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73
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Spring 2014

Is there a better way to get rid of a ship's solid waste?

Technical evaluation of an innovative, energy-efficient waste abatement system.

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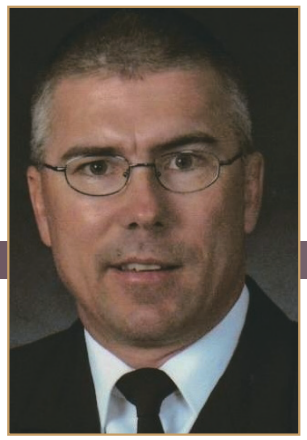
Photo courtesy Davie Shipbuilding Ltd.



Maritime Engineering Journal

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The crew of HMCS *Ottawa* (FFH-341) lands cardboard waste in Esquimalt during solid waste trials in March 2012.

Photo by Amanda Lafleur

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Commodore's Corner

By Commodore Marcel Hallé, OMM, CD

NaMMS – What's in an acronym?

Photo by Brian McCullough

Successful organizations must continually adapt their structure, size, mandate and/or processes to work within the confines of changing environments. This has certainly been true for the naval materiel enterprise that has gone through many iterations over its history to provide the best possible materiel support to the fleet. Some of the changes were driven internally, as with the 'FMF 2000' business and service delivery efficiency initiative at Fleet Maintenance Facility Cape Scott, whereas major changes resulting in significant cuts, such as those brought about by the Management, Command and Control Re-engineering Team (MCCRT) in the mid-1990s, were directed by government.

Looking back on my first posting to Ottawa as a newly minted lieutenant commander in the Maritime Engineering and Maintenance division (DGMEM) in 1992, the Navy was in the midst of its latest major recapitalization efforts: the project management office for the Canadian Patrol Frigate, nearly 450 people strong, was starting to send ships to the navy at the same time as the 250-person PMO team for the Tribal-class Update and Modernization project was delivering modernized *Iroquois*-class destroyers to the fleet. DGMEM was nearly twice the size that DGMEPM is today. The procurement functions were separate and supported by another division, and significantly more was done in-house – such as developing and maintaining materiel standards and specifications.

During that era, materiel support on both coasts underwent significant transformation under the Naval Engineering Maintenance Functional Review. In 1996 the coastal Fleet Maintenance Groups, Ship Repair Units and Naval Engineering Units were rationalized into the two Fleet Maintenance Facilities we have today, with greater emphasis placed on second-level support. In those days, the *Naval Engineering Manual* was referred to as the 'engineering bible,' and the many volumes of what was then

called the Naval *Maintenance* Management System (NaMMS) narrowly described policy that governed class maintenance cycles and materiel support.

Fast-forwarding to today we once again find ourselves in the midst of a major fleet recapitalization effort, this time led by the modernization of the *Halifax*-class frigates, and including three major crown ship projects – the Joint Support Ship, the Arctic/Offshore Patrol Ship, and the Canadian Surface Combatant. Understanding the fiscal and scheduling complexities associated with shipbuilding programs, each of these is competing for limited resources in an environment that has changed considerably from the last time we did this. The project management offices are a fraction of what they were then and place greater reliance on matrix support from DGMEPM, while the in-service support organizations, nearly half their former size, have much less capability in terms of experience and competency levels in key areas like naval materiel assurance and shipbuilding. In addition, the complexity of what we are doing continues to increase, as are the levels of stewardship and accountability demanded of us by Canadians. Our collective capacity to deliver has led to greater reliance on industry for things that were traditionally done in-house, placing additional pressure and importance on our ability to self-regulate.

"Throughout, what has not changed is our responsibility to self-regulate and to ensure our ships are fit for purpose, safe, and compliant with environmental legislation."

The work to ensure we are prepared to deal with the reality of the current environment has already commenced. One example of this new undertaking is the radical change in the way new ships are being procured with the stand-up of the National Shipbuilding Procurement Strategy (NSPS); another is the department's Defence Renewal initiative that is positioning DND for better ways to increase efficiencies that include materiel and acquisition support. It also means doing things differently. Adopting the NATO Naval Ship (safety) Code and engaging classification societies to develop and maintain standards and specifications are but two examples of major initiatives that are being pursued.

Throughout, what has not changed is our responsibility to self-regulate and to ensure our ships are fit for purpose, safe, and compliant with environmental legislation. Doing this effectively is a tall order in our resource-constrained, technologically complex, and increasingly complicated materiel environment. It demands a disciplined and risk-based approach in providing clarity and system alignment. Fundamental to this journey has been the realignment of materiel acquisition and support for the navy within the RCN and the Assistant Deputy Minister (Materiel) group as one system under what is now called the Naval *Materiel* Management System (NaMMS). This more comprehensive approach has enabled us to deliver on all aspects of our business within an understood regulatory framework that is risk-based and performance-managed.

Though the NaMMS acronym itself has not changed since its inception, the subtle amendment of the first M to '*materiel*' from '*maintenance*' is significant, as the new and continually evolving Naval Materiel Management System now represents the single and lead entity that holistically underpins the naval materiel enterprise.

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.

FORUM

The Value of Sea Time

By Capt(N) Simon Page, Chief of Staff MEPM – RCN Technical Branch Advisor

Combat Camera photo by Cpl Johanie Maheu, Formation Imaging Services, Halifax, Nova Scotia, © 2010 DND-MDN Canada

I still remember them clearly – my days at sea as a naval technical officer. As a sub-lieutenant on board HMCS *Nipigon*, I sat cramped in the fire-control equipment room as we conducted gunnery serials through the Mk 69 fire-control radar system.

I was the data gathering officer for the technical portion of the post-firing report, and 23 years later can still hear the voices of MS Gravel and MS Campbell instructing the young naval electronic sensor operators to keep their target within the bucket of the 'A' scope display.

A few years later, in HMCS *Athabaskan* this time, it was the challenging operations with the variable depth sonar, the first surface-to-surface SM2 missile shoot and other events that marked my days as a naval engineering officer at sea. And so it went. That all of these moments were engraved in my memory speaks to the value of sea time in my development as a naval officer. Every day on board ship was irreplaceable to me.

As naval technical officers (NTOs) we have to remember that we are naval officers first and not simply engineers in uniform, a misguided view that has come up in past debates over our profession. Sea time gives us the challenges that help us grow as naval officers, engineers and leaders.

> *"The specific experiences and expertise we gain from practising engineering on board ship are what we will relate to in almost any other engineering job we do."*

It is a simple fact of life that most NTOs today can expect to serve no more than about four years (total days) of their entire career on board a ship or submarine. It stands to reason, therefore, that every one of these

days alongside or at sea must be captured to the fullest, especially since it is the working environment of a warship that allows us to understand and consolidate the systems knowledge we will depend on throughout our careers.

The specific experiences and expertise we gain from practising engineering on board ship are what we will relate to in almost any other engineering job we do.

