cdr Patrick Carnie, RCNC, DMSS 2-2 (UK Exchange Officer)**

RNEC Manadon website

www.rnecmanadon.com

Calling all ex-RNEC Manadon students. Log onto this superb website covering details of those worldwide who served at Manadon. Can you bear to see the current photographs of what is left?

Dial up this highly professional site and be pleasantly surprised. — **Mike Booth, Captain, Royal Navy, Naval & Air Adviser British High Commission; website: http://www.britain-in-canada.org**

National Defence / Défense nationale

FALL 2001/WINTER 2002

News

CANADIAN NAVAL TECHNICAL HISTORY ASSOCIATION

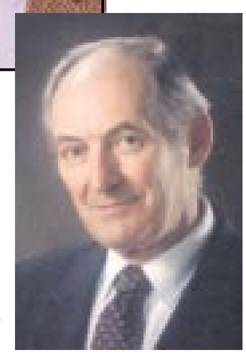
New group to look at navy's industrial history

In late November a group of about 20 interested people gathered in downtown Ottawa for a special meeting of the Canadian Naval Technical History Association. In addition to many of our usual members, half a dozen new participants joined us at the request of Rolfe Monteith to discuss the challenge of assembling the story of the industrial side of our naval technical heritage. As many of you know, Rolfe is one of our association's founding fathers, but to me he also represents our "conscience." When Rolfe calls from somewhere in England, asking — "How's it going?" — things tend to get going as a result! This occasion was one such event.

While it is still early days, a core of interested people has started to construct a framework around which the history of Canada's naval industry can be preserved. I am most pleased to see this new initiative. Anyone wishing to tune in or contribute is invited to connect up with Jim Williams at jarowill@sympatico.ca. Others currently engaged in this activity are: Don Jones (group leader), Doug Hearnshaw, Colin Brown, Gord Moyer and Brian McNally.

Alas, another of our founding members, Phil Munro, has announced that he will be stepping down from the executive of the CNTHA. Over the years, Phil has performed sterling duty in managing our ever-growing collection of documents. On behalf of the Association, I want to thank Phil for his service and guidance along the way. We hope that he will be able to continue to participate in our meetings.

Rolfe Monteith

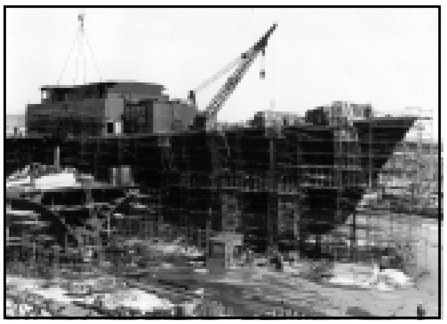


Phil Munro

If anyone is interested in taking over the important job of reviewing and cataloguing documentary contributions to the CNTHA before they are sent on to the Directorate of History and Heritage, please contact me at michael.saker@gpcinternational.com.

— Mike Saker, Chairman CNTHA

Inside this issue:



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The DDH-280 Design Challenge

Article by Cdr Tony Cond

DDH-280

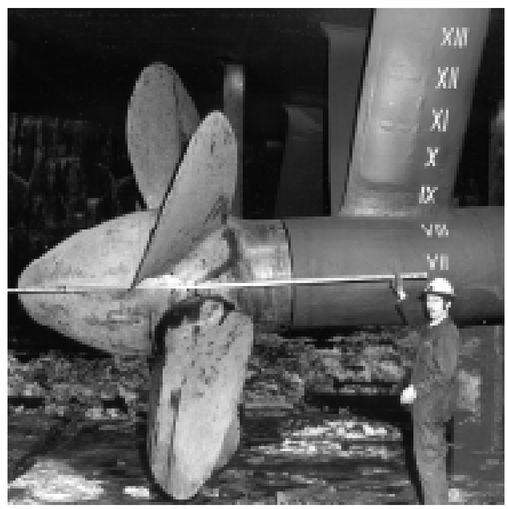
DDH-281

DDH-282

DDH-283

In 1970 Canada's sagging shipbuilding industry received a small, but much-needed boost when the government gave its approval for a class of four warships to be designed and built in this country. Competition was fierce as industry sparred excitedly for the rare contracts.

