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83
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Maritime Engineering Journal

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Feature Article

Frigate Propeller Manufacturing in the Nation's Capital

CANADA 150

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Canada

"Funnel Watch"

The UNTD Cadet Journal of Commodore Mike Cooper, RCN (ret.)

see page 16

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Maritime Engineering Journal

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Editorial

Forum

Feature Articles

News Briefs

CNTHA News

A frigate propeller blade being machined at Dominis Engineering Ltd.
Photo courtesy Dominis Engineering Ltd.

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COMMODORE'S CORNER

Vectors of change inside the "MARE" Council

By Commodore Simon Page, OMM, CD
Director General Maritime Equipment Program Management

Twenty years ago, Cmdre Wayne Gibson used this space to reaffirm the mandate and membership of the Maritime Engineering (MARE) Council – the Royal Canadian Navy's senior advisory body on matters relating to the technical branch. The fundamental objectives of the Council have not changed significantly over the years, and at least twice a year the branch's senior naval engineering officers meet to adjust the ever-so-complex machinery that keeps our naval materiel management enterprise operating at peak efficiency.

As ever, the thrust of the Council's deliberations focuses on providing comprehensive advice to the chair – the Commodore DGMEPM of the day – regarding issues, changes, priorities, and actions affecting the naval technical community. The Council creates a natural and perfect opportunity to discuss the evolution of the naval materiel management enterprise, and where the collective emphasis should be directed.

From the input we have received from within the community, it is clear that a sustained effort must be made to ensure the Council remains relevant, credible and effective to all of our members, and to the RCN at large. In response, we believe that certain vectors of change being introduced by the Council are, in fact, offering significant improvement in how we manage the affairs of the naval technical community.

The membership of the Council has always included captains and above from the Naval Engineering occupation, but a few years ago the DGMEPM Unit Chief was invited to the table to enable a better appreciation for the issues surrounding the non-commissioned members (NCMs) in our technical trades. More recently, in an effort to share even wider perspective on the most urgent and complex issues affecting our enterprise, the first day of every Council session was opened to commanders and chief petty officers 1st class. This also gives the Commodore an opportunity to impress upon a larger audience any specific important strategic messages and guidance.

In a significant move last year, the senior female Naval Engineering commander and senior female naval technical NCM from each coast were added as full-time members with a view to including better representation concerning gender equity issues within our occupations. This alone has created some excellent Council engagement on topics such as service aboard ship while pregnant, precise career management for members with specific and known family plans, and selection for key positions. In the longer term, it is expected that additional issues affecting our community – *whatever they may be* – will be considered during Council deliberations.

Something we know requires further attention is the Council's connection to the junior members of the community, especially the NCMs. It is imperative that there be more open and responsive communication between us, and to this end we have introduced an annual Junior Members segment to the Council agenda to ensure their perspectives and concerns are heard. Good communication across all levels is vital to the Council's success, and efforts are underway to create an innovative, multi-layered mechanism for improving the necessary two-way dialogue between Council and Community. Even the dated name of the "MARE" Council is being refreshed to better reflect who it is we represent, and what it is we all do.

Chairing the Council remains one of my favourite activities as Director General, and I am hoping that these initiatives will contribute to an even stronger forum for rich and meaningful dialogue among all of us. While I am confident that we are headed in the right direction in terms of offering the best possible support to the naval technical community and the Royal Canadian Navy, I will always appreciate constructive suggestions for improvement that any of you might care to give me.

EDITOR'S NOTE

Our enduring qualities

In wishing the readers of the *Maritime Engineering Journal* a very happy 150th anniversary of Canada's Confederation, I can't help wondering what the political architects who attended the Charlottetown Conference and eventually oversaw the birth of our country would think of the results from today's perspective.

For one thing, I am sure they would be proud of how their vision has manifested itself; proud to see the many positive and good things that Canada has brought to the world; proud to see how Canada has evolved in its own right; and proud of the reputation Canadians have earned in the eyes of the world over the last 150 years. This reputation was forged with political vision, military and public service dedication, and entrepreneurship by those who saw a possibility and willingly built a better tomorrow. They invested in themselves, in their communities, in each other, and in Canada. They saw what others might have missed – the awesome potential when good ideas come together with determination, sacrifice, perseverance, and fortitude to produce positive action leading to outstanding results.

Thirty-five years ago, a somewhat less grandiose but no less inspired visionary plan emerged to create a singular journal that would become the voice of Canada's naval engineering community – an inclusive, diverse technical enterprise. The publication would share lessons, tell of accomplishments and challenges, and celebrate its people. Many dedicated individuals have kept the *Maritime Engineering Journal* true to its purpose over the years, and today it is the leaders who take action and have the determination to maintain this publication at such a high level of professionalism that are its engine. With the exception of Production Editor Brian McCullough, the editorial team has changed continually over the decades with the normal comings and goings of our people throughout the enterprise. This ever-changing makeup continues to breathe life into the magazine, with each new edition demonstrating a tangible manifestation of the original vision. And finally, the contributors and readers who, even with their busy schedules, take the time to read the magazine, provide thoughtful comments, and contribute articles, do their part to keep this periodical relevant and evolving. The determination and capabilities of those involved have laid the groundwork not only for 35 successful years of publication in spite of sometimes variable winds of fortune, but have also set a true course that will keep our *Journal* moving forward to its next 35 years and beyond.

The *Journal*'s founding officer, Commodore Ernest Ball (1932-1989)

To that end I would like to personally thank everyone involved in this magnificent publication, and at the risk of offending anyone would like to single out the contribution of one person in particular. Brian McCullough's first involvement with the *Journal* was to write out the initial production specifications in 1982, before taking on the task of copy editing and producing the *Journal* as a secondary duty. At the time, he was into his third year of what would turn out to be a 15-year stint of Naval Reserve Class C service as a MARS lieutenant commander embedded within the naval engineering community. Ever since the very beginning he has maintained the vision and mission of the *Journal* by bringing purpose and focus to each edition, while keeping it broad-ranged, enjoyable, and relevant. You might say he was the architect that brought forward and delivered on the vision of the engineering director general at the time, Commodore Ernie Ball, and the rest of the

MARE Council. I'm sure they would be delighted to see how their fledgling idea has grown, evolved and otherwise manifested itself, and to experience the *esprit de corps* it has brought to the Royal Canadian Navy (RCN) and others. They would be proud of the reputation the *Journal* has earned for itself.

Since the beginning, every Chief Naval Engineer of the RCN has ensured the magazine's survival. There is a saying that it takes a village to raise a child. Likewise, it takes the entire community to maintain this *Journal*. Thank you to those who came before, those who are currently involved, and those yet to come, for this will be a lasting, enduring legacy that will long pay tribute to those who started it three-and-a-half decades ago.

This *Journal* is yours. It is all of ours, and its vision and mission have remained unchanged from the objectives that were published in the first Commodore's Corner in 1982:

a. to promote professionalism among Maritime engineers and technicians;
b. to develop consensus concerning major issues;
c. to provide announcements on MARE programs;
d. to present practical engineering articles of interest to Maritime engineers;
e. to provide personnel news of a type not covered by existing publications;
f. to provide historical perspectives on present situations or events.

The *Journal* has met all of these objectives throughout its history. A quick review of our magazine archive, kindly maintained by the Canadian Naval Technical History Association (http://www.cntha.ca/publications/m-e-j/), bears witness to the *Journal*'s extensive coverage of major projects of the day, significant personnel happenings such as the selection of CSE Commander Marc Garneau to the Canadian astronaut program, and commentary and discussion surrounding the technical and operational issues that affect our daily activities. We have never shied away from informed opinion, or bold leadership. When the *Journal* became the very first DND branch periodical to commit to a fully bilingual format in 1998, we set a new standard for all other publications of its ilk in the Canadian Armed Forces. To this day, our magazine with its humble beginnings continues to be held up as a model of what can be achieved through the publication of a focused, general-technical journal.

Commodore Ball once wrote that the *Journal* was created to fill a need in our community. This need existed then, exists now, and will exist for many, many years to come. The *Journal* has remained true to the values on which it was founded, and it has that enduring quality that comes only from a solid, timeless vision. Its purpose has always been to reach the entire naval engineering community, and not just those of us in uniform. It is therefore with great pride that we continue to encourage anyone and everyone to contribute. I'm sure there will be changes in the future, especially as our naval engineering enterprise grows, but the *Journal* will expand and adapt to meet these new demands, and in so doing will continue to meets its founding objectives and vision.

Thank you for your continued support. It takes a dedicated team of professionals to monitor, mentor, protect, guide, develop, and produce the future of the engineering community, including this fantastic and worthy endeavour we call the *Maritime Engineering Journal*.

I invite you to sit back and enjoy your Spring 2017 edition in its fresh new design to celebrate Canada's 150th anniversary, and to join me in saying happy 35th to the *Journal*, and happy birthday Canada!

Yours aye,

— Captain Dave Benoit, RCN, Senior Editor

LETTERS TO THE EDITOR

Re: Special HCM Issue No. 82

A remarkable issue. I am making sure the Canadian War Museum acquires it. My congratulations to the editors.

