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Maritime Engineering Journal

CNTHA News Inside!

CANADA'S NAVAL TECHNICAL FORUM

Spring 2000

On the Navy's 90th Birthday: Looking Back at the River/*Prestonian*-class Frigates — Backbone of Canada's Post-war Fleet

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Canada

For 35 years the test ranges at Nanoose Bay, B.C. have been serving the operational needs of the Canadian and U.S. navies —

Photo: Terry Berkley, CFMETR

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Maritime Engineering Journal

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Cover Photo

HMCS *Sea Cliff* in 1944: The River-class frigates had good seakeeping qualities, and proved to be very effective ships during the war, with a total of twelve U-boat sinkings to their credit. Story begins on page 7. *(CF photo CN-3503)*

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Editor's Notes

Ninety Years Later — The Canadian Navy's Tradition of Excellence Continues

By Captain (N) David Hurl
Director of Maritime Management and Support

Looking back to May 10, 1910, the day the Naval Service of Canada came into being, we already had a long history of naval technical achievement behind us through our close association with the Royal Navy. Over the years the Canadian navy's fortunes would rise and fall with the priorities of the day, but the determination of our predecessors to deliver reliable, technically sophisticated naval ships and systems never faltered.

By the time the war ended in 1945, Canada had the third-largest naval fleet in the world — aircraft carriers, cruisers, destroyers, frigates, corvettes — more than 400 hulls in all. This couldn't last, of course. Despite a distinguished war record, the fleet was virtually scrapped overnight in the drastic military reductions that followed the Allied victories in Europe and the Pacific. But while the fleet may have been cut back to a shadow of its wartime glory, the Canadian navy continued its tradition as a technologically innovative service that would go on to redefine the state of the art in everything from sonar development to new warship design.

Over the years the navy's engineering, technical and support branches have produced a seemingly endless number of mega-achievements that read like a *Who's Who* of naval technical innovation of the 20th century — such as the ultra-modern *St. Laurent*-class destroyer escorts of the 1950s and 1960s which, teamed with the beartrap, would go on to prove the feasibility of operating large ASW helicopters from the decks of small ships; and the gas-turbine-powered hydrofoil HMCS *Bras d'Or*, reaching an incredible speed of 61 knots on July 17, 1969 to earn a place in the *Guinness Book of Records* for four years running as the world's fastest warship; followed in the 1970s by the sophisticated DDH-280 command and control system, a marvel of integrated computer technology; and more recently the superbly capable *Halifax*-class patrol frigates that were conceived and built "on the shoulders of the giants" who went before them.

Along the way we have often captured the imagination of other navies with our high-tech achievements in variable-depth sonar, integrated machinery control, and naval electronic warfare systems. Not bad for a navy used to making the most out of sometimes very limited resources.

Today we continue that tradition of successful inventiveness through the fine efforts of a technologically proficient workforce and a network of industry professionals. Our fleet may be small in numbers, but it reflects in its sterling performance the heart and soul of an "extended family" of navy and civilian project engineers, technologists and logistical support staff committed to delivering the best. We should be proud of what we have accomplished.

Happy birthday, Navy!

HMCS *Bras d'Or* — Fastest warship in the world, 1969-1973. *(CF Photo)*

Commodore's Corner

Renewal of NEM and NaMMS Manuals Raises an "Old Chestnut"

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

Recently — most particularly at the East/West Coast seminars — the state of our Engineering & Maintenance policy documents has been forcefully pointed out. It has been rightly observed that our Naval Engineering Manual (NEM) and the Naval Maintenance Management System (NaMMS) Manual are out of date. A myriad of other technical orders and specifications also need review, but certainly the NEM and the NaMMS Manual are central.

Over the past decade, two factors have combined to place us in this situation. First, our fleet renewal has added much to the existing technology baseline. This is most evident in the NEM which, like its predecessor, BRCN 5521, has been viewed as the marine engineering "bible." And notwithstanding that much of the baseline remains relevant, once portions of it are perceived to be out of date the unfortunate tendency is to dismiss the entire publication as an entity, including the good engineering practice and lessons learned over many years of naval service.

The second factor was the dramatic downsizing and reorganization of our Engineering & Maintenance organizations on both coasts and in Ottawa. This is most apparent in the Naval Maintenance Management System, where I accept that entire categories of E&M support have disappeared (such as in the preparation of in-service trials agenda, for example). Among other things, this has led to a perception of organizational confusion and duplication of effort.

While the resource issue has certainly not gone away, we have turned our attention to updating our two key policy documents. The NaMMS Manual is being incrementally rewritten as we, collectively, rebuild our processes and subordinate orders. And, as LCdr Perks noted in the Fall 1999 issue of the *Journal*, the Naval Engineering Manual is also getting a well-deserved overhaul.

Regarding the *raison d'être* of these two manuals, I have been hearing the notion, or rather the *assertion*, that our cornerstone documents are needed as "bricks" with which we can beat commanding officers and others over the head whenever they contemplate committing some heinous sin against the E&M community or its technology! Yes, our ships and sailors represent huge investments of taxpayers' dollars; yes, they are public trusts to be operated and maintained wisely. But we must also recognize that they are in the business of risk. Ultimately, any decision on risk to equipment or personnel remains the purview of Command, having received all expert advice.

While Command is accountable for adhering to technical orders issued under the authority of the Chief of the Defence Staff, it is well understood that these orders cannot reflect all possible circumstances and situations that may be encountered. I do expect, however, that the NEM and NaMMS Manual, together with professional judgement, will form the basis of our advice and, yes, challenge as necessary, to Command.

The Naval Engineering Manual and NaMMS Manual were never intended to be self-sufficient. The intent of our revisions is for them to provide overall orders, guidance and procedure, with the detail left to subordinate documents. They should not be expected to provide simple prescriptions to solve all the problems of our complex business — they are, however, ignored at one's peril.

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

A "line in the sand" — One Ship's Perspective

Article by Cdr Joe Murphy

As I was about to take up my duties as Marine Systems Engineering Officer on board HMCS *Iroquois* in June 1998, I spoke to LCdr Garry Pettipas in DMSS 2-2-4 to gain his insight into the weight-critical TRUMP ships. As he pointed out later in this journal, *Iroquois*-class ships reentered service after the Tribal-class Update and Modernization Program (TRUMP) with no margin for weight growth *("A line in the sand," Maritime Engineering Journal, October 1998, page 26).*


Flagship of the *Iroquois* class: keeping a close eye on weight growth. *(Canadian Forces photo)*

DGMEPM's concern about possible weight growth was evident in that a monitoring process was instituted. Configuration changes were tracked and a "pound on/pound off" policy was initiated. Furthermore, commanding officers were made responsible for controlling and reporting changes to ship weight. Accordingly, when *Iroquois* began a docking maintenance period at MIL Davie in Halifax in July 1998, the ship's commanding officer, Capt(N) S.E. King, launched Operation Slimfast. The primary objective was to reduce the ship's overall displacement and trim the ship more by the stern (*Iroquois* had been sailing trimmed by the bow prior to the docking). The second objective was to ensure the ship would be ready for its upcoming deployment as flagship of the Commander of the Standing Naval Force Atlantic (C-SNFL).

Operation Slimfast was implemented in three phases. The first phase was to reduce the onboard stores by 25 percent. This target was not only accomplished, but surpassed by all departments, in large part due to the enthusiasm of the leading seamen and master seamen who reviewed the stores ashore in lay-a-part from July to November 1998. Command had ensured they both understood the importance of the reduction and were committed to success.

The second phase was to remove redundant brackets throughout the ship, an activity that is still ongoing. The removal of redundant cable runs, however, was deferred because of suspect cable identification. Their removal later could offer additional weight savings. Also during this phase, stores above 2 deck were moved to 3 deck and below, and from forward to aft to assist in changing the ship's trim.

The third phase was to more accurately monitor the ship's liquid load. After reviewing the ship's Periodic Weight Reports, it was determined that *Iroquois* had been ballasting unnecessarily. A new liquid load worksheet was therefore developed by *Iroquois* to calculate the ship's displacement daily at sea. The worksheet (which was later distributed to all TRUMP ships) accounts for black water, fresh water, fuel, ballast and the contents of the two main machinery space bilges in calculating the ship's minimum liquid load. The results were found to be consistently accurate within 10 tons (normally checked against draught marks on the first day back alongside). Using the data from the worksheet, *Iroquois* was able to significantly reduce the amount of ballast she was carrying. Furthermore, as most ballast tanks are situated forward of frame 50, the approximate pivot point of the ship, the reduction of ballast assisted in achieving a stern trim.

All of these efforts could easily be applied throughout the remainder of the weight-critical *Iroquois*-class ships (*Huron*, *Athabaskan* and *Algonquin*), and in the 12 *Halifax*-class frigates as well. Although the frigates are not weight-critical at present, if one were to extrapolate their current weight growth over the projected life of the *Halifax* class, weight could very well become an issue.

Prior to sailing with the Standing Naval Force Atlantic in July 1999, *Iroquois* was subjected to an inclining experiment, the results of which were very favourable. The ship had experienced minimal weight growth when compared to the results recorded just after coming out of TRUMP refit in 1992. Thanks to DGMEPM policies, the new liquid load worksheet and other Operation Slimfast measures, *Iroquois* was able to sail for flagship duties at under 5000 tons, some 200 tons lighter than she had been the previous year. This reduction in growth will have significant benefits for the ship and the navy in that it recovers future growth, improves fuel economy and improves damaged stability capability.

Cdr J.R. Murphy is the commandant of the Canadian Forces Naval Engineering School Halifax.

A "line in the sand" — Applause and Aide-mémoire

Article by Lt(N) Heather Skaarup

After reading a pre-publication copy of Cdr Murphy's submission to the *Maritime Engineering Journal*, I felt compelled to add a few supportive words....

The results of the HMCS *Iroquois* inclining experiment on July 10, 1999 confirmed that Operation Slimfast had indeed paid off; the ship was calculated to have decreased her displacement by five long tons since her last inclining in 1993. This is a particularly noteworthy achievement given that HMCS *Iroquois* had already received most of her C-SNFL upgrades. Even more remarkable is that, in the six years between inclinings, we could have expected a ship of her size to *grow* in displacement by about three tons a year through the natural accumulation of paint, stores, accommodation items and any number of small (under 50 kg), authorized engineering changes — in other words, *by about 18 tons!*

In recent years, the Periodic Weight Reports from the *Iroquois* class have shown a general levelling-off in ships' sailing displacements. In 1998/99, though, PWR data indicated for the first time that the ships were sailing at lighter average displacements than in 1997/98 and even 1996/97. It appears the weight control and reduction efforts of engineering staff are beginning to pay off as excess stores and consumables are removed from the ships. Unfortunately, this sort of weight reduction cannot be used to offset new engineering changes, a number of which are currently on hold for lack of a weight offset. All naval personnel are encouraged to assist in identifying configuration items which may be candidates for removal through the engineering change process, and to notify the DGMEPM Stability Desk (DMSS 2-2-2).