The numerous enabling opportunities that are presented to us on board a naval platform when we serve as officer of the day or in any other secondary function – configuration management officer, safety and environment officer, radiation hazard officer or whatever else – help us to learn our general notions of ship design, system requirements, maintenance and through-life support, specific engineering considerations and human systems integration.

At the more advanced end of the scale, planning and managing a ship's work period, or acting as the damage control officer during action stations, gives an NTO the opportunity to appreciate more than one side of a complex situation. It takes time in the seat to learn how to work as a member of a team to assess the numerous variables that might be in play, and to develop and execute actions that will bring clarity and resolution to a given situation. It is through activities like these that one will connect the dots with respect to concepts such as interdepartmental cooperation, system interfaces, alternate modes of operation, supporting operations and generally understanding the ship as a comprehensive weapon system.

Whether a ship or submarine is at sea or alongside, the opportunities for an NTO to develop into a more competent technical officer are there. A ship or submarine going through any kind of operational program or maintenance routine offers an ideal training ground that cannot be matched.

To this day, the tiered readiness program I was involved in with HMCS *Athabaskan* in 1998 remains one of the most difficult engineering challenges of my career. From the restricted readiness inspections to the weapons certification process and on through the numerous technical trials the overall program was demanding. I actually remember looking forward to workups to get a bit of rest. But with the demands came a significant sense of achievement for all of us on board as we overcame adversity and discovered what we had in ourselves and each other.

Sea duty as a head of department is sometimes seen as little more than a tick in the box necessary for career progression, which is too bad considering it is such a key job assignment in so many ways. Well-rounded naval technical officers with sound experience on board ships and submarines provide credibility to our occupation and assist in fostering our sense of identity as a community of professionals. The understanding of critical principles and concepts of the naval materiel management enterprise currently being advanced through the Naval Materiel Management System begins with a sound perception of how the engineering departments support operations and how risk is managed within an operational environment at sea. Nothing really replaces this.

"To this day, the tiered readiness program I was involved in with HMCS Athabaskan *in 1998 remains one of the most difficult engineering challenges of my career."*

All junior officers should strive not only to become a head of department at sea, but to look upon it as one of the key goals of their career. How you approach the job will dictate its value and richness, so I would therefore challenge all junior officers under training to approach head of department employment as an aspiration. Everyone's tour will be different, but the result will be a mix of essential skills, knowledge and experience that will in time transform into reliable engineering expertise in support of the RCN, the Materiel Group or the Canadian Armed Forces at large.

Something else I learned during my own early training on board a YAG training vessel is that *fun* should be an integral part of the work day at sea. On this note I was truly heartened by Lt(N) Jamie Lawless' upbeat presentation to the MARPAC naval technical seminar last November. As she spoke of the benefits of her time at sea, it was good to hear her remind everyone that every day on board ship will indeed bring its fair share of challenges, but will also provide a fun and gratifying environment.

Cherish your sea time. Optimize it. Enjoy it.
You will never regret doing so.

FEATURE ARTICLE

Technical Evaluation of an Innovative Energy Efficient Waste Abatement System

By Cdr Jacques P. Olivier, CD, BEng, MSc, MBA, PEng, PMP, IMarEST
and Dr Theodora Alexakis, BEng, MEng, PhD

Photo by Amanda Lafleur

The crew of HMCS *Ottawa* lands gash in Esquimalt dockyard during the ship's solid waste retention operational evaluation.

Introduction

With the amendment to the MARPOL 73/78 Annex V regulations for the prevention of pollution by garbage from ships, discharge of virtually all garbage except food waste into the sea is now prohibited as of January 1, 2013. Since the Department of National Defence (DND) adheres to a policy of exercising due diligence and environmental stewardship, an integrated solid waste management solution should be sought whereby compliance and efficiency are regained with the current fleet systems, and carefully designed from inception for the future fleet.

Implementing such an integrated waste management system across the current fleet through technology insertion, and sustaining this capability into the major capital projects, would promote equipment commonality and support continuous horizontal capability planning, development and acquisition in the environmental domain. While exempt from MARPOL Convention and the Canada Shipping Act, DND is self-mandated to meet or exceed the letter and spirit of all federal laws. Therefore, the Royal Canadian Navy (RCN) has a duty to take a proactive approach to exercising due diligence and environmental stewardship.

Problem Definition

Efficient abatement of solid waste for naval vessels is more than a desired green activity; it is a matter of logistical imperative and combat readiness primacy. Ineffective solid waste abatement in terms of volume reduction may yield negative impacts on the ship's endurance at sea, health and safety conditions, waste disposal cost, labour burden on crew, quality of life at sea, damage control, and fire fighting. Furthermore, security remains a concern in that reducing the time spent alongside or in proximity to foreign ports may significantly mitigate the susceptibility and vulnerability risks from asymmetric threats.

Waste management systems on naval vessels are too often cumbersome, energy inefficient, low-throughput performing, time-consuming, and labour-intensive. Moreover, because the overall waste management approach has traditionally been shaped by the isolated evolution of international regulations by waste types, each waste stream tends to use different equipment. The end result is multiple systems, *dysfunctionally* arranged in one or more compartments throughout the ship, which exacerbates systems' operation and maintenance.

The self-sufficient nature of naval activities demands a robust, compact, simple, inexpensive, and reliable system. Technological solutions must therefore be capable of continuous operation in the rigorous naval environmental conditions including shock and vibration, static and dynamic loading through several degrees of freedom, and extreme operating temperatures. Providing such an integrated solution requires technology transfer and innovation.

Potential Solution

The readiness level of several potential technologies was assessed with a view of identifying promising pollution abatement systems for current and next generation Canadian naval vessels. Of interest was the Micro Auto Gasification System™, or MAGS™ (Figure 1), a compact and environmentally responsible solid waste conversion appliance designed for small habitats such as ships and land-based sites. The MAGS development began in 2005 with support from the RCN, the US Office of Naval Research, and Sustainable Development Technology Canada.

MAGS is a patented technology based on the concept of 'auto-gasification' that thermally breaks down hydrocarbons into solid carbon (biochar) and synthesis gas (syngas), and, in turn, uses the syngas to fuel the process. This quasi self-sustained process allows the energy efficient conversion of mixed solid refuse such as plastics, papers, food, cardboards, textiles, wood, used oil (petroleum and cooking oils), sludge, and biochemical waste into biochar and thermal energy. Biochar is produced by sequestering the carbon found in the biomass waste, and ultimately reduces greenhouse gas emissions (Figure 2). The thermal energy produced by the system is in the form of hot water that can be beneficially used by any site. The MAGS technology is specifically designed to avoid the formation of polychlorinated dioxins and furans (PCDD/F) which are pollutants that are typically formed during incineration processes.

A MAGS 4.3 prototype was installed on HMCS *Protecteur* (AOR-509) for the treatment of shipboard solid waste (Figure 3). The overall objective of this technical evaluation was to gauge the MAGS performance and ability to process the various waste streams generated on board the ship while at sea. The evaluation was carried out while the ship was alongside at Esquimalt Harbour in Victoria, British Columbia and during a five-week mission in the months of May and June 2011.