Best regards,

Alec Douglas

Dr. W.A.B (Alec) Douglas served as Director of History for the Department of National Defence from 1973 to 1993, and as Director General History until his retirement in 1994. His article, "*On Canada's Doorstep – The 1942 Battle of the Gulf and River St. Lawrence*," was published in the *Journal*'s 25th anniversary edition (MEJ 62) in 2007.

Alec was born in Salisbury, Southern Rhodesia in 1929, and emigrated to the U.K. as a child. He was evacuated to Canada with other children during the wartime Blitz, but returned to England in 1943 as a "guest of the Admiralty," on the understanding he would join the Royal Navy if the war was still on when he came of age. The war ended first, and he came back to Canada in 1947. He joined the University Naval Training Divisions (UNTD) during his undergrad at the University of Toronto, qualifying as a navigation officer in the Royal Canadian Navy.

Alec served as squadron navigator and operations officer with the 7th Canadian Escort Squadron from 1961 to 1964, and during this period earned a Master of Arts degree in history at Dalhousie University. His 1962 thesis: "*Halifax as an element of sea power, 1749–1766*" led to his 1964 posting as an associate professor of military studies at the Royal Military College of Canada. In 1967 he was assigned as a historian with the Directorate of History at National Defence Headquarters in Ottawa, and in 1970 became senior historian there. Alec completed graduate studies at Queen's University under Sydney F. Wise, earning a Ph.D. in 1973 with his thesis: "*Nova Scotia and the Royal Navy, 1713–1766*," after which he retired from active naval service.

Alec's publications include, *No Higher Purpose* (Vanwell 2002), and *A Blue Water Navy* (Vanwell 2007) – the two-volume official operational history of the Royal Canadian Navy in the Second World War.

— ***Editor***

Thank you for passing on a copy of the *Maritime Engineering Journal* featuring the Halifax Class Modernization project. I just received it this morning and was so surprised to get it. This is extremely thoughtful and very much appreciated. I've been following the progress of the project over the years with only access to the big highlights, so I really look forward to reading through this, and will certainly be hanging on to this copy.

This is such a nice memento to have. My dad (initial HCM Project Manager Paul Hines) was very passionate about the project, and I've been very proud of his contribution to such a successful program.

Thanks again,

— ***Matthew Hines***
Deputy Project Manager
Force Mobility Enhancement (FME)
Directorate of Armament Sustainment Program Management
National Defence Headquarters, Ottawa

FORUM

Anchored in the Future

By RAdm John Newton, Commander Maritime Forces Atlantic

It is hard to imagine inadvertently dropping an anchor. To prevent such an occurrence, there are drilled procedures, crisp communications, a safety briefing, and frequent training. To drop the anchor, the cable party would have to be up and about their equipment, a heavy mechanical restraint tripped, and a braking mechanism laboriously released. Finally, all this activity would occur under the watchful eye of an alert officer-of-the-watch who would surely query the commotion.

In my story, the cable party had been held for hours at monotonous standby when, out of the blue, the team's communicator was certain he heard someone order the anchor to be let go. With that his watch mates jumped into action and the anchor shot away, pulling out great lengths of chain as it accelerated toward the seabed. Fortunately, the cable party executed the panicked countermanding order from the bridge with the same alacrity with which they had released the anchor in the first instance, leaving hundreds of feet of cable hanging vertically beneath the ship.

I took lessons from that experience and demanded of myself that I understand how a basic element of ship safety could become in actuality a liability. I learned what had already been learned, that watch teams must not be abandoned at their posts. The teams must be included in conversations and visits by supervisors. For their part, they must remain alert and fully cognizant of the ship's progress. In the case of the incident described, an attentive cable party might have judged whether there was time to query the surprise order. A more thoughtful officer-of-the-watch might have asked if a cable party was indeed required for hours on end where threat of grounding was not imminent.

Weeks later, while steaming up the St. Lawrence River, I noted during evening rounds of the steering gear compartment a noise not unlike water hammer in kitchen plumbing. My rudiments of engineering confirmed to me that hammering in very high-pressure hydraulic lines was not normal. The engineering watchkeepers agreed with me, but the issues with our steering system had been chronic, and this was but one symptom of bigger challenges that various repairs had been trying to address. My duty done, I left it to the engineers to operate the system safely.

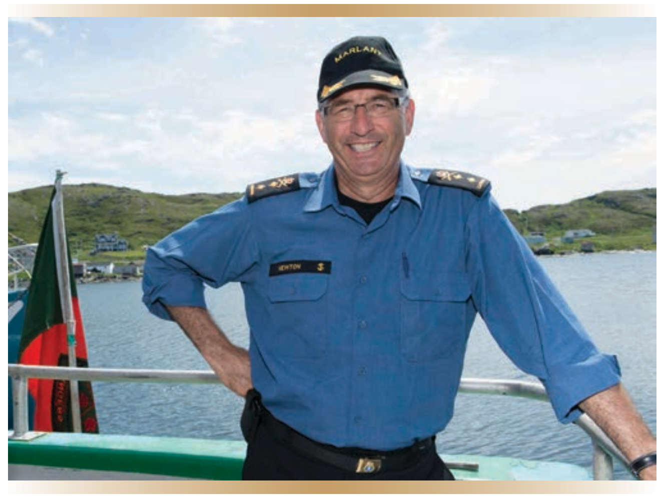


Photo by Cpl Chris Boudrias, Exercise Coastal Ranger 2014

The next day we were sailing upriver from Quebec City when the captain asked me to relieve him on the bridge for a few minutes. Proceeding at 24 knots against a strong river current is a thrill to say the least, but the dangers are manifold. While at first the river was still wide, the channel was narrowing quickly. My initial action was to establish order on the bridge. A large delegation of HMCS *Athabaskan* survivors from the Second World War was present, guests for the day, celebrating their annual reunion. Their awe at the modern surroundings compared with their wartime Tribal-class destroyer generated excited chatter, a distraction on the bridge as the channel narrowed to 500 yards.

As I turned to look up the river, I felt the ship suddenly heel over, and the horizon began angling diagonally across the windows. I grabbed something for support and barked a query at the officer-of-the-watch, wondering why he was changing course ahead of any planned alteration. As he stammered, befuddled by the emergency building around him, the helmsman shouted above the noise that he had not turned the helm. The ship was racing forward under maximum rudder angle toward an imminent grounding, with the 80-year-old *Athabaskan* survivors holding on for dear life on the steeply sloping deck. With the ship clearly in extremis, a full-speed-astern engine order and the anchor were all that stood between the veterans and what appeared in the moment to be their second warship disaster.

The bite of the astern pitch on the racing propellers could be felt almost immediately as the channel edge loomed. Alarmingly, the telltale rumble of the anchor never materialized. On this occasion, the cable party was attentively looking back to the bridge for a clear signal that the anchor was indeed required. Madly shouted orders communicated the urgency of the situation. With the swing of a sledgehammer and a spin of the brake handle the anchor was let go. Heavy chain surged out of the ship with a roar like none of us had ever experienced, the anchor clawing at the shoaling bottom with great effect. With only yards to spare, the nightmarish dash toward a grounding was arrested.

Subjected to literally thousands of hammering vibrations in the steering gear hydraulic lines, a card assembly controlling the rudder angle had failed. We had been given ample warning that an unusual situation had developed in the steering system, a risk we arguably failed to account for in our preparations for the river transit. Then, in accordance with classic accident causation theory, as soon as all the critical factors had lined up – stressed machinery, speed, proximity to danger, and with hundreds of guests on board – the system had failed.

This is a simple story of the drama possible in a high-powered warship. I relate it to highlight that we must be genetically wired to constantly re-evaluate our shipboard actions, organizations, and standard operating procedures. Introspection must occur at the unit level, and more widely at a navy level. While the former has always been the case, the latter has not.

In my anchor story, I examined whether the organization we employed and the procedures we followed actually served the purpose of making the ship safer. We used the near-grounding to reaffirm our discipline toward bridge watchkeeping, steering gear failure drills, and communications. That said, we were not suitably set up as a navy in that era to examine the organization and watchkeeping scriptures more thoroughly: We simply took those as immutable and corrected what we could control. The near-grounding burned into my brain a concern that our navigation and watchkeeping routines are manpower intensive, thereby contributing complexity to our procedures. A simpler elegance might possibly reduce the very risks we were trying to mitigate.

I also noted that we practise certain drills as mitigation in the event that a low-probability accident scenario occurs. For instance, we routinely conduct man overboard drills when, arguably, there is a higher probability for mishap and injury during the training than during an actual man overboard situation. We contend that these drills serve many purposes without weighing by what other means these purposes could be served. There are other examples of self-induced risk, such as full-power trials, blackout drills, and full-speed-ahead to full-speed-astern demonstrations, all of which require careful assessment of the risk versus reward. On another front, we assign manning and procedures to undertake tasks that a specific technology is also performing, a sort of human affirmation that the technology is working correctly. Finally, we have a healthy reserve of human capital for round-the-clock operations, damage control, and manual procedures as battle may demand of us.