As a result of the HMCS *Iroquois* inclining results, a new Manual of Trim and Stability will be issued to all *Iroquois*-class ships this year. The manual uses revised consumable stores load figures that agree with stores weight data collected since TRUMP, and recommends a new minimum seawater ballast load of 147 tons (versus the current 204 tons) mainly to reflect changes in the location of stores following the TRUMP modernization. This should assure that, with good onboard weight management, the ships will be able to leave harbour for extended deployments below their 5300-ton maximum displacement.

It is hoped that the upgraded *General Load Monitor* (*GLM*) software now in service throughout most of the Canadian naval fleet will provide a more functional replacement for the liquid load worksheet developed by Cdr Murphy. *General Load Monitor* can convert draught mark readings to corresponding displacement and hydrostatic details, and provide a report of solid and liquid loads according to input data collected during normal engineering rounds. With *GLM*, ship's staff can simulate fluid transfers and observe the changes to trim and heel that would result. Load data for stores, spares, ammunition, personnel numbers and tank contents can easily be adjusted, and complete stability assessments can be produced and printed with only a few keystrokes.

The *General Load Monitor* software is being regularly improved to better meet the needs of the fleet. For instance, a recent upgrade to add the capability of modelling a ship with flooded compartments means that it is possible to evaluate a ship's freeboard, trim, heel, righting arm, etc. (previously available for intact conditions only) with any specified compartments flooded. Suggestions for further improvement will be welcomed by the DGMEPM Stability Desk.

Lt(N) Skaarup is the Stability Officer in DGMEPM.

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.

Submission Formats

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

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

Looking Back

River/Prestonian Class Frigates — Backbone of Canada's Post-war Fleet

Article by Harvey Johnson

HMCS *New Waterford (Canadian Forces photo E-44531)*

At the beginning of the war in 1939, the total inventory of warships in the Royal Canadian Navy consisted of six destroyers. Immediate efforts were made to build up the fleet as quickly as possible, which resulted in the construction of the Flower-class corvettes. Based on a basic trawler design, the corvettes could be built quickly and 107 of them were constructed in various Canadian shipyards. The first corvette to enter service was HMCS *Collingwood*, commissioned in late 1940. They were originally intended for coastal deployments, but were soon assigned to North Atlantic convoys and patrols, a role for which they became famous through the gallant efforts of their crews.

Although the corvettes were the mainstay of the fleet as escort vessels during the height of the Battle of the Atlantic from 1941 to 1943, an improved type of anti-submarine ocean escort was needed for operational and seakeeping requirements. The designer of the corvette, William Reed, OBE, of Smith's Dock Company, South Bank-on-Tees, U.K, put forward a design for a "twin-screw corvette" which was accepted by the British Admiralty and laterally by the RCN in the person of Vice-admiral Percy Nelles, Chief of the Naval Staff. It was Vadm Nelles who suggested that the ships be classified as "frigates," and an order for 60 of the new vessels was placed by the Canadian Navy.

The ships were all built in Canadian yards: Yarrows (Esquimalt, B.C.), Morton Engineering (Quebec City), Davie Ship (Lauzon, Quebec), Canadian Vickers (Montreal), and George T. Davie and Son (Lauzon). Shipyards on the Great Lakes could not be used for the simple reason that the frigates were too long to transit the existing canal and lock system leading into the St. Lawrence River. Thirty-three frigates were built under the 1942-43 program, and 37 (including 10 ships for the Royal Navy*) were built under the 1943-44 program. [*Two of these ships were acquired by the USN and became the prototypes for their "77" ship class, and later became the basic design for their massive escort shipbuilding program.] The first Canadian frigate to enter service was HMCS *Waskesiu*, commissioned in June 1943.

The new ships, originally designated "PF" and classified "River" class, were a considerable improvement over the corvettes (a fact that didn't escape the notice of former corvette crews who went on to man them). They carried a complement of eight officers and 133 other ranks, a 65-percent increase over the crew size of a corvette. The frigates were larger, some 92 m (301 feet) in length as opposed to 63 m (205 feet) for the corvette, and displaced 1570 tons, versus the corvette's 900 tons. The River class had good seakeeping qualities, and their large fuel capacity (some 720 tons, almost a third of the ship's loaded displacement) allowed a range of 9500 nautical miles at 12 knots. This was a vast improvement over the corvette's 4000 mile range at the same speed, but was not always cheered by the crews who were called on to do "an additional stint" before returning to port from an extended patrol.

Prestonian class vs. River class: Compare the flush-deck profile of the modernized HMCS _Sussexvale_ (top, CF photo) with the cut-down quarterdeck arrangement of HMCS _Antigonish_ (below, CF photo F-3206) seen here in her wartime camouflage during the summer of 1944. The upgraded combat suite in the _Prestonian_s replaced the hedgehog ASW weapon with two triple-barrelled Squid mortars aft. Other significant changes included the addition of an enclosed bridge and a taller funnel. Gone, too, were the Carley floats.

Two triple-expansion reciprocating engines, developing 5500 h.p., along with twin screws, gave the frigates more manoeuvrability and increased speed capability over the single-engine corvettes. The engine-room was fitted with 12 skylights that could be opened for ventilation. Two Admiralty pattern, three-drum boilers were located in two pressurized boiler rooms, with fans supplying air to the spaces and the boilers. This system, which was standard for the time, required the boiler rooms to have double-door airlock access. Care had to be taken not to open both doors at the same time as the loss of air pressure in the space would cause an immediate flashback from the boiler. Warning signs were well posted, large and obvious. The anchor windlass was a steam-driven unit which could be a bit cantankerous at times. The little steam engine driving it required some dexterity on the throttle to get the speed required when hauling in the "pick."

The main 220-volt d.c. electrical power was supplied by three steam generators and one diesel generator. The diesel generator was not fitted with a starter, but was started by motoring the generator from the starting batteries. As with all d.c. systems, the frigate d.c. power system required a high level of maintenance. Commutator refurbishment and brush replacement were ongoing

With their twin-mounted four-inch guns, the frigates could speak with some authority. This photograph, dating from December 1961, shows HMCS *Cap de la Madelaine*'s guncrew closed up during a shoot. Note the hawser and fender stowage forward of the gun. *(Photo courtesy Mr. Ted Lemoine)*

tasks for the electricians, who also had to deal with the occasional electric motor fire!

Combat equipment included two improved sonar sets, one to provide bearing and range data on a submarine contact, the other to determine the submarine's depth. The frigates were the first Canadian warships to be fitted with this advanced equipment. Also included were an HF/DF direction-finder, which was at the time a top-secret device capable of zeroing in on enemy radio transmissions, an improved radar, a gyro compass and the new ARL plotting tables which provided a near-real-time "action plot" of enemy ship and submarine movements in relation to the frigate's position.

The first 15 frigates built were fitted with single, four-inch gun mountings fore and aft, but after that the remaining ships were fitted with twin-mounted, four-inch guns forward. Up to this point, twin-mounted four-inch guns (made by the Massey Harris Tractor company), were found only on Tribal-class destroyers. Other weapons included four twin Oerlikon 20-mm guns, a foc'sle-mounted hedgehog launcher that fired 24 anti-submarine contact projectiles, and four depth-charge throwers aft. While depth charges (some 150 to 200 were carried on board) had to be launched across the ship's noisy wake at the last detected position of a submarine, the 24 hedgehog projectiles were fired in an elliptical pattern ahead of the ship while still in sonar contact with the submarine in the quiet water ahead of the ship. (*"Canada and Hedgehog: The First Ahead-throwing Anti-submarine Weapon," Maritime Engineering Journal, February 1999, page 18.*)

The River-class frigates proved to be very effective ships during the war, and with a total of twelve U-boat sinkings to their credit were considered to be one of the best anti-submarine vessels in the world. There were losses. In May 1944, HMCS *Valleyfield* sank off Cape Race, Newfoundland with the loss of 125 lives (nearly her entire crew) when she was torpedoed after leaving a convoy. Others were so badly damaged in action that they were not repaired for further service. HMCS *Magog* was torpedoed in October 1944 while escorting a convoy in the St. Lawrence and had almost 30 metres of her stern blown off. She was declared a total loss. Another ship, HMCS *Chebogue*, was torpedoed off the coast of England on her third convoy and lost most of her quarterdeck. She was towed to Port Talbot, Wales and was eventually scrapped.

Following the victory in Europe, many of the frigates were to be converted for use in the South Pacific against the Japanese, but few were actually completed by VJ-Day. With the war over, eight of the frigates were scrapped, while 11 others were stripped and sunk as breakwaters for various logging operations on the British Columbia coast. A number of the surplus frigates were sold to the navies of India, Pakistan, Israel, Chile and Peru. Of note is HMCS *Storemont* which was sold to shipping magnate Aristotle Onassis for conversion into his well-known yacht, *Christina.* (After the conversion, the ship was practically unrecognizable from her original configuration.) Some of the frigates were retained for other roles. HMCS *Victoriaville* became the diving tender *Granby*, while *Stonetown*, *St. Stephen* and *St. Catherines* became weather ships for the Canadian Coast Guard.

Birth of the *Prestonian* Class

Between the years 1953 and 1959, twenty-one River-class frigates were converted and redesignated "FFE." The first of the new class, HMCS *Prestonian*, was recommissioned on Aug. 28, 1953. (The ship was actually named after Preston, Ontario, but there was already an HMS *Pres-*

Sailors from HMCS *Swansea* go ashore near Washington, D.C. ***(Canadian Forces photo HS-17269)***

ton in the Royal Navy.) She did not remain in the fleet, but was loaned to the Norwegian navy in 1956 and renamed *Troll*, then sold outright to Norway in1959. In that year she became a submarine depot ship, renamed *Horten*, and was eventually scrapped in 1972.

The conversion package was an extensive one, the most obvious detail being the change to the foc'sle deck which was extended all the way aft, making the ships flush-deckers. A much larger superstructure was incorporated to house the new command position, operations, sonar control and radio rooms, and required the installation of a taller funnel. The seven ships of the Fourth Canadian Escort Squadron were fitted with a large deckhouse to provide classroom and messing facilities for officer cadets under training.

Another change to the hull structure was a strengthening of the bows against possible ice damage, even though the hulls were very rugged to begin with. When *Beacon Hill* rammed the starboard quarter of *Antigonish* after a misinterpreted flag signal during officer-of-the-watch manoeuvres on a bright sunny day back in the 1960s, she struck so hard that *Antigonish* heeled over to a considerable angle. The port anchor temporarily became an occupant of the P2's mess, and when exiting, created a 4 m x 2 m "window" in the steel plating. (The only occupant of the mess, who was napping over the noon hour, recalled that he didn't think his feet even touched the deck until he arrived on the upper deck.) Repairs basically consisted of replacing the plating and straightening the frames in the local area of the damage. No other area of the hull was affected.