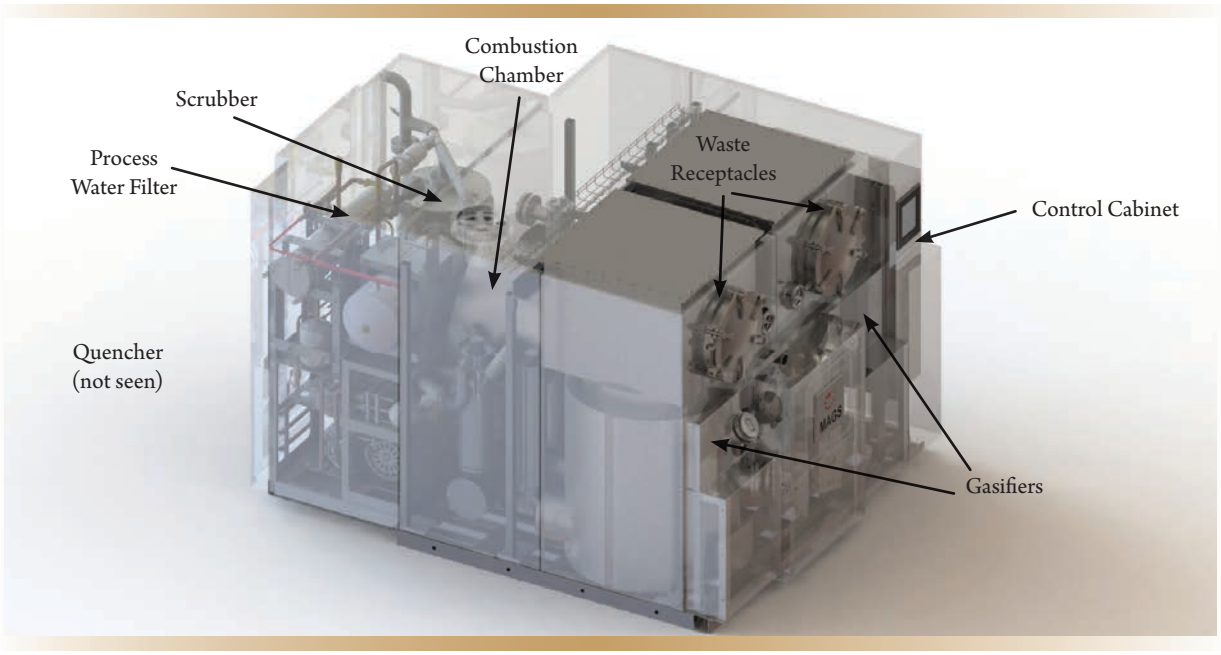
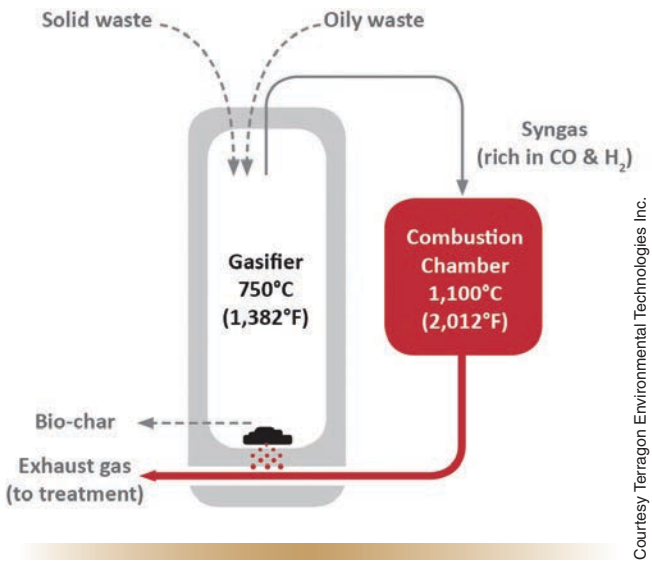


Figure 1 – Micro Auto-Gasification System (MAGS™) equipment



Courtesy Terragon Environmental Technologies Inc.

Figure 2 – Simplified schematic of the auto-gasification process

Photo by Amanda Lafleur

Figure 3 – MAGS 4.3 installed on HMCS *Protecteur*

Results

The technical evaluation commenced with a successful alongside trial during which the behaviour of the MAGS was tested with various waste streams – including highly energetic and hazardous waste. Concurrently, preliminary data on the throughput of the MAGS was gathered and initial staff training was conducted in preparation for the sea trials.

The sea trial objectives included using MAGS to process the waste generated while at sea, comparing MAGS with the equipment currently used, and the commencement of crew training on the operation of MAGS. Overall, MAGS performed well, processing all garbage generated, except for metal and glass, in a timely manner with minimum downtime. As can be seen in Figure 4, the daily average mass of waste processed was approximately 140 kg. The daily average mass of char reclaimed was 2.6 kg corresponding to a mass reduction of 98 percent.

The average composition of solid waste processed by MAGS while at sea was 69 percent paper and cardboard, and 25 percent plastic. The absence of a food component is due to the fact that, while at sea, food waste is pulped and discharged overboard. However, while in port the ship is restricted from discharging food, and therefore the food waste becomes a significant fraction of the waste stream to be processed by MAGS.

Additionally, it was demonstrated that MAGS has the ability to process waste that would normally have to be stored and offloaded at port. Examples of "other" waste include shoes, shower curtains, binders, carpet, and laser printer cartridges.

The fuel consumed was primarily necessary during the warm-up period of approximately three hours – normally four litres per hour. Little or no fuel is required during regular operation due to the 'auto-gasification' self-sustained process. Fuel is required only when the combustion chamber temperature goes below set values due to interruption of waste feeding or feeding of very wet garbage. This was demonstrated by a daily average fuel consumption of only 14.6 litres with a daily average processing time of 11.5 hours.

Although data was captured for seven days, MAGS was used for the duration of the mission, which lasted five weeks. During that period, four crew members were trained in the operation of MAGS and were able to provide first-level maintenance. It was reported that the

crew perceived MAGS favourably compared to current waste treatment appliances due to its simplicity and potential reduction in waste manipulation. Moreover, MAGS could contribute to a notable betterment in quality of life as the working environment mitigated unpleasant odours normally produced by other appliances. Overall, the evaluation of the MAGS 4.3 prototype on board HMCS *Protecteur* showed promising results.

Discussion — Waste Processing Capacity

Subsequent solid waste trials were conducted in HMCS *Ottawa* (FFH-341) in March 2012 and HMCS *Edmonton* (MM-703) in April and May 2013 to determine, among other things, the quantity and composition of solid waste generated, and the impact on endurance at sea should the RCN fully comply with IMO regulations. These studies enabled comparative analysis within the RCN, other navies and the cruise industry.