Photo by Cpl Chris Ringius, Exercise Cutlass Fury 2016

HMCS *Athabaskan*

Today, we are experiencing a confluence of events that is permitting us to examine all aspects of our shipboard organizations and the procedures we follow. The executive plan laid out by our commanders and the shipbuilding strategy are not unrelated. Indeed, they present a golden opportunity to adopt increasingly powerful technologies, and to critically re-evaluate the fundamentals of crewing. Our Experimental Ship, or X-Ship, program has been identified to lead the evaluation of the efficacy and efficiency of our many shipboard routines. Innovation in X-Ship draws on the talents of our two Sea Training teams, now combined into a single command, Canadian Sea Training Group, under the aegis of Commander Maritime Forces Atlantic. A single Naval Force Readiness director, also under Commander Maritime Forces Atlantic, has overhauled each naval order relating to collective training, and every combat readiness requirement right down to the detail of personnel requirements, drill procedures, and periodicity.

Navigation techniques are being completely reassessed, with a keen eye turned to the lessons learned over two decades of success with digital charts and modern track-following software. Most recently, bridge manning has been dramatically

Photo by Cpl Anthony Chand, Formation Imaging Services, Exercise Spartan Warrior 2016

Photo by Cpl Anthony Chand, Formation Imaging Services, Exercise Spartan Warrior 2016

reduced as technology has proven to be a trustworthy substitute for human operators. The Enhanced Naval Boarding Party has been introduced, and the requirements of a standard team amended so that crew members are not double-tasked with boarding training and employment duties in addition to their primary job aboard ship.

Machinery control-room watchkeeping has been reduced, and the duties of a single rounds person clearly articulated as we adapt to the Integrated Platform Management System delivered with the Halifax Class Modernization. Better data-logging, and more numerous CCTV cameras now watch over the machinery. Personnel liberated from watchkeeping are being marshalled to undertake increased levels of planned and corrective maintenance so that any risks developing in the machinery are intercepted before failure.

There are other areas to be examined, including the crew requirements of cable parties, replenishment-at-sea teams, and boat launch-and-recovery teams. Boat operations have come under critical review in time to better support increased naval operations in the north. Combat drills and operations room manning may very well change, subject to the performance of modernized sensors and command management systems.

The potential for increased optimization of our crewing structures and shipboard routines is occurring against a backdrop of other changes. We anticipate new levels of in-service support contracts to be delivered with new classes of ships. We can expect increased levels of machinery automation, alarm condition sensing, and more effective damage control systems. We have already learned that onboard training simulation is highly effective, and a standard adjunct to modern operating systems. We stand witness to improved shipboard communication technologies that fundamentally change how we direct emergency teams to face fire and flood.

Concurrently, teams are re-examining the task expectations of trades managed by the Royal Canadian Navy. With technology, there is a narrowing of the differences in the training and onboard employment of various combat operator and engineering trades. The *Harry DeWolf*-class Arctic and Offshore Patrol Ships will be our first foray into a high-voltage power plant, necessitating a review of the training and shipboard manning by marine technicians that will serve in these ships. There will be increased automation controlling the power plant and associated hotel machinery systems, improvements readily apparent in modern warship classes on the international market. Reliability factors, the number of personnel required, and their organization and routines will change accordingly.

Throughout all this, our proficiency will continue to be tested regularly, first by ourselves exercising as teams to scripted serials, then by external validators. Our corporate memory of what we formerly achieved will challenge the new arrangements to confirm that capability and effectiveness have not been lost unless accounted for by other measures. The tools needed to assess that a sailor is being sent to sea with the requisite certifications, qualifications, and experiential coefficient are being built and trialed. Leadership at all levels will have visibility to the readiness of ships, aggregating technical, personnel, and collective training variables into a readiness assessment. If we find that we have weakened our readiness rather than strengthened it, we will re-evaluate the changes set in motion.

Photo by Cpl Chris Ringius, Exercise Cutlass Fury 2016

Change is neither easy nor pleasant. It takes leadership courage, good followership, and ownership by our most experienced personnel. The naval occupation analyses now underway are a case in point, wherein our most experienced chief petty officers are leading the change. The machinery control-room watchkeeping review gained energy and constructive input by senior chiefs serving in Canadian Sea Training Group. Revision to training was concurrently executed by engineers in the Naval Training System. This navy-wide focus bodes well for the pursuit of well-reasoned and beneficial changes.

It is an immutable fact that residual risks will exist. Risk is a constant in the difficult and dangerous work at sea, and it is the commander's business to decide whether to accept or refuse residual risk. Risk that manifests itself as an accident or near miss will continue to demand our full attention. Risk can also be measured in morale, attrition, and career paths that have become too difficult. These will all need our close attention, along with mitigating strategies inherent in our commander's motto of, "People First, Mission Always." That said, while there is risk inherent in change, risk itself cannot be held out as a reason not to proceed with a full and comprehensive assessment of where our system can be made better.

Much has already been set in motion under the clear lines of authority facilitated by functional leadership authorities. Improved governance, X-Ship, and the experience of our most senior non-commissioned members are all ensuring that we are digging deeper into institutional considerations and not simply skimming the surface. The gravity of fleet recapitalization can be felt, and the good news story of the Halifax Class Modernization is an unexpected bridge to walk across as we examine the feasibility of new structures and procedures. I am inspired by the veritable army of personnel participating in this effort, an observation that confirms to me that we are not at all anchored in the past.

I am certain now that we are in a position to re-evaluate the circumstances of the inadvertent anchorage and near-grounding incident described at the beginning of this article, and bring meaningful corrective action items to bear across the breadth and depth of our great navy.

Photos courtesy of LCdr Kelly Williamson, Senior Public Affairs Officer at Maritime Forces Atlantic HQ, and LCdr Amber Comisso, Executive Assistant to Commander Maritime Forces Atlantic.

Photo by MCpl Jennifer Kusche, Canadian Forces Combat Camera

FEATURE ARTICLE

Manufacturing Propellers in the 21st Century

By Claude Tremblay and Slobodan (Bodo) Gospodnetič

Figure 1: HMCS *Calgary* - *Halifax*-class Frigate

A great many things are made in Ottawa: Legislation, software, propellers... *Propellers?* Yes. As in frigate propellers. Who would have thought?

When the *Halifax*-class Canadian Patrol Frigates (CPF) (Fig. 1) were being built starting in the late 1980s, the Department of National Defence (DND) acquired the proprietary rights from the original propeller manufacturer to allow spare propellers to be manufactured from a third party of DND's choice whenever needed. A recent competitive contract to make two sets of spare frigate propellers (10 right-hand blades, and 10 left-hand blades) was won by a small high-tech firm in Ottawa: Dominis Engineering Ltd.

Dominis Engineering uses high-precision computer numerical control (CNC) milling machines to manufacture large and small propellers and waterjet impellers, with the help of technology developed at Canada's National Research Council a few years ago. CNC machining is fairly common these days, but machining ISO 484/1 Class S (the finest of ISO tolerances) noise-reduced propellers to final form is a rarity in North America. Refer to Table 1 for a summary of the ISO 484/1 & 2 Class S tolerances.

Measured propeller blade parameter	ISO 484/1 Propellers of diameter greater than 2.5 m
	Tolerances for class S
Surface roughness, R_a	less than 3 µ metre
Thickness	+ 2%, max. of 2 mm - 1%, min. of -1 mm
Chord length	± 1.5%, min. of 7 mm
Local pitch	± 1.5%
Mean pitch of each radius	± 1.0%
Mean pitch per blade	± 0.75%

Table 1: Class S Tolerances per ISO 484/1

Propeller Blade Design

A propeller is more complex than it seems. Its shape is driven by the principle of lifting surfaces, the same principle aircraft wings use; however, the rotational movement of a propeller adds a new level of complication. The surface speed through the water increases with the diameter of the propeller, thus producing higher lift. In order to keep the lifting force relatively constant throughout the propeller blade, the pitch needs to be changed and adapted to the changing diameter. Years of research have refined the shape of propeller blades to reduce drag, push cavitation inception farther up the speed curve, eliminate vibration and resonance (otherwise, they would sing like mermaids!), reduce wake disruption and noise reverberating through the hull, and improve efficiency, which we understand better as fuel savings.

When the resulting propeller blade design is put on a drawing, it is surprisingly simple, comprised of a table of numbers, and not too many of them at all. Hydrodynamicists calculate the shape of the propeller blade as it goes through the water. Since it rotates, the surface that touches the water at constant speed is found at a given cylindrical section (Figure 2). To visualize this, imagine a cylinder centring on the shaft and cutting through the propeller; the resulting intersection on the blade thickness is a cylindrical section.

The designer will take that section and "unwrap" it to get a two-dimensional shape (Figure 3). That 2D shape will look very much like a cross-section of an aircraft wing. Once they apply their lifting surface theories and modern calculation techniques, the resulting shape is divided into sections. One reference line called the chord line, or pitch helix, runs longitudinally, while a series of perpendicular lines cross the two blade surfaces – one being the face or pressure side (PS), the other being the back or suction side (SS). If the reference zero is on the chord line, the ± distances of the two faces are the data found on the propeller drawing offset table.