The entire steamplant was overhauled and upgraded in some areas, but retained the original Admiralty pattern boilers and triple-expansion reciprocating engines. The original 220-volt d.c. electrical system was upgraded by the addition of a second diesel generator in favour of one of the three steam generators, providing greater total current capacity. (Paralleling the generators in a d.c. system was a function of voltage control only, rather than of speed as is the case with alternating current systems.) The voltage regulators were controlled at the main switchboard which was in a tiny compartment the size of a telephone booth. This was adequate, however, since no watchkeeper was required.

Combat upgrades were made to the sonar, plotting tables and radar equipment, and to the weapons fit as well. The hedgehog and depth-charges were replaced by two modern triple-barrelled ASW mortar "Squid" mounts installed in a quarterdeck well. The associated metadyne drive-control system and magazine were fitted on either side. The new mortars could fire 180-kg bombs forward over the mast to the indicated target with a high degree of accuracy. The bombs were armed in three stages, by a depth-setting mechanism before firing, by inertia when fired, and by pressure once in the water. The four-inch gun arrangements remained unchanged, but the original Oerlikon guns were replaced with one quad and four single 40-mm Bofors. The quad Bofor was trained and fired remotely from a director mounted on top of the after superstructure (which housed the bos'n and shipwright workshops), and was powered by a metadyne drive follow-up system.

A new laundry and a 12-man cooks and stewards mess were fitted abaft the mortar well. The mess, which later became "home" for petty officers second class, offered an exhilarating ride in heavy seas as it was situated directly over the screws (the author speaks from experience, here). Overall, though, habitability was significantly improved in the *Prestonian* class. While living conditions would not be considered palatial by today's standards, the days of hammocks and broadside messing were over, replaced by cafeteria style messing and the fitting of bunks.

In addition to their Cold War anti-submarine patrols, the frigates deployed on extensive training cruises. The large deckhouse abaft the boat position visible here on HMCS *Antigonish* contained classroom and messing facilities for officer cadets under training. *(Canadian Forces photo E-79010)*

The demise of the antiquated broadside messing system, where meals had to be drawn from the galley and carried back to the messes (where the dishes would also later be washed), was not mourned by anyone. Occasionally at breakfast, a late sleeper's hammock would still be slung above the messdeck table, and a foot would suddenly appear beside one's plate of bacon and "red lead" (heated canned tomatoes), standard breakfast fare in those days. The comments made on those occasions need no clarification here.

Sadly, air-conditioning was not part of the new package, and the lack of it was cursed by the crews when on deployment in southern latitudes. Another "hot" source of irritation was the system of steam lines (for the steering gear) running underneath the cafeteria deck, adding to the already hot conditions below decks. "Air-conditioning" consisted of opening the scuttles and fitting the traditional wind scoops. This was done in moderate seas only, but even then there was the occasional unscheduled deckwashing when a freak wave came along.

Scuttles apparently had other advantages, as well. During one cocktail party being held on the quarterdeck to host dignitaries in a foreign port, the engineer officer noticed that the bar seemed to be going through an inordinate amount of alcoholic refreshment. As the evening wore on, he began keeping a close eye on the two petty officers who, earlier, had been quick to volunteer to tend the bar that evening. Every so often, he noticed, one of the bartenders would crouch down out of sight below the bar, which was situated near one side of the quarterdeck. Easing his way through the crowd to get a better look from the rail, he soon cleared up the mystery of the disappearing booze. As the engineer officer watched, one of the bartenders carefully lowered a bottle over the side of the ship to a waiting hand extending from the scuttle in the P2's mess immediately below the bar! The engineer went below and advised the startled accomplice in the mess that the operation was bust. The various bottles were returned and nothing more was said.

The *Prestonian*-class frigates went on to become the backbone of the RCN fleet. After the war they were assigned lengthy training cruises, and maintained this country's Cold War anti-submarine patrols on both coasts. They became obsolete with the arrival of the new *St. Laurent* and *Restigouche* classes in the late 1950s, but continued in service until the late sixties when they were gradually decommissioned and sold to other countries or scrapped. As it turned out, HMCS *Granby* was the last of the class to survive in Canadian naval service and was sold for scrap in 1974.

Acknowledgement

The assistance of Marilyn Gurney, director of the Maritime Command Museum in Halifax, in supplying photographs for this article is gratefully acknowledged.

Harvey Johnson served in the frigates New Waterford *and* Antigonish *as the electrical sonar and weapons maintainer. He retired with the rank of chief petty officer first class in 1981, and now works in DMSS 2 as a life-cycle material manager for ships hull and domestic equipment.*

"Strapdown" Inertial Navigation in the Canadian Navy

Article by Lt(N) Jim Pedersen, B.Sc., 44C,
with technical input from Defence Scientist Jeff Bird, M.Eng., and
Litton-Marine Systems Engineer Henry Stacey, B.Eng.

In the spring of 1996, staff at the Canadian Patrol Frigate Project Management Office (PMO CPF) in Ottawa were alerted to a serious problem being experienced by one of our ships on operational duty. HMCS *Calgary*, berthed in Valparaiso, Chile, was without a working heading reference. Both of her inertial navigator/attitude reference systems were unserviceable. This was the latest and most serious of a number of such system deficiency reports to reach PMO CPF during the previous two years. Cdr Fred Jardine, head of the combat systems team at PMO CPF, immediately mobilized the author to look at ways to replace the gimbal stabilized Mk-29 inertial navigators with something a bit more robust.

From the outset, it was decided that the replacement would be based on the NATO Ship's Inertial Navigation System (SINS). Litton-Marine Systems had already developed and built such a system — the Mk-49 Ring Laser Gyro Navigator — in response to a 1985 NATO staff requirement. Canada was involved with the Mk-49's development right from the start, with National Defence's research and development branch contributing a principal member to the international NATO SINS Steering Committee, as well as providing significant funding for vendor initiatives. By 1996 Mk-49 systems were alive and well in the navies of Britain, Spain, the Netherlands, Australia, New Zealand and the United States.

With the weight of this product track history behind it, PMO CPF, along with the Directorate of Maritime Policy and Project Development and the Directorate of Maritime Ship Support built a convincing case for sole source replacement of the Mk-29 system with the Mk-49. In March 1998, DND's Senior Review Board granted funding and approval to proceed.

Just over a year later the first unit was installed in the Pullen Building in CFB Halifax, while the first shipborne installation took place on board HMCS *Montreal* in early 2000. The Canadian version of the Mk-49 is called the "SINS-HFX," for Ship's Inertial Navigation System for *Halifax*-class Ships.

Some Combat Systems History

Anyone who has performed a detailed assessment of a modern warship's combat system will have noted that a ship's inertial navigation system is nothing less than critical in the combat system architecture. It wasn't always this way. The combat philosophy of the *Halifax* class represents a huge departure from that of the steam destroyers of just a few years ago. In the steamers, each gun director had its own gyros to provide attitude and attitude rates to the weapons it was controlling. On board HMCS *Saskatchewan*, for instance, there was a gun director mounted atop the bridge that had two built-in single-axis gyros, providing attitude correction and rate signals to the twin 3" 70 guns forward, as well as to the twin 3" 50 mount aft. The after "director" was little more than a conical scan fire-control radar snuggled between the barrels of the 3" 50, but it, too, had built-in gyros, and could provide attitude and attitude rate information to the after mount. Both directors relied on the ship's gyrocompass as their only source of heading information.

On board the steamers, the gyrocompass was just that — a gyrocompass. It fed heading information, but neither pitch nor roll information to the various peloruses and tape repeats, weapons and sensors. The fire-control solution "gyro" hardware was autonomous to each gun or ASROC (anti-submarine rocket) mounting. I have noted some similarities between the "old" and "new" navigation data distribution architectures. First, the old featured two ship's gyrocompasses, remotely located from each other (forward and aft). Second, there were four vital steering repeats, fed by two independent distribution panels, with each of the panels slaved to an individual gyro. Two were on the bridge, and two in the wheelhouse. The "non-vital" repeats for the radars, fire-control directors, the ADLIPS Automatic Data Link Plotting System, bridge wings, etc., were fed from a single non-vital distribution panel which in turn could be fed from either gyro. This was a good redundancy feature. You could lose a gyrocompass and still have synchro heading data to vital and non-vital repeats from the other gyro.

The similarity between the old and new architectures ends right there. A graphical depiction of the steamer navigation data distribution system is given in *Fig. 1*. To keep the diagram in context (not to mention uncluttered), some blocks have been deliberately omitted. Most conspicuous by its absence is that "olde space heater" of an analogue fire-control computer which offered niceties such as ballistic and parallax corrections into the gun-control signals.

As stated previously, each steamer weapon system had its own source of attitude data. With the *Halifax* class, the generation of attitude data was centralized. Heading, pitch and roll are taken from the Mk-29s and distributed to "non-vital" repeats like fire-control radars, weapons and other sensors through a synchro distribution network. As well, an improved level of redundancy was built into the *Halifax* class. There are two heading references and two vital heading distribution systems, as there were in the steamers, but there are also two non-vital synchro distribution panels (whereas the steamers had only one). The non-vital synchro heading distribution system was the single point of failure in the steamer combat system; we have eliminated that vulnerability in the *Halifax* class. The "vital" repeats on board the *Halifax* class are the centreline pelorus, the helm operator's console, and a repeat in the ops room. (One wonders about the use of the term "non-vital" as it applies to the combat system repeats. Aren't these also "vital" systems? Just saying something is non-vital implies we can live without it.)

Most weapons and sensors in the *Halifax* class need non-vital synchro attitude data to function. (The Mk-29s are not the only home to spinning gyros in the ship; there are spinning gyros in the 57-mm Bofors, but they are for rate determination for the elevation and train limiting functions of the gun.) Since the fire-control solution for all CPF weapons relies heavily on the Mk-29 inertial navigator, the ships carry two Mk-29s, along with two reliable non-vital synchro distribution systems ("navigation switchboards") spatially distributed for added redundancy. Still, if you lose both Mk-29s or both navigation switchboards, you cannot fight. But with one good Mk-29 you can still steer, unless you also lose both vital distribution panels! As was pointed out in the first paragraph, being left up the proverbial creek by this navigation system is not an entirely remote possibility.

The auxiliary switchboard is in CCER no. 3 just above the forward INS space; the main switchboard is in the machinery control room. The *Halifax*-class navigation data distribution system is depicted (simplified) in *Fig. 2*. Incidentally, the forward vital panel is a real "panel," near the forward Mk-29. The after "vital panel" is simply heading repeats hardwired from the after INS into the after navigation switchboard and distributed to the bridge and ops room.

