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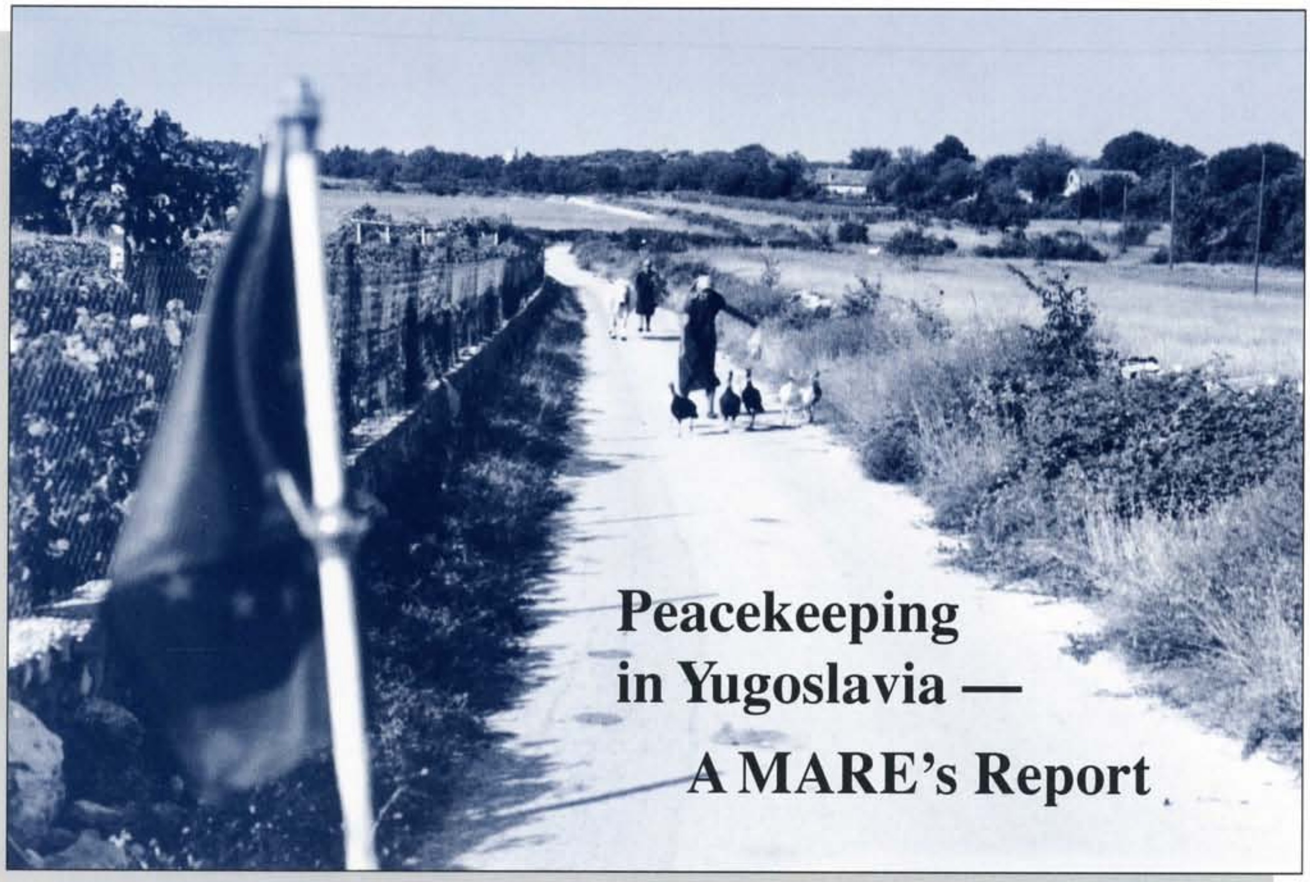
Maritime Engineering Journal

July 1993



Also:

- *Target Motion Analysis*
- *Looking Back at HMS Captain*

Canada

PHOTO: CFB SHEARWATER BASE PHOTO

Diving tender replacements are on the horizon — see page 25

Maritime Engineering Journal

MARE

Established 1982

JULY 1993

DEPARTMENTS

FEATURES

OUR COVER
A European Community Monitoring Mission vehicle shares the road in the Krajina region of Yugoslavia. *(Photo by LCdr Bryan Leask)*

The *Maritime Engineering Journal* (ISSN 0713-0058) is an unofficial publication of the Maritime Engineers of the Canadian Forces, published three times a year by the Director General Maritime Engineering and Maintenance with the authorization of the Vice-Chief of the Defence Staff. Views expressed are those of the writers and do not necessarily reflect official opinion or policy. Correspondence can be addressed to: **The Editor, Maritime Engineering Journal, DMEE, National Defence Headquarters, MGen George R. Pearkes Building, Ottawa, Ontario Canada K1A 0K2.** The editor reserves the right to reject or edit any editorial material, and while every effort is made to return artwork and photos in good condition the *Journal* can assume no responsibility for this. Unless otherwise stated, *Journal* articles may be reprinted with proper credit.