The propeller blade is usually made of 10 to 20 cylindrical sections (Figure 2), from 0.3R (30% of full radius) to 0.95R and 0.975R (the tip being 1.0R). With reference to Figure 4, each of the sections is listed with an associated pitch angle (since it changes throughout the diameter). Additional features are skew (the whole section is moved back along the chord line to reduce noise), and rake (induced by the skew, or added or removed for design efficiency). The design is then complete, and the hydrodynamicist goes home

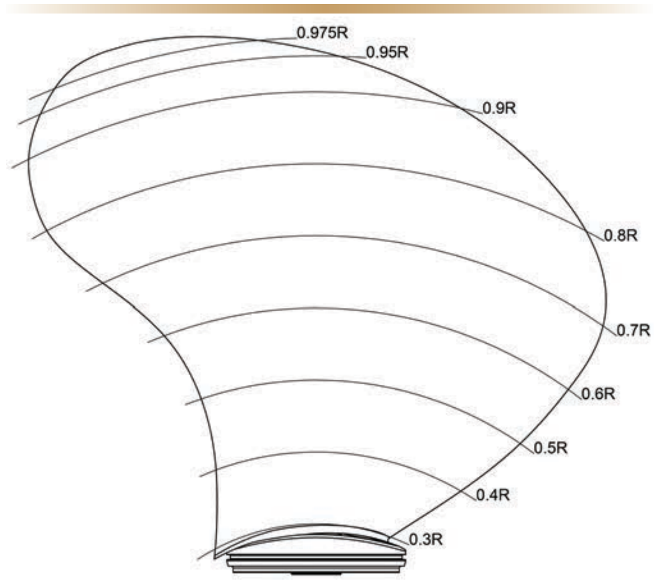


Figure 2: Propeller with Cylindrical Sections Superimposed

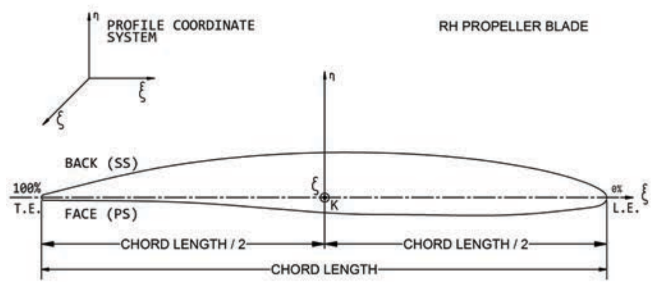


Figure 3: Unwrapped (2D) Propeller Blade Section

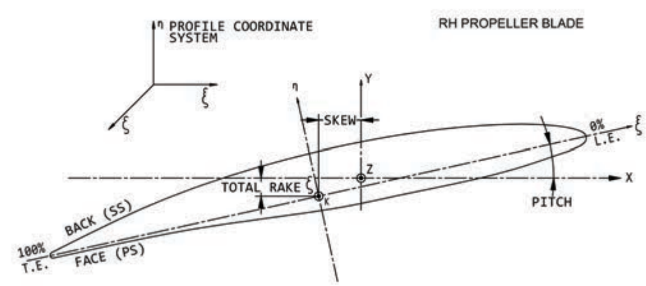


Figure 4: 2D Propeller Blade Section Adjusted for Pitch, Rake, and Skew

(in a simplistic world, since model testing and various other tests are required). The challenge is to now accurately machine this design to full scale.

Propeller Blade Manufacturing – The New Era

Traditionally, propellers are made by hand. Well, sort of. Skilled craftsmen build propeller patterns, manufacture templates, and produce wooden shapes to use for imprinting the mould for the castings of the rough propeller. They use mathematical transformations to wrap, pitch, skew, and rake the 2D model of the drawings. Once cast, the rough propeller is usually installed on a drilling machine; for controllable pitch propellers, individual blades are mounted on a dummy hub that is then turned to design pitch. The drilling machine will drill holes whose depth will be at the exact position of the surface of the finished propeller in accordance with the offset table. Once the guiding holes are completed the craftsmen then start grinding off the excess material around the holes until they disappear, which means that the desired surface has been reached. Since the drawing only identifies a limited number of cylindrical sections, there are large gaps between sections. That is where the skills come into effect; the extra material is ground off until the whole surface of the blade is smooth as felt by hand from one section to the next.

This is very exacting, time-consuming work, and skilled workers are hard to find these days. CNC milling machines can do the work much faster, but can they replace the expertise of skilled workers? That was the challenge Dominis Engineering Ltd set for themselves to solve, and they succeeded.

The initial step was to build a 3D computer model of the entire propeller geometry, not just the cylindrical sections. Since a limited number of points are provided by the designer, an accurate interpolation method was required to compute any undefined point on the propeller surface. Dominis Engineering uses proprietary in-house software to interpolate and check all propeller blade sections provided in the table of offsets for smoothness. The software is used to identify bumps and discontinuities (Figure 5), and correct them (Figure 6) to improve the blade section and, eventually, the propeller blade's performance. The corrected blade section is used to improve the computer model.

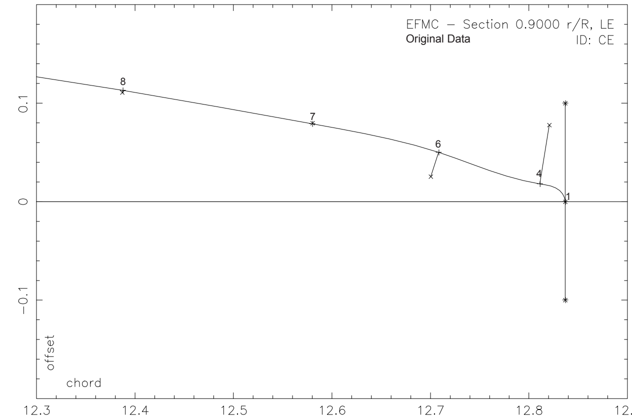


Figure 5: Original Data before Smoothing of a Sample Blade Section

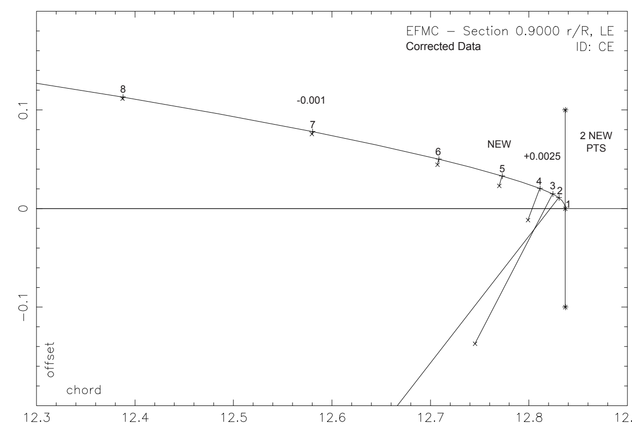


Figure 6: Data after Smoothing of a Sample Blade Section

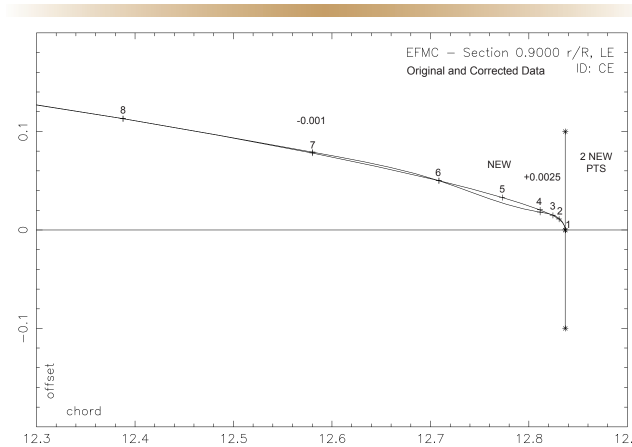


Figure 7: Original and Smoothed Data of a Sample Blade Section

Figure 7 shows the overlap of the sample blade section before and after smoothing with Dominis Engineering's in-house software. The smoothing process is iterative and requires looking at all the blade sections. In some cases, new interpolated blade sections are created to improve smoothness between sections. A smooth propeller blade is not just important for performance, but also for the ability to machine it, as a bumpy surface can wreak havoc when creating a CNC machining program.

To be able to machine the whole blade to final form, much more information than the cylindrical section is required to enrich the model. Leading edges are usually provided in the shape of gauges; trailing edges with the "anti-singing" alterations. Fillets, which are the rounded sections required to strengthen the base of the blades in order to transmit the full thrust without bending, are not well defined. Details of the trunnion or blade palm, the circular portion that fits in the hub allowing the blades to be turned to change pitch, must be very well defined.