In summary, it appears we have evolved a distinctive area of vulnerability in our *Halifax*-class combat system. With the steamers, a multitude of gyros had to fail before we lost the ability to fight. Now that multitude has been reduced to just two, which can quickly become a

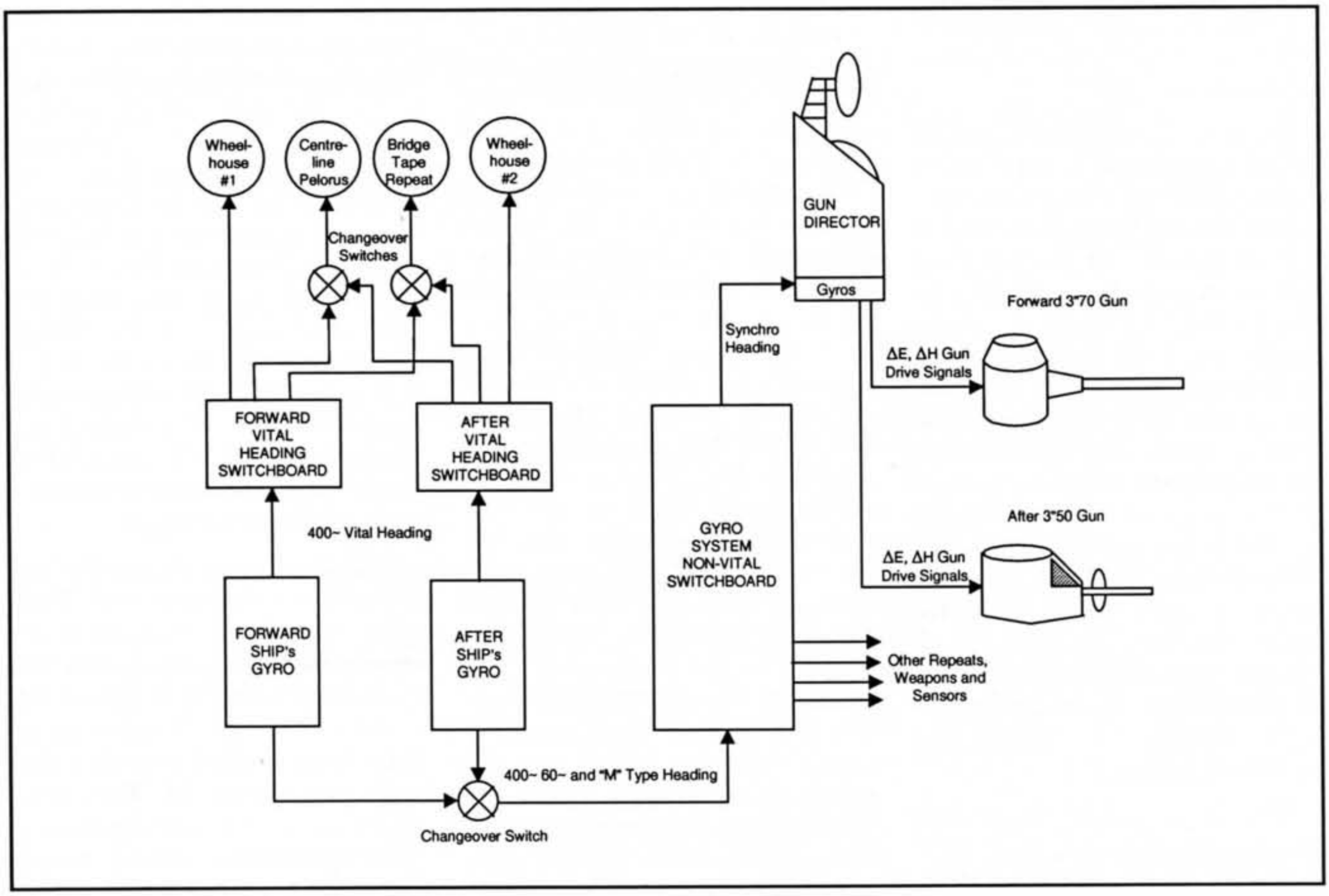


Fig. 1: A graphical depiction of the steamer navigation data distribution system.

"multitude of one" should your after Mk-29 be commandeered by a higher-readiness ship!

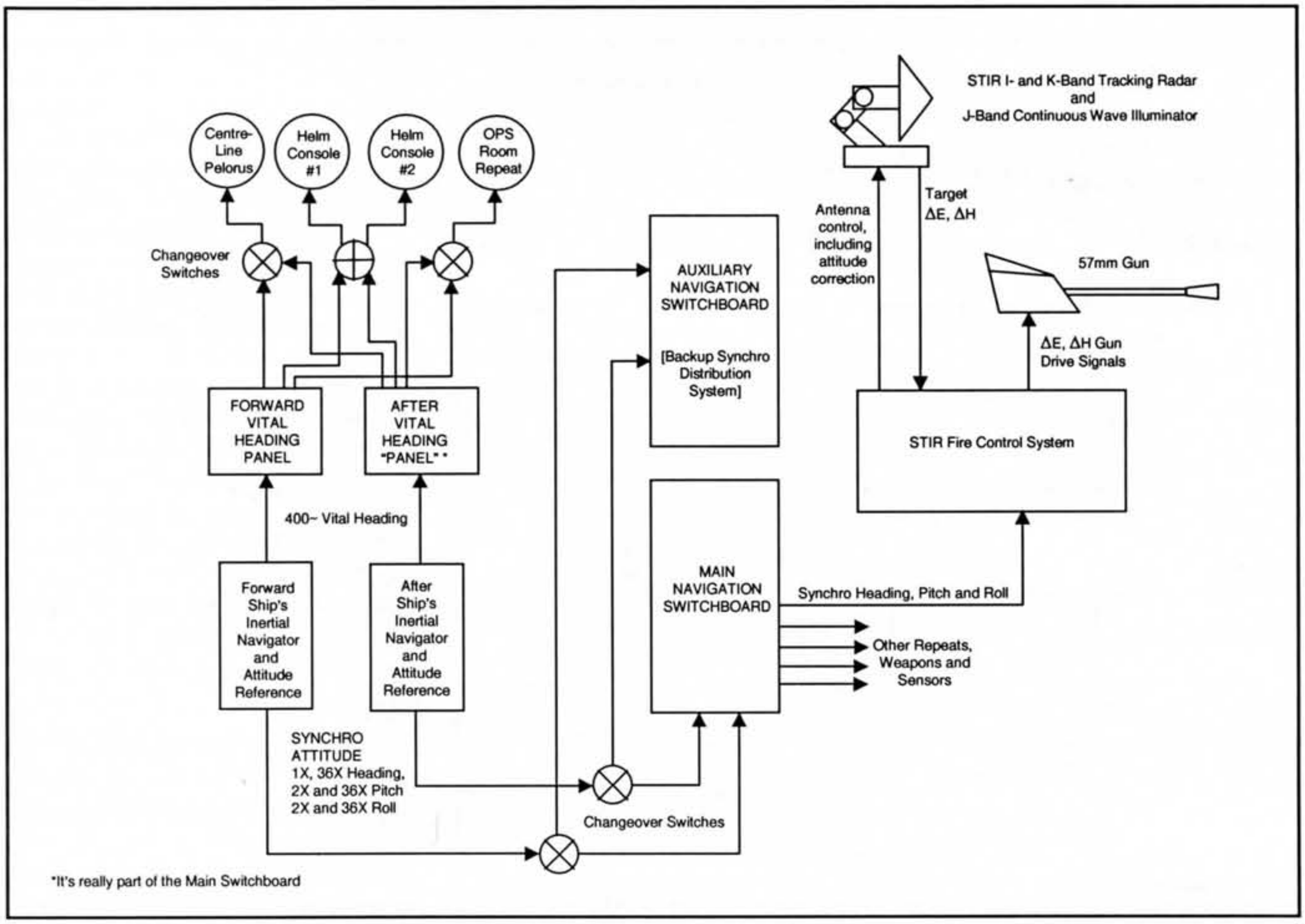
The Solution: How Ring Lasers Solved the Tuned Rotor Gyro Design Problem

There are two ways to mechanize inertial navigation — through "platform stabilization" and "strapdown." For years the guidance systems companies dreamed of building a reliable strapdown system. In fact, they wanted nothing more than to get away from platform stabilization. Why? Because a nagging two-part problem had to be solved.

The Tuned Rotor Gyro Design Problem (Part One)

With gyroscopic precession, a circular mass spinning at great speed wants to keep the same orientation, regardless of Earth or vehicle rates. So an untorqued free-spinning gyro will appear to move with 24-hour periodicity, when it is actually keeping the same orientation. The earth is moving around it! It wouldn't take much torquing force to keep this gyro in the same orientation relative to the observer, even on the equator where Earth velocity is maximum. If this gyro were then moved to another latitude, say 20 degrees farther north, less torquing force would be required to keep the gyro level because the Earth velocity at the higher latitude is less. So if we didn't compensate our torquers, the gyro would move relative to the observer. Measuring (integrating) this change in torquing rate is analogous to measuring a displacement in position, and this is the basis for inertial navigation.

Unfortunately, it's not that simple. In a moving ship or aircraft, Earth rates, measured in fractions of a degree per hour, must be measured with the same precision as vehicle rates, which can be as high as tens of degrees per *second*! Imagine the engineering chore of developing a torquing device that can cancel vehicle rates as efficiently as Earth rates. One solution is to isolate vehicle rates from the inertial equations through gimbal stabilization, as was done with the Mk-29 INS in the *Halifax* class and the WSN-5 in the *Iroquois* class. Then the torquers only have to measure Earth effects. But gimbal mechanisms have a lot of moving parts. They are maintenance-intensive and involve use of the "S" word. Yes, slip rings! Another solution is to use small tuned rotor gyros, as is done in a lot of aircraft strapdown inertial applications. A smaller moment of inertia in the gyros will allow for easier torquing, even for screaming vehicle rate effects. So why not just use small gyros in our inertial navigators? There is another problem...which takes us to Part Two.



*It's really part of the Main Switchboard

Fig. 2. Halifax-class navigation data distribution system.

The Tuned Rotor Gyro Design Problem (Part Two)

Drift in tuned rotor gyros is directly related to parasitic torque, which is in turn an inverse function of the gyro's moment of inertia. In other words, bigger gyros drift less and therefore work better in inertial applications. But bigger gyros are harder to torque! In response to a requirement for an extremely low-drift gyrocompass, Litton-Marine Systems built a stabilized heading reference with enormous, 16-cm-diameter iron wheel gyros. They had to pay the Devil to torque them. Despite that particular challenge, the Mk-19 gyrocompass was a highly successful product line.