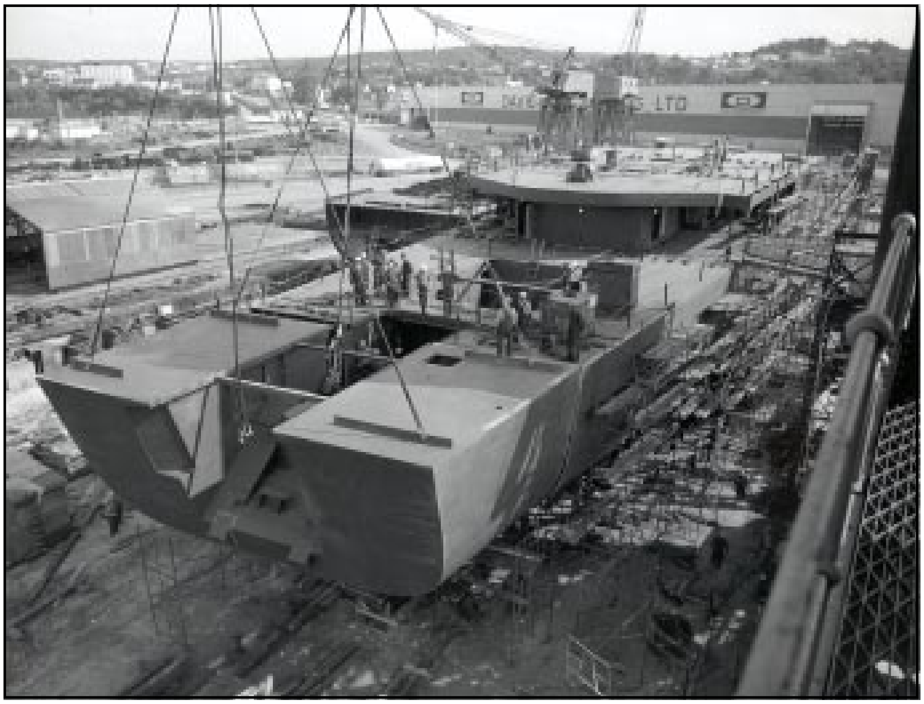
This next generation of ship for the Canadian navy would build on the extensive innovations envisioned for the *St. Laurent*-class destroyer escorts. It would be gas-turbine powered and incorporate an integrated and automatic digital information display system for command and control. In an attempt to reduce the number of sailors required to man the ships, and to improve habitability and provide more space for equipment, the navy would also introduce automatic combustion and machinery control. Canada was about to rewrite the state of the art, and in short order the four ships of the DDH-280 class, *Iroquois*, *Huron*, *Athabaskan* and *Algonquin* — these "Sisters of the Space Age" — would take their place as flagships of the Canadian naval fleet.



Naval engineers developed an innovative fix for inherent problems with the DDH-280's controllable pitch propellers (*Athabaskan*'s screw is shown here). *(Davie Shipbuilding Ltd. photo)*

The development of the DDH-280 class marked a significant turning point for both the navy and industry. Previously learned lessons in steel fabrication, gas-turbine technology and specialized anti-submarine technology were challenged to the limit. The Canadian navy needed a quiet ship that could conduct extended operations against a wide variety of surface, subsurface and air threats in virtually any sea state. Clearly, the older *St. Laurent* (DDH-205) class could not offer this level of performance; nor could the smaller hydrofoil *Bras d'Or* (FHE-400). Driven by a demanding set of requirements, the Canadian navy became the first western navy to commit to an all-gas-turbine ship. For Canada's modestly sized navy, this was a significant change, one which would affect personnel, support facilities and industrial suppliers for many years to come.

The experience gained from integrating a command and control system for *Bras d'Or* allowed DND to successfully develop the CCS-280 system for its new class of ship. When it went to sea in the early 1970s, the CCS-280 was the best destroyer-sized, integrated command and control system available. The system combined radar data, sonar information, operator-selected electronic warfare bearings, graphic overlays and alphanumerics into a single display that had facilities for weapon system control. A lone operator using the CCS-280 system could detect, track, identify and, if necessary, en-



Job H-670 (HMCS *Athabaskan*) under construction at Davie Shipbuilding Ltd., Lauzon, Québec in July 1970. *(Davie Shipbuilding Ltd. photo)*

gage a contact with the five-inch gun or Sea Sparrow missile system. It was an awesome capability.

A higher level of quietness became a most demanding parameter in the ship's design. To improve the ship's sonar detection capabilities and to prevent enemy submarines from detecting her presence, the ship had to reduce both airborne and hull-transmitted noise to an absolute minimum. Stringent noise and vibration parameters were enforced throughout the ship's development, a practice unknown in earlier ship designs.

Gearing was one of the major sources of hull-transmitted noise. The selection of a combined-gas-or-gas (COGOG) system meant that a relatively complex clutch and reduction-gear installation would be required. Although Canada no longer possessed the technology to build such gearboxes, firm pressure was applied on foreign suppliers during the tendering process to guarantee low levels of noise and vibration, something that had never been asked of them before. After rigorous evaluation the navy selected gearing that met the exacting parameters it had demanded.

To ensure even further quieting, the navy required that the entire propulsion plant be resiliently mounted on a single raft — another first for the time.

This sophisticated approach presented a number of interesting design challenges. Because of the very high torque available at low speeds, the mountings had to be married to achieve power balance. Procedures therefore had to be developed for aligning the propulsion machinery during installation, taking into account factors such as temperature change, and construction and launching techniques. Navy engineers and shipbuilders worked together to develop innovative construction procedures, with the satisfying result that both quietness and correct alignment were achieved.