Final Form and Finish

Now the real calculating begins. The goal is to machine the propeller blade, as Dominis Engineering refers to it, to "final form and finish." Final form of a propeller is defined by the propeller's table of offsets, while finish is the desired final surface roughness of the propeller which is dependent on scallop height, the scallops being the material left between passes of the cutter (Figure 8). The selected maximum scallop height was set at 0.3 mm, which means that the only operation left to be done by hand at the end would be polishing. The scallop height is determined by the size and type of the cutter, and by the spacing between cuts or passes. The larger the cutter, the more spacing that is required; however, the smaller cutters are more accurate. For a spherical cutter of radius $\mathbf{r}$, distance between cuts (step over) being $\mathbf{s}$, scallop height $\boldsymbol{\varepsilon}$, can be approximated as $\boldsymbol{\varepsilon = s^2/8r}$.

As mentioned earlier, surface roughness is dependent on scallop height, where $\mathbf{R_a}$ (arithmetic average roughness) can be approximated as $\mathbf{R_a = 0.032s^2/r = 0.256\varepsilon}$. These approximations are valid when $\boldsymbol{\varepsilon \ll r}$.

Propeller Blade Machining

One of the most important machining factors that must be considered is the cutting speed. The cutting speed is the result of many required decisions since it is influenced by many factors such as size and type of cutter, rotational

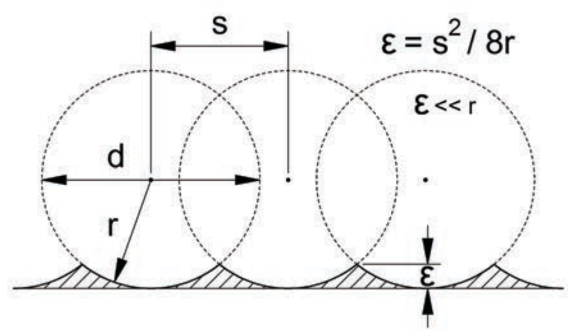


Figure 8: Relationship between Scallop Height (ε), Distance between Cutting Passes (s), and Radius of Cutter (r)

speed of the cutter, desired scallop height, base material, shape of the propeller section (less curvature can be cut faster than high curvature), heat-removal capacity, and let's not forget the computer controller speed. All these decisions result in hundreds of machining programs, each required to refine the features of the blade.

As with everything else, precision is the key. Special fixtures are created to fit under the blades to hold them in place, and to allow them to be turned 180 degrees to machine the opposite face. They are themselves accurately machined, and include dowel pins and locking devices. A minute error in the rotation of the blade during machining would result in the two faces of the propeller blade not matching.

One important factor required to be considered in the sequence of machining is the bending or movement of the blade under the pressure of the machining tool. If one face is fully machined from top to bottom before being rotated, then when the opposite face is machined, there would be less material behind it which would make the blade weaker (propeller blades are quite thin). The risk is that it will bend more in that direction and accuracy will be lost. To alleviate this problem the programs split the blade in smaller sections, and the blade is rotated after each section is machined; the machining also starts from the tip and proceeds down to the thicker sections so more material is at the base during machining, strengthening the blade.

Before the work is started on an actual blade, the programs need to be tested. A special program, CGTech's Vericut software, can simulate the whole operation on the computer. It will identify any conflict, any breach of the desired surface of the finished product, and identify parts that were not well defined. It can also be used to optimize the speed in order to reduce machining time. A full-scale propeller blade is then manufactured in *wood* so that the fixtures, handling procedures, and the CNC milling operation itself can be tested before any actual metal blade material is machined.

While the engineering team is designing and refining the programs, the actual Nickel-Aluminum-Bronze blades are being cast at North America's only commercial foundry able to manufacture large propellers – the Rolls-Royce facility in Pascagoula, Mississippi. The propellers for our frigates were cast there, as were the large propellers for the *Arleigh Burke* destroyers, and those for the massive monoblock propellers for the USS *George H.W. Bush* aircraft carrier. Rolls-Royce was contracted to cast the blades one inch thicker than the final product. The key in machining from a casting is to initially position it on the CNC machine perfectly in the middle. A bit off and some sections of the blade will have no material left to machine at the other end. To help in the positioning, the castings included some reference points for which the foundry provided exact 3D coordinates.

Once the castings have been delivered, the first part to be machined is the palm of the blade – the round part that fits in the hub (Figure 9). This allows the propeller blade to accurately sit vertically on the fixture in the CNC machine when machining the face and back. Then, once everything has been tested, verified, checked, re-verified, and double-checked, the propeller blade is reinstalled on the CNC machine with a different precision fixture, and the machining programs are started (Figure 10). The machining progresses 24 hours a day under the supervision of qualified technicians until all 20 propeller blades are completed 40 weeks later.

Measurement and Analysis of Machined Controllable Pitch Propeller Blades

The last step in the contractual obligation is to prove the dimensional accuracy of the final product. Some features are easy to measure, but the actual shape of the pressure and suction faces are quite challenging. DNPS 3 has developed a unique measurement system that provides an accurate comparison with the points shown on the design offset table drawing. The method uses a coordinate measuring machine with six degrees of freedom at the probe to scan the cylindrical sections in 3D. The collected data is then superimposed on a 3D computer model made

Figure 9: Propeller Blade Palm Rough Machined

Figure 10: Propeller Blade Machining

from the design drawing. Since the drawing points were given in 2D, the same mathematical conversion method of wrapping, pitching, skewing, and raking that were used to define the machining model are used. In order to determine the difference between the model and the actual measurement accurately, 3D helice reference lines are added to the model.

Using subroutines created in the AutoCAD software, the model and the actual scans are rotated and positioned perpendicular to the viewer's point of view so that accurate relative distances can be extracted. This measurement method was proven to be accurate and much faster than the traditional method that requires pre-shaped gauges, feeler gauges, a pitchometer, and many hours of labour with approximate accuracy.

Analysis was made of the measurements performed on the new propeller blades with respect to the following five key parameters: blade thickness, chord length, local pitch, mean pitch at each radius, and blade pitch. An example of the measured accuracy is shown at Figure 11. In this example the blade thickness deviation from design thickness is 1.0 mm in 97.5% of the blade point measurements. The 1.0 mm extra is half the highest ISO tolerance and is also set intentionally by Dominis to give an allowance for wear throughout the propeller's lifespan. All 4360 points measured were found to be accurate to 0.3 mm, which is well within ISO 484/1 Class S tolerances.

Conclusion

The new spare propellers manufactured by Dominis Engineering Ltd were proven to be extremely accurate, and have already been installed on *Halifax*-class Canadian Patrol Frigates. The improved performance should become evident over time, but have the captains and crews of those frigates noticed where their new propellers were manufactured? Possibly not. The "Made in Ottawa" tags were quite small.

Claude Tremblay is the Transmission Systems Engineer in the Directorate of Naval Platform Systems in Ottawa.

Slobodan (Bodo) Gospodnetič is president of Dominis Engineering Ltd, a leading company in high-precision, five-axis machining of three-dimensional complex surfaces such as CPF propellers, and waterjet impellers for the U.S. Navy's LCS program.

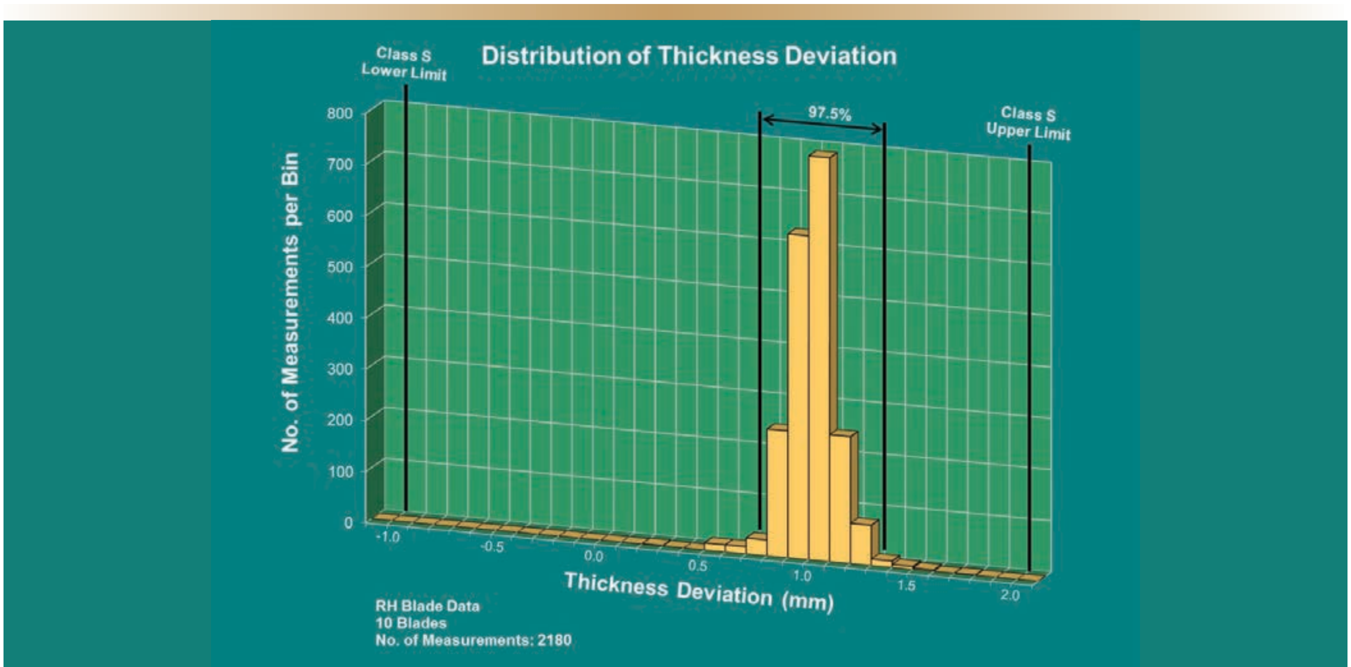


Figure 11: Distributions of Thickness Deviations for RH and LH Propeller Blades

LOOKING BACK

The UNTD Cadet Journal of Commodore H.A. "Mike" Cooper

By Brian McCullough

A familiar face at the annual MARLANT Naval Technical Officers mess dinner in Halifax is that of 80-year-old, retired Commodore Henry Anthony "Mike" Cooper. For years this quiet, dignified gentleman with the perfect manners and the quick smile has been presenting the Naval Association of Canada Award to the officer who achieves the highest standing in professional achievement during Naval Engineering Indoctrination. It is a double honour for the recipient, considering that Commodore Cooper is believed to be the last officer in the Royal Canadian Navy to wear the purple stripe of the Engineering Branch.