The two parts of the design problem are graphically presented in *Figures 3 and 4*, which are qualitative representations, not graphs of real experimental data. *Figure 3* represents the simplified fundamental equation of a spinning wheel gyro, $T=Hx\Omega$, where H represents the angular momentum of the spinning wheel and equals the product of the spin rate and the wheel's moment of inertia. In this representation, $H1<H2<H3$. T represents the torque required about the gyro's input axis to make the gyro wheel precess (rotate) at a rate Ω about its output axis.

The fundamental equation and *Fig. 3* show that as the angular momentum (H) of the gyro gets larger, more torque (T) is required to make the gyro precess at a given rate (Ω). There are two ways to change the angular momentum of the gyro — change its spin rate, or change its moment of inertia (its mass and diameter). In strapdown or other high dynamic-rate applications, therefore, it would be advantageous to keep the angular momentum of the gyro small so that less torque is required to keep the gyro stabilized under high input-rate conditions. However, *Fig. 4* shows why this is a trade-off.

Friction and imbalances within a spinning gyro can never be eliminated. These forces cause unwanted torques that result in gyro drift. The same equation above can be used to demonstrate the effects of these unwanted (or parasitic) torques: Ω(DRIFT) = T(PARASITIC) x 1/H. This shows that to minimize the drift rate, one must maximize the angular momentum. This is the classic trade-off in gyro design: larger angular momentum minimizes the unwanted drift, but increases the demand on the torquing mechanism.

Okay, who's paying attention here? Who picked up on the wonderful bonus that "solving" the tuned rotor gyro design problem by platform stabilization gives us? *Answer:* If a gimbal system is used to eliminate vehicle rates, and the inertial platform is kept in a fixed-level orientation as a result, why not use the platform offset as an attitude reference? It's as easy as picking-off the synchro signals on the gimbal drive mechanisms. No computing, no data conversion, just pure, real-time synchro.

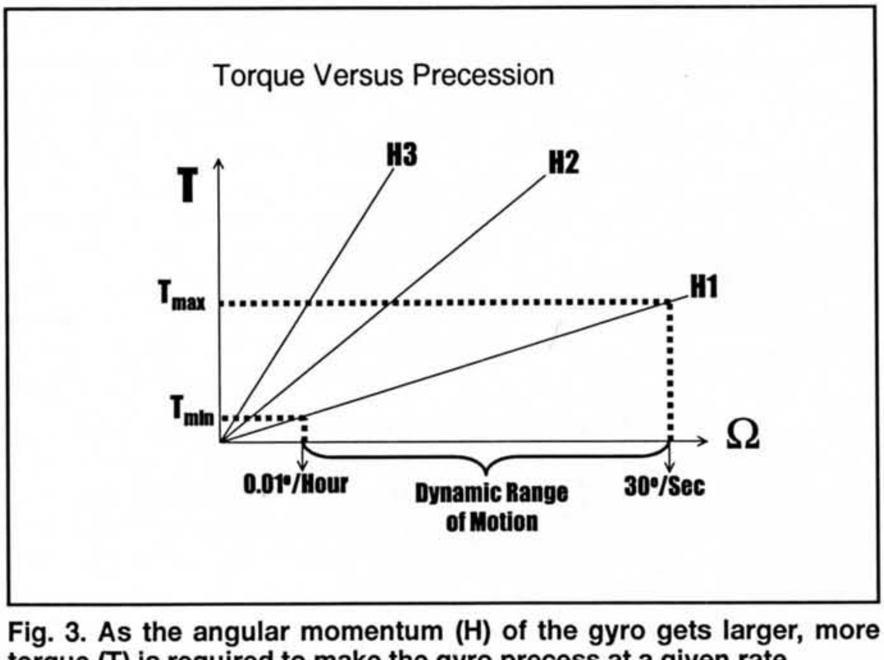


Fig. 3. As the angular momentum (H) of the gyro gets larger, more torque (T) is required to make the gyro precess at a given rate.

With the design and production of the navy's platform stabilized inertial systems in the late seventies and early eighties, a central source of attitude data became available. The "bonus" became the *raison d'être* for shipboard inertial navigators, with all shipborne weapon and sensor systems now using a common, centralized attitude reference.

The Move to Strapdown Applications

Like most engineering problems, the gyro design problem wasn't solved, it was dealt with. However, the preferred "fix" of platform stabilization resulted in maintenance-intensive gimbal stabilization schemes, schemes that were not very sailor-friendly in nature. The guidance companies continued in their quest for a good strapdown navigator. The gyro problem was truly solved when a new motion sensor entered the scene. First of all, ring laser gyros are not traditional gyros, at least in terms of 20th century references. Because of Elmer Sperry's toys we now associate "gyro" with "spinning," and ring lasers don't spin! Ironically, though, the word "gyro" is derived from the Greek *gyros*, which means "ring." (I dearly love it when engineers re-insert literal cognizance into the world of languages.)

The sensing element works by generating two counter-propagating laser beams, using mirrors to reflect them into a triangular or square path, then combining them at the end of the path opposite to their point of origin. The interfering beams produce a fringe pattern. When the device experiences rotational movement along the normal axis of the laser path, the beam propagating in the direction of rotation experiences an apparent increase in path length. This beam will have an apparent decrease in frequency as a result. The converse applies to the beam propagating in the direction opposite to rotation.

The difference in frequencies between the two beams will result in the fringe pattern moving (relative to the gyro) at rate and direction proportional to the frequency difference, i.e. the input angular rate. The passage of each fringe past the photo-diode beat detector indicates that the integrated frequency difference (integrated input rate) has changed by a specified increment, and a gyro pulse of integrated angular rate (a gyro "count") is generated.

The gyro counts, together with accelerometer outputs are resolved about direction cosine matrices into acceleration components. Doubly integrating these accelerations yields position displacement. In the Mk-49 there are three ring laser sensors and three accelerometers in the sensor block. They are used to produce three acceleration values; one each for the pitch, roll and heading axes.

This is a clean, functional sensor. It can pick out an Earth effect from vehicle noise with the greatest of ease. No torquers here — there are no spinning masses in the inertial block! No platform stabilization is required, either. The sensing elements are effectively strapped down to the deck, hence the title, "strapdown navigator." (That literal cognizance yet again!)

Apart from the gyro design problem, there was another stumbling block on the path to strapdown. The computational chore of performing multiple direction cosine matrix and quaternian differential transfer applications at a rate sufficient to effect real-time attitude and position data was not trivial. A rate of at least 50 transfers every second is required. By the mid-eighties we were cooking with computational gas, as it were, with the advent of the 286 processor. Together with the ring laser sensor, this made strapdown inertial navigation practical.

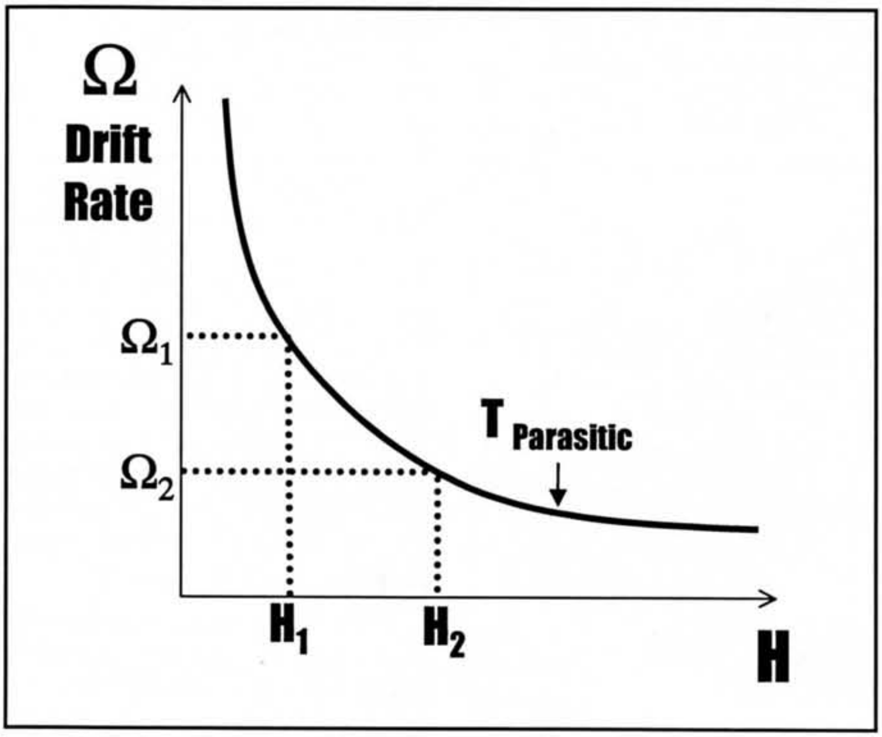


Fig. 4. Friction and imbalances within a spinning gyro can never be eliminated. To minimize the drift rate, one must maximize the angular momentum.

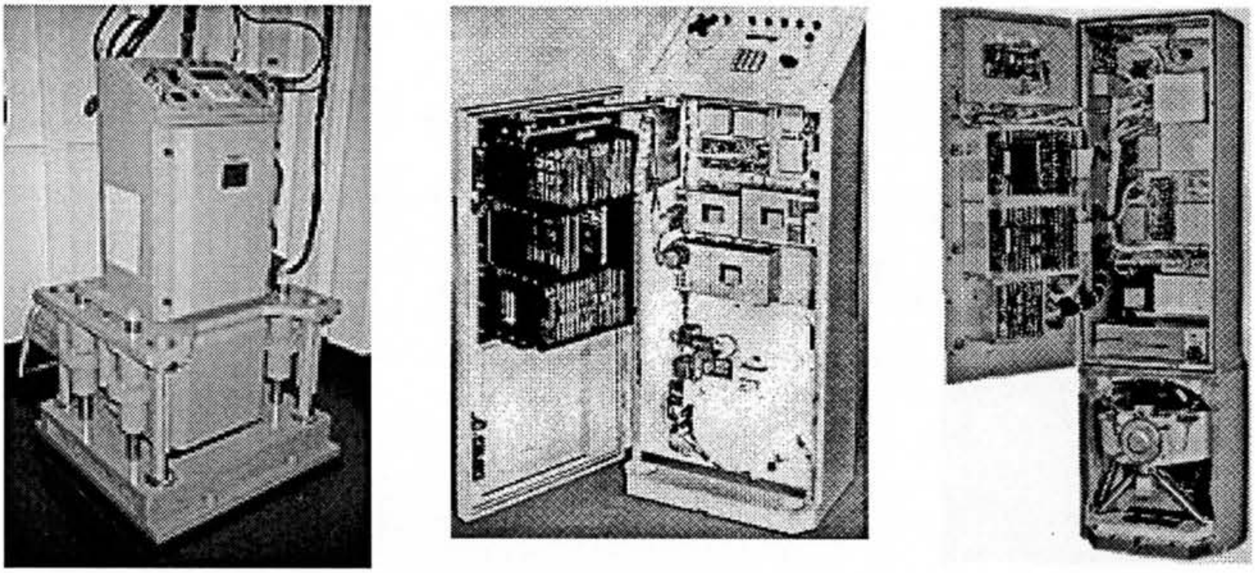
An Early Ring Laser Sensor Application

In the seventies the United States Navy's fire-control philosophies were identical to our own. The first thing the USN cried out for was a reliable attitude reference for their directors. In response to this, Litton-Marine Systems built the Mk-16 Strapdown Attitude Reference (*Fig. 5*) which was used in the Mk-68 fire-control system. This was the first shipborne use of the ring laser sensor. It required heading from the ship's gyro, and produced training and elevation correction signals for the guns and missiles. They were clearly a long way from the inertial systems of present. The evolution of the strapdown inertial navigator is depicted in the photo-essay in *Fig. 5*.