Table I indicates the average daily waste generated per person for various platforms while **Table II** shows a waste characterization comparison between RCN surface ships. Given MAGS' demonstrated performance at sea and its potential mass processing rate of 40 kg/hr, such technology could possibly allow the efficient abatement of all solid waste generated at sea while meeting environmental legislation.

Thermal Energy Recovery

The RCN should aspire to adopt industry's best practice with regards to environmental sustainability and energy efficiency. Considerations ought therefore to be given to initiatives such as the Energy Efficiency Design Index (EEDI), which was made mandatory for new ships and the Ship Energy Efficiency Management Plan (SEEMP) for all ships with the adoption of amendments to MARPOL Annex VI in 2011.

Although not tested nor used on *Protecteur*, MAGS converts the calorific energy of waste to thermal energy, thus making it an example of a biomass heater. Using waste as its fuel source, a technology such as MAGS provides thermal energy, up to 2,000 kWh/day, for use by ships to improve system efficiencies. As such, MAGS is an energy production appliance fuelled by waste rather than simply a waste elimination device. Furthermore, its operation may be most beneficial when ships are at port, during which time many of their engines are offline and a limited amount of thermal energy is being recovered for use.

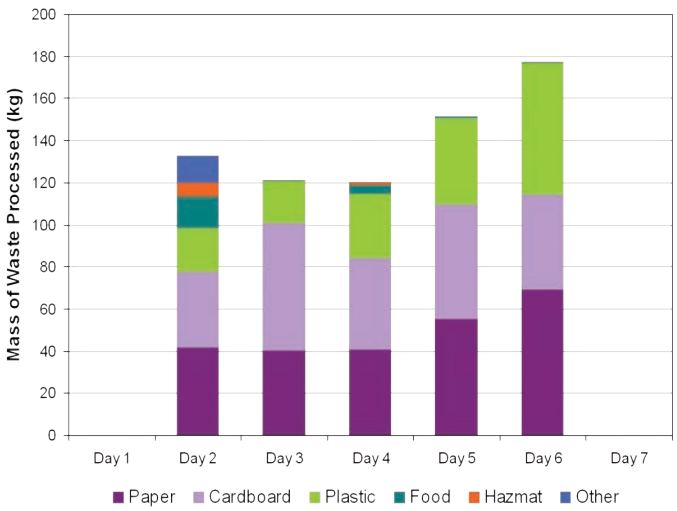


Figure 4 – Mass and composition of waste processed during MAGS at sea trial

PLATFORM	YEAR OF SURVEY	COMPLEMENT	WASTE GENERATION
HMCS *PROTECTEUR*	2011	244	0.58*
HMCS *OTTAWA*	2012	233	0.63
HMCS *EDMONTON*	2013	31	0.93
USS *NIMITZ*	2008	4,316	1.68
CRUISE INDUSTRY	2008	500 – 8,000	0.32 – 3.49

Table I – Waste Generation Comparison (kg/person/day)
Note: *Excluding the pulped food discharged overboard, and the retained metal and glass waste.

WASTE STREAM	PRO*	OTT	EDM
PAPER	35%	22%	27%
CARDBOARD	34%	23%	13%
PLASTIC	25%	11%	11%
FOOD	3%	24%	36%
GLASS AND CERAMICS	NO DATA	3%	3%
METAL	NO DATA	5%	5%
HAZMAT	1%	NO DATA	NO DATA
OTHER	2%	12%	5%

Table II – Waste Characterization Comparison (%)
Note: *Excluding the pulped food discharged overboard, and the retained metal and glass waste.

Implementation Strategy

Limited retrofitting options exist for the current fleet, which is minimally equipped with waste processing equipment capable of meeting the current MARPOL requirements. The option of retaining all solid waste on board until visiting ports-of-call is deemed to restrict the ship's at-sea endurance and may also degrade the ship's military capabilities and crew's quality of life.

A recent unsatisfactory condition report from a deployed ship validated some of these impacts in that their attempt to conform to the new environmental regulations resulted in compounded problems including the authorized holding capacity for solid waste being maximized after less than ten days at sea. Also, retaining solid waste on board prolonged the "gash landing" activity at port, while occupying much of the crew and increasing the hygiene and sanitary issues for personnel handling solid waste, which led to cases of nausea and gastroenteritis. Additionally, there were hazards to helicopter flight operations due to increased count of wildfowl following the ship. It was also mentioned that the fitted compactor was not necessarily practical because it does not reduce the weight of solid waste but rather increases its density – which may make handling more difficult.

Many constraints have to be considered when choosing a suitable onboard waste abatement system. These include waste-induced odour reaching objectionable levels, compromised damage control infrastructure, alternate storage space allocations losing their intended purposes, and additional labour-intensive waste management activities. Because of modularity and adaptability, suites of obsolete equipment could potentially be replaced with a technological solution such as MAGS that might provide a smaller footprint, improved performance, and the ability to meet most stringent environmental legislation.

> *"Many constraints have to be considered when choosing a suitable onboard waste abatement system."*

For future constructions, careful design considerations should be exacted in the development of a compact system that can simultaneously convert all incoming solid and liquid waste into inert char, gaseous fuel, sanitized inorganic material, and pathogen-free clean water that can be safely discharged into most environments or recycled. Such a truly integrated solution should ideally consider operations in all possible missions within the spectrum of modern conflicts as well as military operations other than war.

Conclusion

This article highlights the environmental challenges facing modern expeditionary navies and explores one innovative technology transfer potentially providing an integrated solid waste treatment system. MAGS proved to be an energy-efficient device that has the potential to achieve the complete elimination of combustible waste including paper, cardboard, plastic, oily rags, and food in a manner that is environmentally responsible. The RCN in concert with industry must implement technical solutions that will meet the current and upcoming environmental and energy efficiency regulations.

Photo by Amanda Lafleur

Paper waste collected on board HMCS *Ottawa* during the ship's solid waste retention operational evaluation.

Cdr Jacques P. Olivier was the Maritime Equipment Program naval material authority for marine auxiliaries including solid and liquid waste environmental protection systems from July 2011 to April 2013

Dr Theodora Alexakis is the Vice President of Business and Technology Development at Terragon Environmental Technologies Inc.

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FEATURE ARTICLE

3D Printing — Additive Manufacturing in the RCN

By LCdr Steve Morrell

(Photos courtesy of Gilbert Lewis and Colin Davis, Fleet Maintenance Facility Cape Scott)

Introduction

Additive manufacturing (AM) has been steadily gaining popularity over the last few years. The ability to achieve near-net-shape objects by converting a digital model into an actual three-dimensional part seems futuristic, but the future is here and the capability of this technology is very real. The Royal Canadian Navy (RCN) acquired a prototype AM system through the National Research Council in January 2012, and has achieved a great deal of success since its implementation in January 2013.