Because the COGOG design implied continuously rotating shafts, engineers specified controllable pitch propellers which would give the system the highest shaft horsepower rating in the world at that time. This came at a price, however. Apart from

(Cont'd on next page)

Tech Specs: DDH-280 Class

Displacement: 4,200 tonnes
Length Overall: 130 metres
Beam: 15.2 metres
Draft: 4.4 metres

Aircraft:
- 2 Sea King CHSS-2 A/S helicopters

Weapons:
- 2 quad Sea Sparrow missile launchers
- 1 single 5"54 Oto-Melara gun
- 1 triple Mk 10 Limbo A/S mortar
- 2 triple Mk 32 tubes for Mk 46 A/S homing torpedoes

Main Engines:
- 2 Pratt& Whitney FT-4 gas turbines (50,000 shp)
- 2 P&W FT-12 cruise engines (7,400 shp)
- 2 shafts

Speed: 29+ knots
Range: 7,500 km at 20 kts
Complement: 245

Source: ***Jane's Fighting Ships***

(Cont'd from page 3)

cavitation and noise difficulties, there was an inherent problem with these propellers. If they were improperly positioned, they could produce excessively high torques and thrusts which could result in potentially severe damage to the gear train and shafting. To study this problem, naval marine engineers developed a simulation model using the analogue computer facilities of the National Research Council of Canada. They ultimately developed a modification to the ship's electro-pneumatic control system so that acceptable ship response times could be achieved without exceeding allowable limits. This was a major success story for navy engineers who were fast becoming very flexible in their approach to new design, and very good at identifying potential problems and developing innovative solutions before the first ship was even constructed.

Cdr Cond is a project director with the Directorate of Science and Technology Maritime (DSTM 2) in Ottawa. This article was excerpted and adapted from his paper, "A Century of Canadian Marine Technology Development," prepared for his Bachelor of Military Arts and Science program at the Royal Military College of Canada.

About the CNTHA

The Canadian Naval Technical History Association is a volunteer organization working in support of the Directorate of History and Heritage (DHH) effort to preserve our country's naval technical history. Interested persons may become members of the CNTHA by contacting DHH.

A prime purpose of the CNTHA is to make its information available to researchers and others. The Collection may be viewed at the Directorate of History and Heritage, 2429 Holly Lane (near the intersection of Heron and Walkley Roads) in Ottawa.

DHH is open to the public every Tuesday and Wednesday 8:30-4:30. Staff are on hand to retrieve the information you request and to help in any way. Photocopy facilities are available on a self-serve basis. Copies of the index to the Collection may be obtained by writing to DHH.

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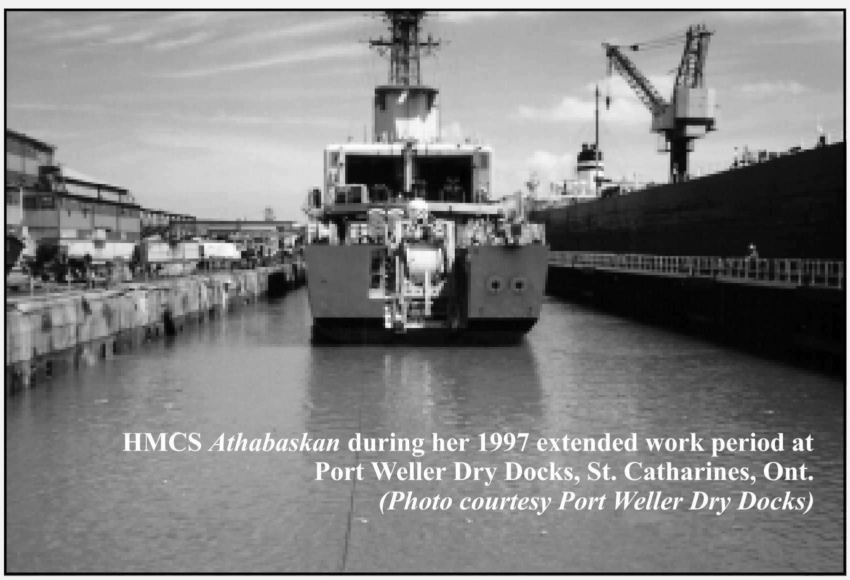

HMCS *Athabaskan* during her 1997 extended work period at Port Weller Dry Docks, St. Catharines, Ont.
(Photo courtesy Port Weller Dry Docks)

CNTHA News **is on the lookout for good quality photos (with captions) to use as stand-alone items or as illustrations for articles appearing in the newsletter. Photos of people at work are of special interest. Please keep us in mind as an outlet for your photographic efforts. Contact Michael Whitby, Chief of the Naval Team, Directorate of History and Heritage, NDHQ Ottawa, K1A 0K2. Tel. (613) 998-7045.**