Conclusion

The best solution to any engineering problem is to eliminate the source of it. With our hot new motion sensor, spinning mass gyros are becoming obsolete, but even the new toys can't save us without good supporting equipment. Any strapdown application, ring lasers or not, still needs good processing power and effective technique to converge. With the advent of ring laser sensors, the 286 processor, and Litton-Marine System's development of advanced gyro bias compensation techniques, real-time strapdown attitude and position computation became possible.

Finally, a confession. All Mk-49 systems, including those being built as our SINS-HFX systems, are not purely strapdown in nature. When people who are so inclined (not just acoustic techs, I hope) start looking inside our SINS-HFX units, they will actually see a two-



Circa 1970:

MK-29 Inertial Navigator and Attitude Reference. "Traditional" tuned rotor gyro sensors, with gimbal stabilization to isolate vehicle rates from the inertial equation. A "strapdown" quality motion sensor was not yet available.

Circa 1978:

MK-16 Attitude Reference, the first warship use of the ring laser sensor. Though a good "torque free" motion sensor was now available, the bias correction techniques to implement inertial navigation had not been developed.

Circa 1990:

MK-49 Inertial Navigator and Attitude Reference. Ring laser sensors, 486 processor power, and good bias compensation techniques enabled strapdown inertial navigation.

Fig. 5. Evolution of the modern-day strapdown inertial navigator.

axis gimbal system. This is for a proprietary gyro-indexing process (bias reduction) which occurs periodically. In addition to this indexing process, the roll axis gimbal also serves to isolate roll effects from the inertial sensors. However, full strapdown equations are still absolutely required. This partial stabilization serves to reduce the dynamic range of motion that must be measured by the sensors, and it has worked very well in this application.

Henry Stacey works for Litton Marine Systems in Charlottesville, Virginia as a systems engineer on the MK-49 line of products.

Lt(N) Pedersen is the Maritime Navigation Systems Engineering Officer in DMSS.

Jeff Bird is a Defence Scientist at the Navigation Section of Defence Research Establishment Ottawa.

Canada/U.S. Joint Naval Operations:

CFMETR — The Canadian Forces Maritime Experimental and Test Ranges

Article by Cdr Gord Buckingham and LCdr Mike Sullivan
Photographic support courtesy of Terry Berkley, CFMETR

If anyone thought CFMETR's future at Nanoose Bay, B.C. was in some doubt during the recent dispute over seabed rights in military exercise area "Whisky Golf," Ottawa's decision to expropriate this area has assured the continuance of joint Canada/U.S. naval operations here. Although a few court challenges remain to be resolved, testing, training and evaluation continue apace.

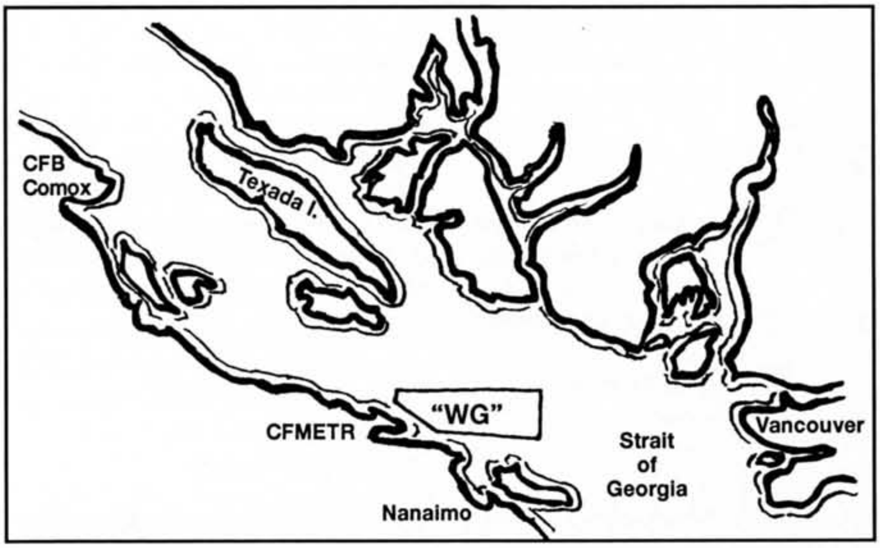
Situated 80 km west of Vancouver, the Nanoose Bay ranges have been in constant use by the Canadian and U.S. navies since 1965. That was the year CFMETR was formed as an ADM(Mat) field unit with the primary role of operating an instrumented, three-dimensional test range (jointly operated by Canada and the United States). Today, the 70 or so employees of this state-of-the-art facility capture and package data obtained from range operations, analyze Canadian torpedo and ship system trials, perform acceptance testing of sonobuoys, and repair and overhaul the Sea King AQS-502 airborne sonar.

The tug CFAV *Lawrenceville* nudges the USS *Greeneville* alongside at CFMETR in December 1999. The improved LA class SSN was visiting the Nanoose Bay ranges for torpedo testing. *(Photo: LCdr C. Hierons.)*

The Strait of Georgia near Nanoose Bay was selected for the range because of its soft, muddy sea bottom and its 300-to-400-metre depth over 217 square kilometres. This is large enough to test most underwater sensors and weapons to their design limits, and affords some shelter from open ocean conditions. Excellent tracking accuracy is provided by short-baseline hydrophone arrays situated on the seabed.

The location is also advantageous to the majority of customers since it is within 15 minutes' flying time for Comox-based Canadian Forces Aurora aircraft, 40 minutes away for the Sea King helicopters from Pat Bay, and about the same for the P-3 Orions from U.S. Naval Air Station Whidbey Island, Washington. Together with a sister unit, the Naval Undersea Warfare Center — Division Keyport, Washington (approximately 210 km to the south), CFMETR provides a significant training, test and evaluation capability that is particularly useful to the ships of the USS *Abraham Lincoln* and USS *Carl Vinson* battle groups, and to the Canadian naval fleet, each a half day's sail away in home ports of Everett, Washington and Esquimalt, B.C. respectively.

CFMETR's staff is made up of 11 Canadian military personnel, 49 DND civilian employees, six U.S. Navy civilian technicians, and various contracted support personnel including Commissionaires. Approximately half of the Canadian employees belong to DGMEPM, while the rest are members of CFB Esquimalt detachments tasked directly by



CFMETR. Everyone lives in the local communities, as there is no onsite accommodation.

The3-D Range

The instrumented 3-D range is a Canada/U.S. joint venture in which the United States Navy provided the capital for technical equipment, some technical personnel (including the salaries of five Canadians), and some range vessels manned by a U.S. contractor. The Canadian Department of National Defence provided the fixed facilities, including the earthquake proof main jetty, some range craft, as well as command, control and security of operations.

From the range operations centre on Winchelsea Island, all platforms and underwater weapons on the range can be tracked three-dimensionally by differential global positioning systems, radar and cine-theodolite, or underwater by a complex system of transducers and receivers. Acoustic pulses from pingers on ships, submarines and test weapons are received by one or more of 30 bottom-mounted hydrophone arrays. The computed tracks are displayed in real-time on various screens and plotters, or transmitted digitally for debriefings in remote locations (e.g. air squadron briefing rooms).

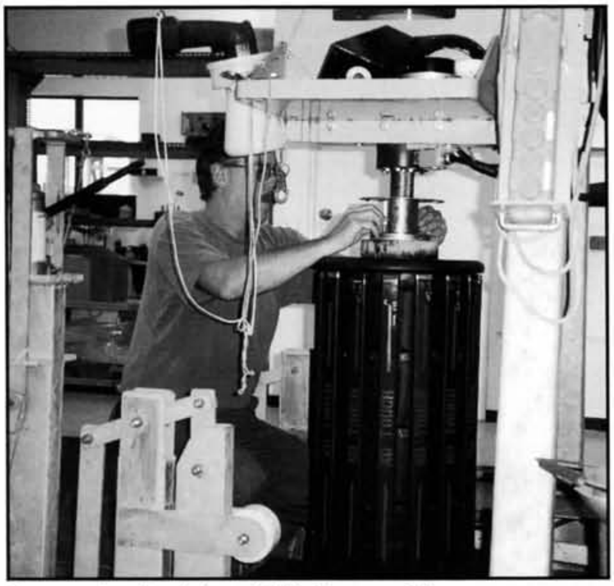
All torpedo warheads are replaced by an exercise head (equivalent to an aircraft's black box) prior to loading. Whenever possible, to reduce the cost of firing real torpedoes, specially configured, reusable non-motorized torpedo-shaped "REXTORPs and HOTTORPs" are used. Most lightweight torpedoes are launched by ships and aircraft, and recovered by a Hughes 500D helicopter on contract from Airspan in Sechelt, B.C. Heavyweight torpedoes are launched by a yard torpedo tender or a submarine, and are picked up by a torpedo retriever boat.

The Canadian range vessels — two torpedo and ship ranging vessels (TSRVs) and a sonobuoy recovery vessel (YAG-680) — deploy a variety of targets, and also measure temperature and salinity vs. depth, as well as underwater noise. These three vessels are crewed by civilians from the Queen's Harbour Master (Nanoose Bay detachment), while a range patrol vessel, the *Pelican* (YAG-4), is crewed by naval personnel. The QHM team also responds to environmental emergencies in the bay.

Sonobuoy Testing and Sea King Sonar Repair and Overhaul

The sonobuoy test facility operates separately from the 3-D range, although it shares the area and some of the infrastructure. Developmental program support, design qualification and production quality assurance testing are conducted in Nanoose Bay, Georgia Strait, Jervis Inlet or Hotham Sound. Typically, one of the TSRVs is configured with a purpose-built, modular laboratory to support testing. To save the expense of tasking an Aurora patrol aircraft from Comox, many air launches of sonobuoys are made from a Turbo-Beaver aircraft chartered from SEAIR in Richmond, B.C. Sonobuoy manufacturers and authorities who make use of CFMETR's operations on a cost-recovery basis include Hermes Electronics of Dartmouth, N.S., Sparton

HS 443 Squadron personnel load a Mk-46 exercise torpedo at CFMETR in November 1999. *(Photo: Cpl Mike Weber)*



Sonar technician Bill Reynolds prepares a helicopter sonar hydrophone for in-water testing as part of the R&O process. ***(Photo: Terry Berkley)***

of Florida, Ultra from the U.K., and recently, the U.S. Navy in-service engineering authority for sonobuoys in Crane, Indiana.