Background

It has been more than ten years since Defence Research and Development Canada Atlantic (DRDC(A)) began working with the National Research Council in the field of additive manufacturing. The possibilities offered by this technology for manufacturing complex designs go far beyond anything available using our conventional methods, but as the technology matured it became apparent that industry would need to be engaged to advance it much further. Despite the potential, industry was reluctant to get on board due to the high start-up costs and lack of established manufacturing standards. This is where the RCN, in cooperation with DRDC(A), recognized the huge potential of this technology and began negotiations with the National Research Council to obtain a prototype system.

One of the major issues facing the RCN is our inability to support obsolescent equipment. The RCN fully understood that the additive manufacturing technology was still in its infancy stage for commercial use, but was willing to take on the challenges of using it in Fleet Maintenance Facility Cape Scott (FMFCS).

To prove the effectiveness of the technology, the National Research Council manufactured a replica of an obsolete, non-critical fuel flow meter component still carried on board the *Protecteur* class (Figure 1). The replicated component has been in service without failure since December 2011. As a result of this success, the RCN procured a prototype additive manufacturing system from the National Research Council and implemented it at FMFCS.

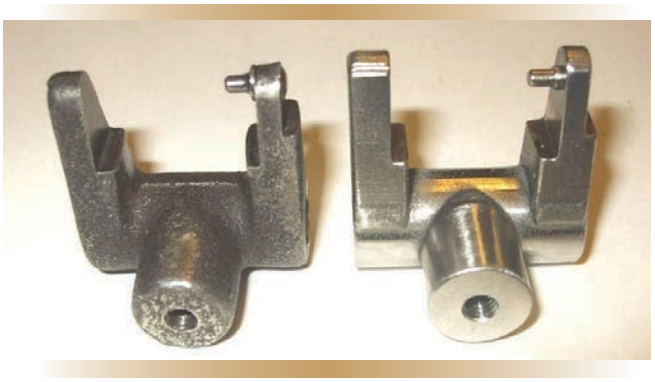


Figure 1 – This fuel flow meter component (original is on the left) was reproduced at right using additive manufacturing. The part has been in service for more than two years without failure.

Additive Manufacturing

There are several types of AM processes that can construct 3D parts from a digital model. The system chosen for the RCN is a powder injection system that distributes fine metal powder through a nozzle and focuses a laser to fuse the material to a substrate (laser cladding). Powder injection was chosen as it is the most advantageous process for repairing damaged components. It also happens to be a 'green' process since 95 percent of the metal powder can be used in the manufacturing process by recycling it. The system is capable of producing a part that is a maximum size of about 46 cm x 46 cm (18 in. x 18 in.), a restriction imposed by the limits of the computer numerical control (CNC) equipment itself, and by the need to have the process conducted inside an argon shield. A larger component could be built in stages.

Implementation

As with any leading-edge technology, additive manufacturing has significant challenges that must be overcome to achieve successful implementation. One of the major technical issues surrounding AM is the lack of proper manufacturing standards, and while much work is now being conducted globally in this area there remains much to be done.

The main challenges identified by FMFCS concerning the use of AM technology were training, infrastructure and, most critically, long-term support once the additive manufacturing system became operational. For the RCN to become a leader in the use of this technology it would be necessary to look at the resources already available both in-house and externally. Fortunately, DRDC(A) has been intimately involved with bringing additive manufacturing to the RCN and possesses a vast scientific community along with the necessary facilities to assist us while a long-term program is developed.

DRDC(A) is currently assisting with issues such as operating parameters, metallurgy, and destructive and non-destructive testing. FMFCS also has a large pool of technical expertise to draw from, so there is no doubt that in time the RCN will become a centre of excellence for the use of this technology. Industry will certainly benefit from what is learned, but this is a long-term process.

Success

The real question is, what can we do with additive manufacturing? Replicating the fuel flow meter component was just the RCN's initial cautious step toward proving the technology. Since then the technologists have made significant strides in advancing their knowledge of how the system works. They have been successful in repairing a number of components that have been, or are capable of being, put into service. These include the Nash compressor impeller (Figure 2), a number of bearing surfaces on shafts, gear splines and cracked castings. A certain amount of R&D testing has also been done using the technology (Figure 3).

Two notable repairs, one to the JP5 cargo pump drive shaft on board HMCS *Preserver* (AOR-510), and the other to the RHIB davit gearbox shaft on HMCS *Halifax* (FFH-330), prevented a situation where the lack of replacement parts, long lead time to have them manufactured and significant costs threatened these ships' operational programs. The quick repairs made possible through the application of additive manufacturing technology resulted in significant savings to DND in replacement parts, potential engineering changes and operational schedules.

The Future

One of the long-term visions of the RCN is to have a deployable system that could be sent into theatre on board an AOR, or perhaps ships could be made self-reliant. The advantage to the RCN is a significant savings in the need to stock spares and have the logistics to maintain them. In addition, ships could be operational much sooner than in the past. The true shift in building warships will come when they are designed and built with this technology.

Figure 2 – Three versions of a NASH compressor impeller: Front left is the laser additive manufacturing replica, while behind it is the brass original part. On the right is a plastic replica produced using 3D printing.

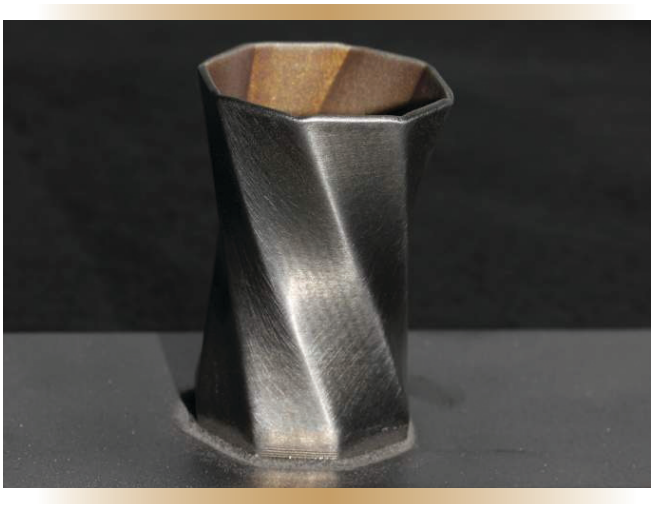


Figure 3 – This R&D test piece was created to demonstrate multiple-axis additive manufacturing capabilities which cannot be produced using computer numerical control milling equipment.

LCdr Steven T. Morrell is Group Manager 4 (Mechanical) at Fleet Maintenance Facility Cape Scott in Halifax, Nova Scotia.

Acknowledgment

The assistance of Cdr Roger Heimpel, OCdt Samantha Morgan and Roger Barakett in the preparation of this article is greatly appreciated.

FEATURE ARTICLE: LOOKING BACK

Memories of an *Athabaskan* Bride

By Iolanda (Vi) Connolly

Editor's Note: This touching story, written by Iolanda (Vi) Connolly, was discovered during work on our last issue of the Journal.