What many people likely don't realize when they see him in his civilian formal wear and military decorations, is that "Mike" Cooper – his mother didn't like the name Henry – was one of the most well-rounded naval officers of his day, with qualifications in engineering, navigation, bridge watchkeeping, logistics supply, and personnel. He did it all, and still found time to involve himself in the Canadian Forces and international military sports scenes in a big way.

During his 44 years of exemplary naval service, this former National President of the Naval Officers Association of Canada received the Canadian Forces Decoration and two clasps, the Queen's Golden Jubilee Medal, Commander's Commendations from both Maritime Command and Air Command, and the Meritorious Order of CISM (Conseil International du Sport Militaire) in the grade of Commander. He was also inducted into the Canadian Forces Sports Hall of Fame, and honoured with the Gold Medallion of the Naval Association of Canada.

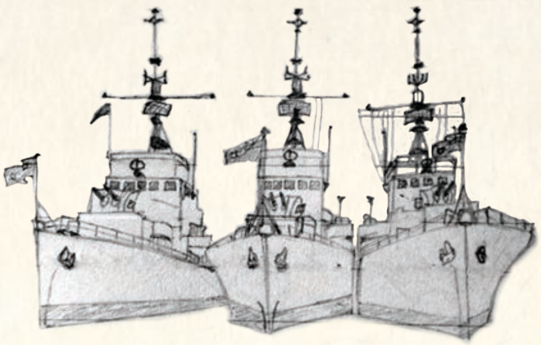
Pretty much what you'd expect from a University Naval Training Divisions (UNTD) cadet who, in true naval spirit, knew how to 'fly with the eagles' the morning after 'hooting with the owls' at a late mess dinner. In something reminiscent of the light-hearted, charity fundraising NTO Challenge following today's mess dinners, Cadet Cooper wrote in his journal in June 1956: "The next morning the technical cadets as well as the rest were subjected to a tabloid of sports in Stadacona gym. Considering that most of us were suffering from the effects of the previous night's indulgence, I think we did quite well to gain third place, only three points behind the winners!"

In his journal, which he maintained from 1956 to 1958, Cadet Cooper describes in detail his guided tour of the U.S. Coast Guard's three-masted training barque *Eagle* the day after a UNTD gunroom ball held in honour of *Eagle*'s own 190 cadets. He wrote that he was "particularly impressed by the spotless machinery spaces," which included a 10-cylinder diesel main engine, and a cylindrical radial-piston air-compressor dubbed "Whiffenpoof" by the crew, a clue to the vessel's German origin as the former *Horst Wessel* built in Hamburg in 1936 for Hitler's navy.

Toward the end of his 1956 summer training at the Mechanical Training Establishment, Mike Cooper and another cadet worked on a special project to draw organizational charts for the Education Officer. They found that if they worked "hard and speedily," they had time to take a short break in the coffee shop in the Administration Building.

"It is a matter worth mentioning," he wrote, "that on the occasions that we did frequent the coffee shop, the Supply cadets working in the Administration Building were invariably ensconced in a far corner devouring coffee and donuts at their leisure." Ah, the perspective of youth.

There was sea time in the 1956 training schedule as well, and Cadet Cooper's journal is filled with his impressions of everything going on around him in his first ship, HMCS *Lauzon* (FFE-322),



a *Prestonian*-class training frigate, during Cruise Bravo. His thoughtful observations of the type of work the cadets were employed at in the engineering spaces, the cafeteria system that still used fannies (kettles) to take food to the messes, and the port visits in the U.K. and Belgium, are often accompanied by his beautiful technical drawings and ship illustrations.

Cadet Cooper didn't shy away from offering some rather outspoken remarks, characteristic throughout his journal, such as those concerning the poor watchkeeping conditions for the engineering ratings, and for the stinginess of the conversion of the *Prestonian* class frigates. The two were not unrelated. Of the latter he said, "It seemed strange that with a two million odd dollar conversion... very little-if-any of that amount appeared to have been spent in the machinery spaces. This is peculiar, and shows a certain degree of short-sightedness, as far as I am concerned, because the efficiency of a fighting ship is directly dependent upon the efficiency of her auxiliary machinery and main propulsion."

He describes his last watch of the cruise in the engine-room on the starboard throttle as his ship entered Halifax Harbour, and then after Finished with Engines had been rung down, closing the bulkhead stops, opening the steam and water drains, and adjusting many other valves, "as probably the most informative four hours I ever spent on board ship."

Commodore Cooper's journal entries offer a delightful glimpse into Navy cadet life, both ashore and aboard ship, from a bygone era of steam propulsion, khaki summer uniforms, and the occasional high-energy 'smoker' party. Perhaps what is most striking is how similar his experiences of 50 years ago are to my own as a Naval Reserve navigation cadet in the early 1970s, and as how they must be in some ways to the young NTOs forging their own careers in our fleet today.

"We departed with many memories," Cadet Cooper wrote at the end of his 1956 summer training, "which I'm sure will be unearthed many times in the years to come as we relive those memorable days spent in the Reserve Training Centre, in the Mechanical Training Establishment, aboard the ships of the Third Canadian Escort Squadron, and in Halifax."

Thanks for the memories, Mike.

Brian McCullough is the production editor of the Maritime Engineering Journal. *(With special thanks to Captain Lou Carosielli, RCN, for first bringing Commodore Cooper's UNTD cadet journal to my attention for this long-overdue feature.)*

Career Highlights

- 1936 – Born in U.K.; 1946 emigrated to Canada
- 1954 – Joined UNTD as Probationary Cdt(E)
- 1955 – Summer UNTD: HMCS *Stadacona*; HMCS *Huron* (216)
- 1956 – UNTD: Mechanical Training Establishment *Stadacona*; HMCS *Lauzon* (FFE-322) for engineering watchkeeping
- 1957 – Summer UNTD: MTE *Stadacona*; Promoted A/Slt(E) RCNR – "Purple stripe!"
- 1958 – Transferred to Regular Force; Midshipman HMCS *Ontario* (C53)
- 1959 – Graduated UBC (BA Math.); HMCS *St. Laurent* (DDE-205) for engineering training; *Stadacona* and HMCS *Assiniboine* (DDE-234) for navigation training
- 1960 to 1962 – Sea phase training, HMC ships *St. Croix* (DDE-256) and *Chaudiere* (DDE-235); Obtained bridge and engine-room watchkeeping certificates; Promoted Lt.
- 1968 – HMCS *Bonaventure* (CVL 22) Assistant Supply Officer
- 1971 to 1986 – Various supply and finance postings; promotion to Cmdre as NDHQ Director General Personnel Services
- 1992 – Retired Reg. Force; Reservist again; member and later Vice-president Conseil International du Sport Militaire
- 1998 – Inducted into CF Sports Hall of Fame; terminated CF Reserve service
- 2003 to 2005 – National President, Naval Officers Association of Canada

LOOKING BACK

A Stoker's View of Life in the Royal Canadian Navy in World War Two

By Angus J. MacGillivray, CD, BEng, PEng, Major RCEME (Ret.), Leading Stoker RCN (Ret.)

Photo: The Roger Litwiller Collection, courtesy Ross Milligan, RCNVR

The Bangor-class minesweeper HMCS *Milltown* (J317) was author Gus MacGillivray's first wartime sea posting.

Gus with his sister Anne in 1943.

Photo: Katherine Koopman, courtesy Peter MacGillivray

The author with his granddaughter Victoria on her wedding day in August 2015.