As well, the AN/AQS-502 helicopter-borne sonar has been repaired on the West Coast for more than two decades. While the "dry end" is refurbished by FMF *Cape Breton* in the dockyard in Esquimalt, the "wet end" is overhauled at CFMETR. Here, staff test, dismantle, repair, reassemble and retest the projectors and hydrophones in the facility's workshops. Final in-water testing is conducted from a special barge that houses automated equipment and a submersible test rig. Over the past year the acoustics section has also overhauled several of the similar AN/AQS-13B units for Canadian industry representing foreign clients (again, on a cost-recovery basis). This repair capability no longer exists in private industry.

Community Relations

Over the years various protest groups have voiced their opposition to CFMETR, but CFMETR's environmental record is excellent. A 1996 study by the Pacific Marine Technology Centre found the environmental consequences of range activities to be minimal — and the unit continues its efforts to be a good corporate citizen. Staff members regularly make presentations to various groups and support local events such as the Nanaimo Marine Festival and World Championship Bathtub Race. The mayors and chambers of commerce of the three nearby communities of Nanaimo, Parksville and Qualicum Beach have been fully supportive of CFMETR's existence.

The recent jurisdictional dispute between the federal and provincial governments over the seabed rights in area WG has now been settled. An area of approximately 8½ square kilometres, containing several rocky islets, was severed from the original tenure and remains choice habitat for the myriad species of wildlife and sealife that have populated this area for eons.

Cdr Buckingham is the Commanding Officer of CFMETR. LCdr Mike Sullivan is the Range Officer Designate at CFMETR.

A United States Navy torpedo retriever boat stationed at CFMETR carries Canadian Mk-48 torpedoes being tested on the ranges. ***(Photo: Terry Berkley)***

Greenspace: Maritime Environmental Protection

Expert Workshop — Findings:

Oily Waste Water and Oil Content Monitoring

Article by LCdr Mark Tinney

As indicated in the previous edition of the *Maritime Engineering Journal*, DGMEPM/DMSS 4 hosted a NATO Special Working Group 12 workshop in Hamilton last fall to discuss and share information concerning all facets of shipboard oily wastewater treatment and control (Greenspace, *MEJ*, Fall 1999/Winter 2000, p. 14). In that article I promised to pass along the results of the workshop once the conclusions and recommendations had been tabled at the subsequent SWG12 meeting. This has been done, and findings and intended actions are listed below.

During the workshop it became apparent that each nation had a different definition of the term "oil." To further complicate matters, we were all using different methods to measure oil content in water. As a result, when we compared notes on equipment performance we were comparing "apples with oranges." In some cases the differences were remarkable. It became obvious that this was a significant problem when the effluent quality of a highly sophisticated oil/water separation process, using the most stringent testing method, was compared to the effluent quality of a very simple system using the least accurate method to measure oil content. On paper the results looked the same, though in reality they were not. These results and other discussions on the problems with oil content monitors led to the group drafting the findings as follows:

- There is a requirement for a precise, universally accepted definition of the term "oil." Many existing regulations do not differentiate between free oil, dissolved oil and total hydrocarbons.
- There is a requirement for a universally accepted standard against which to measure oil content in the effluent of an oil/water separator.
- There is no existing oil content monitor that can accurately, reliably, quickly and consistently measure oil content in water when subjected to widely varying influent. (This situation could be rectified if there were a clear definition of the term "oil," and a universal standard for measuring oil content.)
- There is no requirement for an oil content monitor to verify the performance of a membrane-based oil/water separation that has been tested and certified to meet a certain standard. The nature of membrane technology is such that it acts as a physical barrier to the flow of oil through the membrane. As such, once a membrane-based oil/water separator has been certified to a certain effluent quality, the system will continue to meet this standard as long as the integrity of the membranes remains intact. In view of this, the only requirement for an oil content monitor is to serve as an alarm to alert the operator to stop the system and check the membranes.

In response to this, as a first step, the NATO SWG12 committee agreed to convene a special working group to agree upon a precise definition of the term "oil," and to agree upon a single analytical procedure to measure oil content in bilge water. Ultimately, it is intended to prepare a submission to the International Maritime Organization's Maritime Environmental Protection Committee to formally amend MARPOL 73/78 accordingly.

Summary

These actions could lead to oily water separators and oil content monitors being developed to a common recognized standard, which is not currently the case. Furthermore, information concerning the technology and processes employed to separate and monitor oil content from bilge water will become universally recognized and interchangeable among NATO navies. Perhaps the function of oil content monitors will devolve to that of an alarm in the event of membrane failure, and will no longer be the "Achilles heel" of membrane-based bilgewater treatment systems. It is also believed that membrane-based oil/water treatment systems will become the minimum required standard for future shipboard oily water separator systems.

◆

After three years as project manager of the navy's Maritime Environmental Protection Project, the Journal*'s Marine Systems technical editor LCdr Mark Tinney moves on to the career management shop in Ottawa. The editorial staff of the* Journal *wishes him well.*

News Briefs

ALSC senior project staff appointed

The navy's Afloat Logistics Sealift Capability Project is gaining momentum. As proof, an ALSC project management office (PMO) is being established at NDHQ to provide the necessary support while the project charter, statement of requirements and procurement strategy are developed.

Cdr Eric Bramwell has been appointed Project Manager, and will head up the PMO at National Defence Headquarters in Ottawa. **Cdr Dave Harper**, a Maritime Surface officer in the Directorate of Maritime Policy and Project Development, has been appointed Project Director.

The ALSC PMO will, of necessity, remain modest in size. Current requirements are for an engineering project team of six to eight individuals having skills in project management, systems engineering, integrated logistic support and acquisition/procurement. The project aims to deliver an as yet unspecified number of ships that will give the Canadian Forces the broadest possible flexibility for the next generation of strategic sealift, underway fleet replenishment and joint task force operations.

Cdr Bramwell is a member of the MARE 44E, naval architect suboccupation. His previous capital project experience includes CPF and TRUMP. Most recently, he has served as section head of DMMS 5, the acquisition management section for DGMEPM. Cdr Harper is a MARS officer with five years' experience working with requirements issues. He last served at sea as the executive officer of HMCS *Protecteur*.

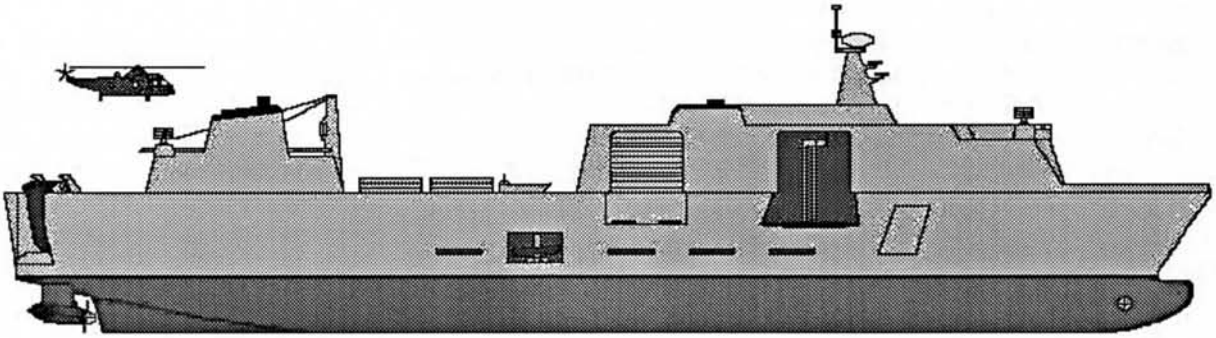
Obituary: LCdr Patrick W. Brett, CD

It is with great sadness that I announce the passing of Lieutenant Commander Patrick Walter Brett on December 24, 1999, peacefully at home after a long illness.

LCdr Pat Brett

Pat joined the navy in 1975, was educated at Waterloo University, and served on board Her Majesty's Canadian ships *Gatineau* and *Kootenay*. In 1994 after extensive combat systems engineering duties on both coasts, Pat, his wife Wendy and daughter Kaighley settled in east end Ottawa while Pat continued his service to the navy in the offices of the Canadian Patrol Frigate Project and later the Directorate of Information Services. Pat is also survived by a daughter, Danielle, from a previous marriage.

In the conduct of his duties, Pat embodied the quiet humanity and professional grace of the true intellectual naval officer. He was my divisional officer for three years, and I can attest that he was "ever on duty," with mature guidance for his people and expert engineering care for the systems in his charge. He will be dearly missed by a loving family and by his navy colleagues who wish him fair winds and following seas. — ***Lt(N) Jim Pedersen, DMSS 8-5-6.***



News Briefs

MARE Journal wins second editing award

For the second time in four years the *Maritime Engineering Journal* has been recognized for the quality of its editing by the Eastern Ontario Chapter of the international Society for Technical Communication (STC). In February the Society announced the results of its annual technical publications competition, conferring the 1999/2000 Merit Award (magazines category) on the production editing team of **Brian McCullough** and **Bridget Madill** for their work on the October 1998, February 1999 and June 1999 issues of the *Maritime Engineering Journal/CNTHA News*.

According to STC Technical Publications Competition Manager Gordon Brown, the Merit Award is given "when a publication consistently meets high standards in most areas and applies technical communication principles in a highly proficient manner." Competitors in the magazines category were required to submit three consecutive issues of their publication as a single entry. In 1996 Brian McCullough and DND graphic designer Ivor Pontiroli received STC achievement awards for their editing and design work on the 1995 volume of the *Journal*.

Brian McCullough and Bridget Madill. ***(Photo: Lori Prowse)***

Brian McCullough began his association with the *Journal* as a naval reserve MARS officer at the magazine's inception in 1982, and took over as full-time production editor in 1985. Following the cancellation of Class C service in 1994, he established Brightstar Communications and has been producing the *Journal* under tendered contract ever since. Bridget Madill earned her Bachelor of Journalism degree from Carleton University in 1973, and worked for many years as an editor for the federal government in Ottawa. She now works as an associate editor with Brightstar Communications in Kanata, Ontario.

In 1998 the *Maritime Engineering Journal* and *CNTHA News*, the newsletter of the DND-sponsored Canadian Naval History Association, joined forces as "strategic partners" in preserving Canada's naval technical heritage. The two publications share production services, but maintain separate editorial boards. *CNTHA News* now appears as a regular insert in the *Journal*.