I would like to take you on a wartime journey that unfolded over three-and-a-half years, a period marked by devastation and isolation, inspiration, faith and, most of all, love. It was undertaken by me as a young woman who, at 19, was a newlywed, working full-time and living with her in-laws.

It began in early 1942 when I said goodbye to my new husband Bill, who was leaving Hamilton, Ontario for the war. While I carried on with my job as a telephone operator at home, Bill trained as a navy signalman before joining HMCS *Athabaskan*, a Tribal-class destroyer of the Royal Canadian Navy.

Two years passed. It was Sunday, April 30, 1944, and I was following my usual routine of going to church and singing in the choir. When I got home, however, my mother-in-law told me I had received a phone call from a Mrs. Hayes, whose son Bill was also on the *Athabaskan*. I called Mrs. Hayes and she asked if I'd heard from my husband. I told her of his most recent letter that had arrived the previous week. She said, "I mean more recently." I told her no, and that's when she burst out: "The ship went down last night!" I collapsed into the arms of my mother-in-law, who without hesitation said, "Bill's OK!" (Mother's intuition?)

This started the most devastating and frustrating time of my life, and that of our immediate family and friends. Yes, it was war after all, and although I knew that tragedy could happen it didn't lessen the ache in my heart. The days that followed were difficult to manage, but it was the nights that I dreaded. Visions engulfed me, making it impossible for me to fall asleep. I knew that Bill was a good swimmer, but had he been able to swim to shore? Was he wounded and still in the frigid water calling for help? All I could do was cling to my faith and pray to God to send my Bill some help.

Photos courtesy Historica Canada

Bill and Vi Connolly

Over the next few days we learned that HMCS *Athabaskan*, with a crew of 260, had been torpedoed by a German ship in the Bay of Biscay, and that HMCS *Haida*, her sister ship, had picked up 47 survivors who were now on their way home. My husband was not among these so-called 'lucky' men, but Bill Hayes was. He was reluctant to see me after he returned to Hamilton because, as I learned, he had seen my Bill's action station – the communications section – blown right off the ship. Bill did his best to explain that it was almost impossible to account for anyone's whereabouts in the water, as it was utter chaos. Of course, I was looking for any thread of hope to hang onto.

In the weeks that followed, the Germans announced they had picked up 85 survivors of *Athabaskan* and that they had been sent to a PoW camp [*Marlag und Milag Nord, 30 km northeast of Bremen*]. They also stated that they had no intention of giving out those names. That left a total of 128 unaccounted for.

Eventually, I received a telegram from the government telling me that Bill Connolly was 'missing.' The news for many other families was not good either. Much later we learned that 91 bodies had washed ashore along 150 miles of French coast. The bodies were buried in nine different cemeteries. Some could not be identified and the markers simply read: Known only to God. Today, 37 men are still unaccounted for.

We waited for three long, tortuous months before the Red Cross was able to convince the Germans to abide by the Geneva Conventions and release the names of the PoWs. Then, one day, we received a pre-printed post card signed by my husband, confirming what I had been hoping and praying for – that he was alive, albeit a prisoner in a German PoW camp.

We had a darling postman on Locke Street in Hamilton. The morning he recognized Bill's card in his pack he came directly to our neighbourhood, telling all of our friends and neighbours along the way the good news. By the time he reached our house there were at least a dozen men and women behind him. Some were waving flags and others were shouting: "He's alive, he's alive!" I was at work that morning, so my mother-in-law had the pleasure of receiving them. When I got word of the news, my boss enthusiastically sent me home early to celebrate with my family. As I took off down the stairs of the plant where I worked, everyone was hammering on their machines, their way of saying: "Hooray!"

Not knowing the fate of my husband for so long had taken a toll on me, so my doctor suggested that I become more involved with the war effort. I decided to answer an ad for work in a steel mill. I eventually worked in several different places, but my last job, at the Sawyer Massey Argus Company, involved drilling holes into the thick round steel bases that fit under the gun mountings that were on the Tribal-class destroyers like my husband's ship! (Was this irony or destiny, or both?)

It was truly exciting work and I remained there until my husband returned home. It was during this time that a photograph was taken of me working at my drill press. The photo was used in Women in the Workforce poster to illustrate the hard work that the women of Hamilton were doing for the war effort.

Although this period of challenge lasted for only three-and-a-half of my 67 years of married life with Bill, who passed in 2008, it seemed like a lifetime. When I look back, I realize that going through those tumultuous times shaped me into the person I am today.

To all of you I say, go forward and enjoy every precious moment of your own life journey.

[*This edited memoir by the widow of Signalman Bill Connolly first appeared in the publication* An ABC of the Battle of the Atlantic, *an interdisciplinary educational resource initiative sponsored and supported by The Naval Officers' Association of Canada, with a web adaptation sponsored by Fire Services Credit Union and completed by Saul Bottcher. It is reprinted here with the permission of Iolanda (Vi) Connolly.*]

Photo by Tom Douglas

Bill Green (left), Iolanda (VI) Connolly and Keith Wood speak to high school history students in the Greater Toronto Area and Atlantic Canada about the experiences of Canada's veterans.

Remembering Canada's Heroes

Iolanda (Vi) Connolly is now in her 90s, but age hasn't slowed her down when it comes to honouring the memory of her late husband Bill and other Canadian veterans who served their country in times of war.

The Burlington, Ontario resident is one of the driving forces behind a registered charity called Remembering Canada's Heroes that coordinates school visits in the Greater Toronto Area as well as in Atlantic Canada.

Vi, along with the organization's founding director, Bill Green of Halifax, Nova Scotia, Royal Navy veteran Keith Wood of Hamilton, Ontario, and a roster of volunteers, keeps up a hectic schedule of talking to high school history students about the experiences of Canada's veterans.

Green said that he started the school visit program when he lived in Hamilton and served as executive director of Friends of HMCS *Haida*. "In Ontario, Grade 10 History is a compulsory course of study covering Canada's growth as a nation in the 20th century," he said. "I quickly became aware of the shortcomings of most of the high school history textbooks currently approved for the course."

Green added that the long-term goal of his organization is to persuade textbook publishers to put more emphasis on the contributions made by Canada's fighting forces and especially the country's Second World War, Korean War, Cold War and Peacekeeping veterans. **— *Tom Douglas***

Book Review

Lost Beneath The Ice: The Story of HMS *Investigator*

Reviewed by Tom Douglas

Lost Beneath The Ice
Text by Andrew Cohen

Dundurn: ISBN 978-1-4597-1949-1
152 pages; 89 colour illustrations
$29.99

When the end of the Napoleonic Wars left Great Britain with a swollen Royal Navy and little for the men and ships to do, the Admiralty turned its attention to seeking a northwest passage. A prize of £10,000 would be given to the ship's crew that discovered Canada's elusive northern waterway to the Orient.