Angus J. "Gus" MacGillivray, born in Nova Scotia in 1923 and currently living in Kingston, Ontario, served in the Royal Canadian Navy Volunteer Reserve (RCNVR) as a leading stoker during the Second World War. He later took a degree in engineering, and remustered into the Canadian army's Royal Canadian Electrical and Mechanical Engineers (RCEME), with whom he served throughout the Korean War and subsequent Cold War, retiring in 1969. His memoirs were submitted to the Maritime Engineering Journal *by his son, naval marine systems engineer Cdr (Ret'd) Peter MacGillivray, who served from 1971 to 1995. We are pleased to reprint an edited excerpt from that Gus' memoir here. The original manuscript can be found at* www.cntha.ca *(Editor)*

During World War Two the federal government introduced conscription. Being 18 at the time, I was concerned I would end up in the army. I had an affinity for the navy, so just before Christmas 1941 I submitted to an interview and medical exam, and soon afterward received orders to report to the recruiting office.

After taking an oath of allegiance, I (and 30 other recruits) mustered at Naval Stores where we were issued with a sea bag, a canvas hammock, a mattress, and a blanket. We were next given some strange-looking clothing by someone who estimated the size by our height. We were then required to dress in the uniform and henceforth follow orders from our seniors, mostly petty officers, who only had one tone of voice, and that was to yell.

We went by rail to HMCS *Protector* – the Point Edward Naval Training Base at Sydney, Nova Scotia. The base was considered a ship, and beyond the main gate was deemed ashore. On arrival we entered a large building, and were ordered to lay out our kit on six-foot folding tables. The regulating chief petty officer warned us that if any items were missing we would be in trouble. If we had too much kit we would be in even deeper trouble. This precipitated a flurry of activity by street-seasoned kids who, having pilfered items from their unsuspecting neighbours, were now returning the stolen items.

Basic training consisted of parade square drills, classroom lectures, and associated naval activities. One of the more exhausting exercises was whaler drill. The whaler was a large, heavy rowboat that seated six men in pairs on thwarts, each man holding an oar – three to starboard and three to port. A coxswain in the stern gave the orders one-two-three-four. One meant that the heavy oar, weighing about 20 pounds, was held in position horizontal to the water. On two, the oar was pushed forward. On three, the oar was dropped into the water, pulled to the stern and then out of the water, ending with the oarsman lying horizontal in the boat. On four the oar was brought back to the horizontal position. Frequently, the coxswain would delay the number four order until one or more of the horizontal oarsmen collapsed. The victims would be required to do 50 pushups when the whaler returned to the dock.

The grueling training schedule left us dog-tired by the end of the day, and we were frequently awakened at 3:00 a.m. for fire drill. Serving on a ship at war would be far worse than any training program, so the system was designed to break the recruits.

Off to Sea

Six weeks of basic training made me a 2nd class stoker, and I was required to take a two-week course in steam training to introduce me to the technical equipment that propelled a ship. The boilers, engines, propellers, pumps, and ancillary equipment were skimmed over quickly. The more detailed instruction would occur at sea. I was posted to the Bangor-class minesweeper, HMCS *Milltown* (J317), where the engineer officer briefly explained the steam boiler system that drove the twin, triple-expansion reciprocating engines.

The ship sailed from Montréal down the St. Lawrence River and on to Pictou, Nova Scotia for working-up trials prior to performing escort duty out of Halifax. On my first trip home on leave in Halifax my mother was surprised to see me wearing a sailor's uniform instead of an officer's uniform. In one of my letters I had told her I'd been appointed Captain of the Heads. Her disappointment was obvious when she was told that in navy terms the toilet was called the head, and the sailor who was assigned to clean the heads was called the Captain.

Although *Milltown* was a minesweeper, she did not carry her minesweeping gear. The 672-ton ship was about 180 feet in length, with a 30-foot beam, and was manned by a crew of six officers and 77 enlisted chiefs, petty officers, and men. She had a three-inch gun in an open turret on her foredeck, and two 20-mm Oerlikons on her port and starboard mid-decks, but her main armament was depth charges. *Milltown*'s task was to protect the North Atlantic convoys from prowling German U-boats.

Milltown had two boiler-rooms with a Yarrow boiler in each. The boilers had a steam drum, and two mud drums on the bottom forming a triangle. The mud drums were connected to the steam drum by steel tubes, forming a firebox. The front of the boiler had four sprayers that were connected to a heater and an oil pump, and extended into the firebox. The mud drums, the tubes and half the steam drum were filled with feed water. Oil passing through the sprayers was ignited and heated the water, forming steam. The steam at 250 pounds pressure was collected from the top of the steam drum and passed through superheater coils and heated to 750 degrees Fahrenheit. The height of the water in the steam drum was critical, and was shown by a water gauge. Too much water could cause priming, where water could pass over to the pistons causing damage to the engines. Too little water could damage the boiler, and either situation would cripple the ship. My job was to control the amount of oil and water to make sufficient steam to run the engines, which continually varied in speed when in action.

The two main engines were reciprocating engines, each having three cylinders. Dry steam was passed into the small high-pressure cylinder of each engine, expanding and driving the pistons down. The expanded steam was then passed into the larger intermediate cylinders, driving those pistons down and then into the still larger low-pressure cylinders. The spent steam was passed through a condenser that turned the steam back into water and returned it to the feedwater tanks. My duties in the engine room were to oil the main engines, make up fresh water using the evaporator, go aft to oil the steering engine, and pump out the sea water that had gathered in the engine-room bilge.

The weather on the North Atlantic was unpredictable. In winter, conditions at best could be described as unsettled, but could often be violent. U-boats operated in wolf packs intent on torpedoing the escort ships and the merchant vessels under their care. In order to confront these dangers it was necessary to have complete cooperation among the boiler-room, engine-room and bridge. The crew on the bridge had to be able to handle the ship in adverse conditions. In the boiler-room it was necessary to have a watch who could provide steam for the engines during rapid changes in the vessel's speed. Only experienced crew in the engine-room would know how to answer the call for a change in speed from the bridge, and yet not draw too much steam from the boiler-room and cause the boilers to prime.

As the fleet proceeded into the North Atlantic the escort ships would run a zigzag pattern on each side of the convoy, ever watching for U-boats. The group would travel about 500 miles out into the North Atlantic, where they would turn the convoy over to the Newfoundland-to-Londonderry escort. Whenever depth charges were dropped, for those of us in the boiler-room and engine-room the sound of the underwater explosions striking the ship's side was like being in a steel barrel that someone was slamming with a sledge hammer. Sometimes the boiler's water gauge would break, or the lights would go out and we would have to work with flashlights.

In early 1943, with U-boats targeting merchant ships coming down the St. Lawrence River to join the convoys forming in Halifax, the RCN established a flotilla of 12 Bangor sweepers to escort ships from the Québec ports to Sydney, Nova Scotia. Shortly thereafter, *Milltown* was taken out of service for a refit and I was posted to HMCS *Caraquet* (J38), another Bangor minesweeper doing the Rimouski to Sydney run. After four months I was posted ashore to attend a three-month mechanical engineering course in Halifax – a prerequisite for promotion to leading stoker – before being posted to a new frigate, HMCS *Outremont* (K322), for four months of convoy duty.

Big Ship Training

In the summer of 1943 I was one of 200 personnel selected for big ship training with the Royal Navy to provide crew for the new cruiser HMCS *Ontario* (C32) being built in Belfast, Ireland for the RCN. In early 1944 I joined HMS *Duke of York* (17), flagship of the British Home Fleet, at anchor in Scapa Flow in the Orkney Islands off the north coast of Scotland. The battleship was longer than two football fields, and had for main armament three 14-inch gun turrets that could fire a projectile 20 miles – six miles farther than the horizon. Along with her secondary armament of 16 x 5.25-inch guns, her fearsome firepower was a match for any enemy warship. For protection, her hull was armoured with steel plating 14 inches thick. Six inches of steel plate protected the upper deck, and the magazines were shielded by 14-inch armour. The *Duke*'s eight boiler-rooms drove four steam-turbine engines, producing a top speed of 28 knots.

As a leading stoker I was assigned to be a killick, British Navy slang for a junior NCO in charge of 12 stokers. In addition to my regular engineering duties, I was to look after the welfare of my men. The other 20 Canadians and I on board the ship claimed space to sling our hammocks in the machine shop, and the area soon became known as the Canadian Legion.

Duke of York's assignment was to protect the convoys bound for Murmansk, and to prevent the German *Bismarck*-class battleship *Tirpitz* from breaking out of Altafjord, Norway, where it had sought refuge following a fierce battle with ships of the British fleet. One day, on a return trip to Scapa Flow from Murmansk in company with the battleship HMS *King George V* (41), two cruisers and 10 destroyers, *Duke of York* fired her 14-inch guns at the *Tirpitz*, still anchored in Altafjord, and appeared to make several hits. As we proceeded south along the Norwegian coast we engaged a German convoy of 12 merchant vessels and four destroyers. Shore battery searchlights and guns came into play, but within two hours, the batteries were taken out, and all the German ships, including the destroyers, had been sunk.

With the *Duke* in Liverpool for refit, I was posted to the cruiser HMS *Norfolk* (78) to head a bricking party of stokers from various ships. We would go aboard HMS *Kent* (54) upon her return from active duty, and undertake repairs to her boilers. The job required replacing damaged firebricks, and removing accumulated scale in the drums using steel brushes and chipping hammers. The heater tubes running from the steam drum to the mud drums were checked for blockages. The whole job took two weeks, after which we returned to our respective ships.