The Society for Technical Communication was established in the 1950s to improve the quality and effectiveness of technical communication for audiences worldwide. With some 24,000 members, it is the largest professional society in the world dedicated to the advancement of the theory and practice of technical communication.

No bug bites

Over the last two years, significant resources were committed to preparing systems for the rollover to Jan. 1, 2000. Since an uneventful New Year's greeted us, we've collectively been wondering what all the fuss was about.

Did the Y2K bug not bite at New Year's? Was it thwarted? Was it ever there? Did we spend a lot of needless effort?

The Y2K bug was predicted to send machinery haywire, cause power failures, create financial disruptions and trigger nuclear emergencies. In fact, nuclear plants in Japan and Spain did suffer system failures, and a man in Albany, NY was charged $96,000 in late fees on a video rental. Elsewhere, a British bank suffered disruptions to its credit card operations, while slot machines in Delaware and automatic bus ticket dispensers in India went crazy.

What to make of all this? Were these anomalies spurious Y2K computer glitches, or the tip of an iceberg of yet-to-come crises?

The navy did fix a number of systems that exhibited hard Y2K failures during early testing: global positioning systems, communication systems, and certain direction finding equipment, for example. Furthermore, other critical systems were tested and shown to be unaffected by the date rollover: missile launchers, propulsion systems, firefighting and monitoring systems, etc. The few Y2K anomalies that we did observe were minor glitches.

It is now obvious that Y2K preparation was necessary. In the course of undertaking this effort we became better able to quantify and manage our materiel and operational Y2K vulnerabilities, and became better informed about our systems as well. ***— LCdr Richard Gravel, DMSS 8, and Lt(N) Erick DeOliveira, DMSS 5-6.***

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National Defence / Défense nationale

SPRING 2000

News

CANADIAN NAVAL TECHNICAL HISTORY ASSOCIATION

DHH Launches Post-War Naval Oral History Project

I ran into Dr. Wilf Lund (Captain (N) ret'd) at the Bytown Mess during Up Spirits on the Friday preceding the Battle of Atlantic weekend. He informed me of a project upon which he is working that will be of interest to us all. Dr. Lund has been tasked by the Directorate of History and Heritage to conduct an interview program with former Maritime Commanders and other senior naval and air officers. The objective is to capture, for historical record, personal perspectives on the development of policy and the major challenges and issues at the higher levels that affected the Canadian Navy in the post-Second World War period.

The undertaking includes focus on the major acquisition projects such as the general-purpose frigate, the DDH-280 tribal-class destroyer, the Canadian patrol frigate, submarines, maritime patrol aircraft and helicopters. Specifically, DHH hopes to enhance its understanding of the acquisition decisions and processes from the standpoint of both requirements and policy. The interviews will provide guidance to the interpretation of the extensive documentation available, as well as important personal insight.

Dr. Lund has asked me to pass this information along to our members, some of whom will be on his list to be interviewed. He also mentioned that a subsequent interview program will be conducted by DHH to gather information on the more technical aspects of acquisition projects from project managers and others who were involved. This is precisely the purpose of the Canadian Naval Technical History Association, to gather and record this type of information for historical purposes. Those who wish to be included in these projects, or who would like to provide written input are encouraged to contact the Directorate of History and Heritage.

— Mike Saker

Inside this issue:

CNTHA News *Est. 1997*

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Damage Control in the *Huron* Grounding Incident of July 13, 1953*

(*Condensed and edited from file: DHN 1151-355/10, dated July 30, 1953.)

On July 13, 1953 the destroyer HMCS Huron went aground during operations in the Korean War. The ship's engineer officer, ***Lt/Cdr.(E) H.D. Minogue, RCN****, submitted the following damage control report:*

The ship was cruising in state III. All "X" hatches and W/T doors were closed. The watertight integrity of the ship was at its maximum, with only "Y" manholes open to living compartments and ventilation on throughout the ship.

Damage control parties were piped to close up immediately after the impact at about 0038. Reports coming in to the DCHQ from damage control parties indicated the damaged area to be in the forecastle. The engine-room reported engines stopped and that machinery was not affected by the grounding. Propellers were free and generators operating satisfactorily.

The EO and electrical officer went forward to determine the extent of the damage. A preliminary examination showed that maximum damage extended aft to the forward lower messdeck and forward of W/T bulkhead 30. Number 3 deck was heaved up forward of W/T bulkhead 25, rivets were missing and the W/T hatches to No. 2 naval stores and No. 1 provision room were distorted. The following spaces were found to be flooded: No. 2 naval stores, No.1 provision room and the 144Q2W compartment, the refrigerating machinery compartment and the cold room. The 147F compartment was examined and rocks were seen piercing No. 3 deck. The paint locker and forecastle were not entered at this time.

W/T bulkhead 30 was the flooding boundary. Since it showed no signs of leakage, it appeared safe to back the ship off the rocks before permanent shores were placed behind the bulkhead. So long as the ship was operated astern, bulkhead 30 would hold.

Damage control parties erected vertical shoring in the forward upper and lower messdecks to carry the vertical weight in the forecastle area of the ship. Two-by-fours were used for this work because no larger timber was available in the ship. It was found that two-by-fours placed flat on the deck at either end of a mess bench made good temporary shoring. The mess benches distributed the loading over as wide an area as possible.

By 0400 considerable temporary shoring had been completed. As much fuel oil as possible had been pumped aft from the forward tanks, and the first lieutenant had slipped both anchors. Pumping ceased at 0400 to ensure the boilers did not lose suction. All personnel except for the watchkeepers were piped aft to the quarterdeck.

The ship went to "full astern both" in easy stages with no result. The bridge then ordered "stop port, full astern starboard." The ship took on a definite port list. The bridge then stopped the starboard engine and ordered "full astern port." At about 0426 the bridge reported the ship clear of the rocks. The ship went slow astern to the seaward side of Yang Do, where *Huron* rendezvoused with the USS *Rowan* at about 0500. The destroyer squadron engineer officer from *Rowan* came aboard to see the damage and find out what equipment would be required. *Huron* requested

Canadian Navy 90th Anniversary!

1910-2000

one complete set of oxyacetylene cutting equipment, 30 16-foot lengths of four-by-four, and a quantity of wedges. In addition, *Rowan* supplied a crew of welders to assist.

Since the ship could now manoeuvre astern and W/T bulkhead 30 was holding, it was decided to recover the watertight integrity forward of bulkhead 30 as far as possible. Curtain bulkhead 18 forming the after part of No. l central stores would be used as a watertight bulkhead. The entrance was considerably distorted, so a section of the door frame was cut away. Two-by-six planks were placed horizontally across the opening, and seat cushions were placed horizontally along the planks to make a seal. The whole section was backed by a steel door, a table top and two mess benches. Shores were then placed against the backing. Number 3 deck was made watertight by the use of small shot plugs, splinter boxes and seat cushions backed by half-doors or radiators. An attempt was made to pump out the cold room compartment using two 70-ton portable pumps and main suction without success. The attempt was abandoned and shores were placed on the closed hatch.

At 0853 on July 13, *Huron* proceeded *astern* to meet the docking ship and rescue tug until 1133 when a stop was made to cool off main engines. The docking ship and tug were sighted on the horizon and it was decided to wait for them. They came alongside and the tug proceeded to transfer anchor cable aft to the quarterdeck. The tug also tried to remove the asdic dome, so that the forward 90 feet of *Huron* could be put into the docking ship. The tug's underwater cutting gear gave considerable trouble, but before the dome could be cut away the effort had to be abandoned as the weather began deteriorating.

At 2224 *Huron* started south accompanied by the tug and docking ship. With W/T bulkhead 30 now completely shored, *Huron* could proceed at slow ahead. Progress was satisfactory until the afternoon of July 14 when waves began working at the loose plating on the starboard side. The ship was stopped at 1652 and the senior officer in *Rowan* ordered the tug to take *Huron* in tow astern. The ship reached Sasebo, Japan without further incident on July 18.…

Postscript

In the covering letter to his engineer officer's damage control report, *Huron*'s CO, ***Cdr R.E. Chenoweth, MBE***, reported to the Commander Canadian Destroyers Far East (embarked in HMCS *Iroquois*):

"The Ship's Damage Control organization was found to work smoothly and efficiently. The time element in this

(Cont'd page 4)

Technical Timeline

CNTHA members Pat Barnhouse and Mike Young are collaborating on an ambitious effort to produce a "Timeline of Canadian Naval Technology."

The timeline is intended to identify and briefly describe all the technological achievements of our navy — good, bad and indifferent! The first version is expected to be published in the Spring 2000 issue of *Maritime Affairs*. That edition will be a special one, commemorating the 90th anniversary of the founding of the Royal Canadian Navy.

The authors welcome any comment on this work in progress and it is hoped that the next update will be included in a future issue of this newsletter.

— Mike Young

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 casual readers alike. So how can you get to read some of it? For the moment there is only one copy of the Collection, situated at the Directorate of History and Heritage located at 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 is on hand to retrieve the information you request and to help in any way. Photocopy facilities are available on a self-serve basis. Access to the building requires a visitor's pass, easily obtained from the commissionaire at the front door. Copies of the index to the Collection may be obtained by writing to DHH.

◆

Landlocked!

This mid-section mock-up of a *St. Laurent*-class hull compartment was one of the projects constructed by the Trade Group 3 shipwrights as part of their course syllabus at Engineering Division in *Stadacona* in the mid-1960s.

All three men in the photo are brand new petty officers (second class), but we only know the names of two of them: Darwin Robinson, who is kneeling by the hatch went on to receive his commission and eventually retire as a lieutenant-commander; and Don Teed, who left the navy after seven years, is standing in the doorway. Can anyone identify the man at the deadlight? *(DND photo, 71244)*

— Harvey Johnson, DMSS 2

◆

(Cont'd from page 3)

case was a major factor in that it was essential that every effort be made to refloat before first light due to the proximity of enemy shore batteries….

….this case is perhaps unique in that the damage incurred by the ship subsequent to the refloating and while on passage to Sasebo was negligible. This was largely due to the weather and that the ship was taken in tow stern first. As a result this enabled the maximum amount of stores, equipment and personal gear to be recovered.

It is also desired in the light of experience to submit the following damage control recommendations:

(1) That all ships should be provided with a power driven saw. If such had been the case the shoring time would have been cut down by 50%.

(2) That all ships should have stowage forward as well as aft for bottles of Oxygen and Acetylene. This would eliminate the necessity of having to move these heavy and cumbersome bottles under blackout and adverse conditions.

(3) That at least 90% of all shoring lumber should be 4 x 4's with the remainder 2 x 4's. It was found that 4 x 4's were the primary requirement, and in this instance, in addition to the 4 x 4's carried by *Huron*, the entire supply of two USN destroyers was required."

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