When explorer Sir John Franklin disappeared on such a quest in the Arctic in the 1840s, a massive rescue mission ensued. The unsuccessful search included HMS *Investigator*, captained by Robert McClure, which entered Arctic waters from the west before becoming ice-bound in Mercy Bay on Banks Island. McClure didn't find Franklin, but he was credited with discovering the shipping channel through the frozen north.

Author Andrew Cohen's account of the three agonizing years McClure and his starving crew spent with their ice-locked ship before being rescued by a sledge party from HMS *Resolute* is gripping. By comparison, the second half of the book detailing the 2010 discovery of the sunken *Investigator* by a Parks Canada team seems almost anti-climatic. The wreck was located just ***three minutes*** after the search team lowered their side-scan sonar into the frigid waters of Mercy Bay. As Cohen writes, "There was no eureka moment."

That the Parks Canada crew was able to find the sunken vessel so quickly is a testament to the thoroughness of their preparations...and a little luck. *Lost Beneath the Ice* is a stunning coffee table book featuring magnificent contemporary paintings and diagrams, as well as modern-day photographs of the archaeological expedition and its discoveries. The five pages of *Investigator's* 1848 hull and deck plans alone are worth the cover price.

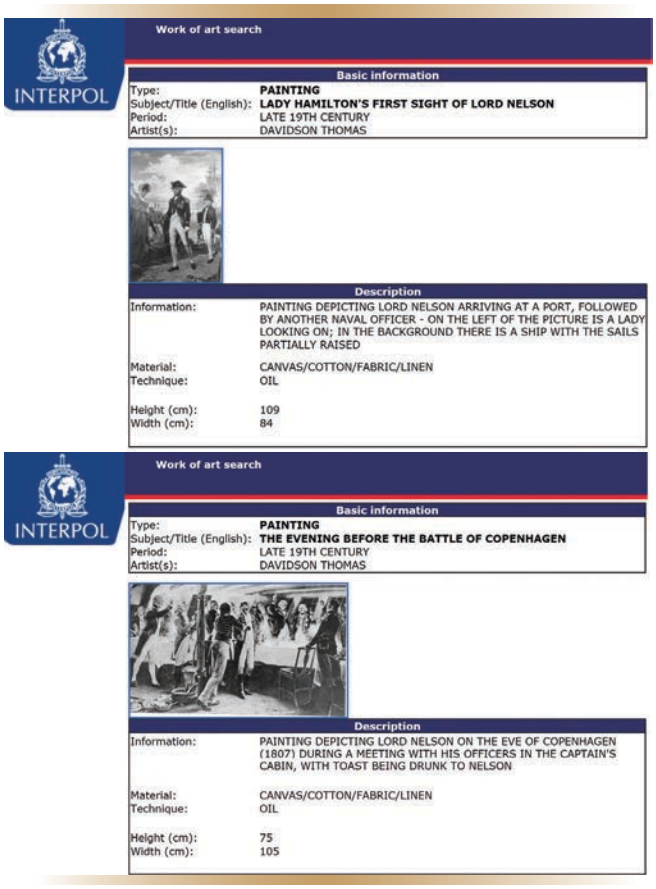
Military author Tom Douglas is the Journal*'s associate editor.*

News Briefs

Way to go!

While awaiting initial training in 2012, A/SLt Youngjun Hwang (left) and A/SLt Felipe Martinez-Gonzales (right) dedicated themselves over nine months to streamlining the consolidation and presentation of preventive and corrective maintenance data from the Defence Resource Management Information System (DRMIS) deployed servers. Consolidated material state reports that used to take many hours to produce can now be created consistently in about five minutes. BZ to these eager engineers. We look forward to seeing what they can achieve once they are trained!
— ***LCdr Tim Gibel***, DGMEPM/DMMS(MIS)3

News Briefs



INTERPOL on the lookout for two stolen paintings of Nelson

The Fall 2011 edition of the *Maritime Engineering Journal* (MEJ No. 68) included a book review of *The History of HMCS Bytown Wardroom Mess* which briefly mentioned "stolen paintings." Readers will be interested to know that the 34-year-old cold case was reactivated in May 2012.

The paintings, both by Thomas Davidson (1842-1919), are: "***Lady Hamilton's first sight of Lord Nelson***," which depicts Lady Hamilton welcoming Lord Nelson in Naples on Sept. 22, 1798 after his victorious Battle of the Nile; and, "***The Evening before the Battle of Copenhagen***," depicting Nelson and his officers enjoying a spirited dinner on April 1, 1801 in the great cabin of his flagship HMS *Elephant.*

Details of the paintings and the Nov. 22, 1979 theft are recorded in the INTERPOL online database of stolen artwork. Screenshots of the database entries are shown with permission. ***— Bill Dziadyk, LCdr RCN (Retired)***

[Copies of the *The History of HMCS Bytown Wardroom Mess* are still available for purchase for $15 from the mess manager at mario.levesque3@forces.gc.ca (613) 235 7496.]

A home for HMCS *Sackville*

The Canadian Naval Memorial Trust has launched a campaign to raise close to $200 million to preserve the last of Canada's corvettes of the Second World War. A proposed Battle of Atlantic Place, situated next to the Maritime Museum of the Atlantic on the Halifax waterfront, will tell the story of *Sackville* in context and is scheduled to open July 1, 2017.

News Briefs

Cross-Canada seminar

The 2013 MARPAC Naval Technical Seminar held last October 23 and 24 was broadcast across the country from newly equipped video conference rooms at Fleet Maintenance Facility Cape Breton in the naval dockyard at Esquimalt, BC. This was the perfect forum for trialling the capabilities of the system while connecting with participants at NDHQ Ottawa and MARLANT Halifax. A wider portion of the naval community was able to participate thanks to the video access.

The theme for the seminar lent itself to this new capability under the umbrella of 'leveraging technology.' Through the tremendous support of FMFCB's IT section, MARPAC was able to host three presentations from NDHQ, two from the East Coast, and five from the local area. Presentations covered the capability of the future fleet, the current use of technology for trainees, briefings on new policy and naval transformations, as well as in-depth technical specifications for guided weapon systems and new ship design.