In December 1944 I was selected to go to Belfast as advance party for HMCS *Ontario*. Since I was to take over the compressor system upon commissioning, I met with an engineer from the builder to observe the construction of the compressors, and learn how to operate, maintain, and repair them. I traced the piping to the turrets, the machine shop and other parts of the ship where compressed air was required, and produced drawings of the system.

In the meanwhile, Allied forces had captured Berlin, the Germans had capitulated, and the war in Europe was over. By this time, *Ontario* had completed her working-up trials, and was ordered to join the Pacific fleet. However, the Canadian government decided that members of the RCNVR who had signed up for the war in Europe could not be sent to the Pacific war unless we volunteered. This was my escape clause. During the signing-up procedure of *Ontario*'s crew I declared, much to the consternation of my superiors: "I'm not signing." It was time to go home.

My stubbornness backfired on me. *Ontario* sailed into the Pacific without me, but the Americans soon dropped two atomic bombs on Japan and the war there was over by mid-August. As penance for refusing to sign on for the Pacific war, I spent the next six months sweeping mines off the coast of England on board HMCS *Caraquet*, and did not get home to Canada until late November.

[Editor's epilogue] Gus was intrigued by the government's Veterans Undergraduate Program that would pay him to get a university education. Through sheer perseverance, he completed the required high school courses he had missed in joining the RCN, and eventually graduated from St. Mary's College in Halifax with a Diploma of Engineering, then enrolled at Nova Scotia Technical College in the Mechanical Engineering division.

News Briefs

U.S. Meritorious Service Medal

Photo by MCpl Brent Kenny, MARPAC Base Imaging

C***dr Darren Rich***, the current Commanding Officer of the Canadian Forces Maritime Experimental & Test Ranges at Nanoose, BC, was presented with the United States Meritorious Service Medal (MSM) on Oct. 12, 2016 by ***RDML James Loeblein***, Assistant Deputy Chief of Naval Operations (Operations, Plans and Strategy). The award was for outstanding meritorious service as the Canadian Joint Operations Command Foreign Liaison Officer at NORAD-United States Northern Command Headquarters at Peterson Air Force Base, Colorado Springs, CO from 2011 to 2014.

Cdr Rich was noted for his contributions in advancing the North American Maritime Security Initiative, the NORAD Strategic Review, and the Mexico-Guatemala-Belize cross-border workshops. His exceptional service contributed greatly to strengthening North American defence and security, and greatly enhanced the relationship between Canada and the United States.

Bravo Zulu, Darren!

National Capital Region NTO Winter Hockey Classic

Photos by Lt(N) Anton (Tony) Korets

On Feb. 9 the naval technical community hosted the second edition of the Winter Hockey Classic, featuring the Marine Systems Engineers vs the Combat Systems Engineers. ***MGen Alex Patch*** – Chief of Staff for Adm(Mat) – opened the competition. Officers and non-commissioned members from the National Capital Region and both coasts participated in an amicable rivalry that saw the MSEs rise to the top in a striking win (after losing to their opponents last year). The teams showed great skill and teamwork on the ice. ***Lt(N) Kayla Bouchard*** and ***Cdr Thomas Wyand*** (with ***Captain Dave Benoit***, right) brought home the MVP awards. This event, which takes place the same day as the NCR NTO mess dinner, will be coming back next year so mark your calendars early! – **Lt(N) Emilie Létourneau**

News Briefs (continued)

NTO Spirit Award

The Spirit Award is presented annually to the most deserving junior naval technical officer from across Canada who, by example, has improved the quality, morale, and esprit de corps of the naval technical community. This year's Spirit Award winner, announced at the Feb. 9 mess dinner in Ottawa by award founder ***RAdm (ret'd) Ian Mack***, was ***Lt(N) Emilie Létourneau*** (Directorate of Naval Platform Systems Ottawa).

Among her many energetic activities, Lt(N) Létourneau took leadership roles with the NCR Naval Technical Mentorship Program, and with the annual NCR Winter Hockey Classic. She was singled out for her ability to generate frank professional discussion, and promote camaraderie and stronger ties within the naval technical community.

Worthy runners-up for the award this year were ***Lt(N) Cynthia Caborn*** (Halifax) and ***Lt(N) Eric Goulet*** (Esquimalt). Their own selfless contributions made significant improvements to the spirit of the teams and individuals in their respective work areas. Bravo Zulu to all!

Photo by Brian McCullough

DRDC Commendation

Cdr Andrew (Monty) Monteiro, Associate Director for the Defence Research and Development Canada (DRDC) Centre for Operational Research and Analysis (CORA) has received "...a prestigious award... only given out under exceptional circumstances," according to CORA Acting Director ***Donna L. Wood*** last December.

The acting director said the commendation recognizes the outstanding and exceptional achievements of an individual. She added that Cdr Monteiro, who took up his new duties about 18 months prior to receiving the award, had readily embraced the role of CORA's Associate Director while taking on the additional responsibilities of the CORA business planner, as well as the technical authority for the Task Authorization Contract – each considered a job on its own.

"His greatest impact has been in generating an environment of collaboration, cooperation, and respect within CORA," Acting Director Wood said. "As a military officer, in all tasks he undertakes, Cdr Monteiro demonstrates integrity, loyalty, courage, stewardship, and excellence."

Photo by Janice Lang

She said that Cdr Monteiro had gained the respect and admiration of the employees of CORA, the gratefulness of the management team, and had earned the respect of the senior leadership within Director General Science and Technology Centre Operations, and the rest of DRDC.

Bravo Zulu Monty!

News Briefs (continued)

HMCS *Sackville* Award

SLt Andrew Torchia has received the HMCS *Sackville* Award, presented annually to the top *non-commissioned* Weapons Engineering Technician (WEng) Maintenance Manager Course graduate. The top petty officer second class candidates from the East and West Coasts undergo a mini-board to vie for the top honours. SLt Torchia, who has since been commissioned from the ranks, is currently undertaking Naval Combat Systems Engineering Officer initial training at Naval Fleet School Pacific. Following graduation in September, he will join a ship for phase VI afloat training. Award sponsor **Captain David Benoit** presented the award in Esquimalt last November. Bravo Zulu Drew!

Photo by PO1 Pete Fraser

Rheinmetall Award

Retired Capt(N) Kevin Laing presents the Rheinmetall Award to **MS Derek O'Rourke** in Esquimalt last November. This award recognizes exceptional technical performance and demonstrated professionalism in a Combat Systems Engineering occupation. The award is made annually to a deserving petty officer second class or below in each Formation. Due to the challenges of personnel restrictions in the submarine environment, Master Seaman O'Rourke is currently Senior WEng Comm Tech aboard HMCS *Victoria* (SSK-876). Bravo Zulu Derek!

Photo by PO1 Pete Fraser

Submissions to the *Journal*

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

PRESERVING CANADA'S NAVAL TECHNICAL HERITAGE

CNTHA

NEWS

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The passing of a good friend of the Navy
Colin Ralph Brown (March 9, 1927 – October 2, 2016)

By Tony Thatcher and Pat Barnhouse (With notes from Dave McCracken)

To those of us involved with preserving Canada's naval technical history through the auspices of the CNTHA, Colin Brown was a dedicated member of the team, and a tireless worker who would do what was needed of him for the cause. It says something about him that he took on the role of treasurer for our organization when he was in his early eighties. His steady presence at our meeting table has been sorely missed.

Colin enjoyed a successful 35-year naval career in the Royal Navy and the RCN that began with his entry as a 15-year-old artificer apprentice in Benbow Division at HMS *Caledonia* in Rosyth, Scotland. It was the start of a lifelong love affair with engineering, ships, and the sea. Following his retirement from the Navy in the 1970s, he worked as a marine engineer for Transport Canada's Marine and Ferries Branch.

Colin was married to his wife Helen for 53 years until her death in 2007, and was a loving and caring family man to his people on both sides of the Atlantic. To his many friends, he was a valued member of his various clubs and naval associations, and was known by everyone as someone who would see things through to completion,


Photo by Brian McCullough

always with the twinkle of good humour in his eye. Those who knew him best say that Colin marveled at the wonders of the natural world, and that his soul will live forever at his cottage on Ashby Lake in the Addington Highlands of Eastern Ontario.

When he died peacefully in hospital in Ottawa on Oct. 2 last year, the loss to the Navy was significant, for in Colin Brown they had a staunch friend and supporter of the highest order. He enjoyed the admiration and respect of everyone who knew him. He was an honourable man.

Roundtable with DGMEPM

CNTHA Executive Director Tony Thatcher met with Cmdre Simon Page, DGMEPM, on Dec. 5, 2016 to discuss forging closer working ties, and raising the profile of the CNTHA within the technical branch of the RCN. A more visible presence by the CNTHA at the Navy's annual technical seminars and other events will lead to greater sharing of information that can benefit anyone concerned with preserving Canada's naval technical heritage, and those looking to access the archived records.