In his closing remarks, Cmdre Marcel Hallé (DGMEPM) challenged the members of the naval technical support community to both learn from and mentor one another. "We are a small community," he said. "We come together like this to reinforce what we do." ***— Lt(N) Kira Yakimovich, Canadian Forces Fleet School Esquimalt, event organizer***

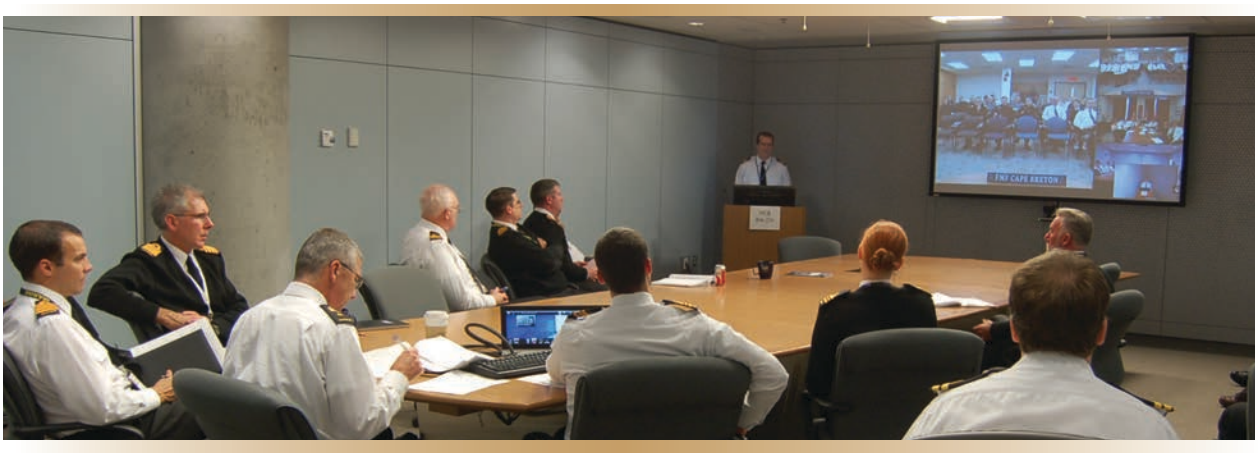


Photo by Brian McCullough

Names announced for future Joint Support Ships

Minister of National Defence Rob Nicholson announced last October that the Royal Canadian Navy's two future Joint Support Ships, which will be built by Vancouver Shipyards Co. Ltd., will be named HMCS *Queenston* and HMCS *Châteauguay* in recognition of the significant battles of Queenston Heights and Châteauguay during the War of 1812.

"The names recognize the achievements and sacrifices of those early Canadian soldiers who fought and died in these critical battles during the War of 1812," said Minister Nicholson. "The War of 1812 was a defining moment in our nation's history that contributed to shaping our identity as Canadians and ultimately our existence as a country."

These ships will provide underway replenishment capability for fuel and other supplies, and offer hospital facilities and strategic sealift for operations ashore. They will ensure that the military can continue to monitor and defend Canadian waters and make significant contributions to international naval operations. The JSS will provide Canada with a modern, task-tailored, globally deployable support capability for naval task groups for extended periods.

PRESERVING CANADA'S NAVAL TECHNICAL HERITAGE

NEWS

Canadian Naval Technical History Association

On the Trail of the Navy's 'Holy Grail'

By Cdr Pat Barnhouse, RCN (Ret.)

CNTHA News *Est. 1997*

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www.cntha.ca

When the Liberal government took power in 1963, one of their first official actions was to cancel the General Purpose Frigate (GPF) building program that had been approved by the previous Progressive Conservative government. For the next few months the naval HQ operational and technical staffs spent much time seeking to define an alternative shipbuilding program, an endeavour one wag referred to as the 'ship-of-the-month club.'

In the Directorate of Systems Engineering, we were at the centre of things as the various proposed designs were passed around. One day a lieutenant commander from the naval staff (I do not recall who it was) dropped in with an exciting message: "We have decided on the way ahead!" he said. In his hand he held a Xerox copy of a back-of-an-envelope sketch for a proposed 'Repeat *Annapolis* Class' ship, apparently made by admirals Ken Dyer and Bob Welland at a cocktail party the previous afternoon. This was the genesis of the ship that grew to become the DDH-280.

Years later, while checking on details surrounding the origins of the DDH-280 for someone, I asked then retired VAdm Dan Mainguy about the sketch as he had been on the naval staff at the time. He not only confirmed the story, but added that he knew who had the original of the envelope – one LCdr Bruce Torrie, who reportedly hadn't seen it in years. Unfortunately, according to his nephew Robert Bruce Torrie, LCdr Torrie died in 1999, and such a thing as a sketch on an envelope would not have stood out as something to be kept when he was going through his uncle's papers.

So, while this trail appears to have gone cold, there is more to the story. RAdm Welland himself commented on it when the CNTHA interviewed him in 2006, four years before his death:

Photo by Canadian Armed Forces

HMCS *Iroquois* (DDH-280) with her gas-turbine propulsion plant, Sea Sparrow missile point-defence system and 5,000-ton displacement was hardly a repeat of the *Annapolis* class (next page), but the family resemblance is there all the same. While the 2,400-ton *Annapolis* (DDH-265) was placed in reserve in 1996 after 32 years of service, a much-modernized version of *Iroquois* is still in operational service with Canada's Maritime Forces Atlantic 42 years after she was commissioned.

> Well you asked about settling the design of the ship and a rumour that went around that it was designed on the back of a cigarette package...absolute crap. We worked our heads off for months: research, everything.

This rather introduces a slight complication. If one of the supposed participants had no memory of doing so, where does that leave us? A back-of-the-envelope sketch clearly existed, but who made it?

Directorate of History and Heritage naval historian Lt(N) Jason Delaney, who worked on volume III of the official history of the RCN, offers some fascinating historical insight surrounding the new ship program:

> Yes, Dan Mainguy's interview mentions this, but every program has a back-of-a-cigarette-pack/envelope/napkin "I designed it" story, and this is just one of them. I don't

Canada

doubt there was some doodling on scrap paper; however, it is a bit of a leap to say that this is how a multi-million-dollar warship procurement program started. There were lots of plans in the works during this period and this was just one of them presented as an option.

We are talking about an era (Paul Hellyer was Minister of National Defence) when the services were under great scrutiny. In fact, there was a moratorium on all DND contracting throughout 1963 when the GPF was cancelled. The government agreed to a repeat *Annapolis/Nipigon* design and the program 'crept' from there, beginning with the change to gas turbine propulsion. This was done for various reasons, but Hellyer liked the new technology and, operationally, the old *St. Laurent*-type hulls had reached their development limit in terms of maximum speed using a steam plant. Quite simply, they were no longer fast enough for modern fleet work, being too slow for operations with American strike fleets and on the verge of obsolescence when dealing with the speed and agility of nuclear submarines. In addition, there was a need for a shipboard air defence system following the retirement of the navy's carrier-based F2H3 Banshee fighter-interceptors in 1962. Our ships were vulnerable to air attack. These were all very big problems that the naval leadership was dealing with at the time. Despite Hellyer agreeing to a repeat design, all these other considerations crept into the program, resulting in a very different class of ship.

Those were interesting times indeed. Every ship has its beginnings, but unless by some strange good fortune the elusive sketch should one day miraculously reappear, the story of the actual genesis moment of the DDH-280 tribal-class destroyer (which is still in service) will forever have this fogbound footnote attached to its history.

For more reading on this subject, go to the CNTHA website and download Hal Smith and Shawn Cafferky's article: *Looking Back: How the DDH-280 Began* (MEJ No. 44 – June 1998) at: http://www.cntha.ca/images/Otherdocs/mej/mej-44.pdf

Photo by Canadian Armed Forces

HMCS *Annapolis*