Editor's Notes

Fertile ground — the 1993 regional maritime engineering seminars

By Capt(N) D.W. Riis, OMM, CD
Director of Marine and Electrical Engineering

Together, this year's three regional maritime engineering seminars covered everything from MARE involvement in naval peacekeeping operations to photogrammetry for shipbuilding and ship repair. Even though, as **Commodore Robert L. Preston**, DGMEM, pointed out, the seminars were individually developed to satisfy the particular needs of a region, two major undercurrents of discussion emerged across the country — the new fleet, and fiscal restraint.

The challenges of introducing and supporting the CPF and TRUMP ships in light of today's fiscal reality are not small. In his address to the Central Region seminar in February, **Rear-Admiral M.T. Saker**, the Assistant Deputy Minister for Engineering and Maintenance, delivered a strong message on fine-tuning the organizational structure to manage the challenges. "We cannot simply peel another layer off the onion as we did in the functional review and expect work to carry on as usual," he said. "We need to examine whether we need all the functional organizations we currently possess, or whether today's technologies allow us to do our business differently and better."

Commodore David Faulkner, Chief of Staff for Materiel in Maritime Command, continued this theme a month later at the Eastern Region seminar when he said, "it comes down to introducing a business-like management approach across the breadth and depth of the naval engineering and maintenance process. We are, after all, running the biggest and most complex ship engineering, modification, maintenance and repair industry in the country."

On the West Coast in April, CPF Project Manager **Commodore Wayne Gibson** (speaking on the Branch Adviser's behalf) expressed the situation this way: "The one constant we can expect in this decade is change," he said. "We must adapt to change to ensure the maximum operational capability and effectiveness." He ended on a bright note concerning the future. "You will have so much opportunity you won't know what to do with it," he said.

No maritime engineering seminar would be complete without its guest and keynote speakers. Always a highlight, they are selected from various engineering-related occupations, both within the navy and without, and usually bring with them a fresh perspective on current issues of importance to us. Here is just a taste of what some of them had to offer audiences at the 1993 seminars:

In Ottawa, Canadian Maritime Industries Association President **J.Y. Clarke** delivered an impassioned, rational discourse on the industry's need for work — steady work. He painted a grim picture of an industry operating far below its potential, and pulled no punches as he outlined the CMIA's strategies for rejuvenating Canada's marine industrial base. Among the CMIA's initiatives, a call for an interdepartmental government planning committee to develop a medium-to-long-term vessel procurement strategy for the navy and coast guard. "This is by far the most technically beneficial and economical way of acquiring a number of same-class vessels," Clarke said. "Let me tell you that three submarines in 15 years doesn't quite qualify!"

The pace was just as lively in Halifax as **Captain(N) (Ret.) Bruce Baxter** presented a unique perspective on the challenges that lie ahead for both industry and the navy. Now vice-president of naval programs with Paramax Electronics Ltd., the former DMEE struck a perfect chord with his insights based on his naval and private sector experience. "Technology is not going to be your problem," Baxter said. "There is probably, today, more technology than you can use in the next 10 to 15 years. The challenge is picking what you want and managing it. We have to plan what we do, and do what we plan."

As if to underscore the validity of Baxter's argument, **Dr. William Tolles** of the U.S. Naval Research Laboratory in Washington, DC gave the Halifax audience a fascinating overview of the vast area of emerging defence technology — everything from nanotechnology to space-based operational monitoring of environmental conditions around a naval task group. And just so things didn't get too fancy, Tolles announced the return of...wait for it...vacuum technology.

Kootenay's commanding officer, **Cdr D.J. Kyle**, got Day 2 of the West Coast seminar off to a great start with his crowd-pleasing view of the CO-MSEO/CSEO relationship. "COs have been trained to ask only two questions," he quipped. "What's broken, and how long is it going to take to fix it?" His checklist of what he expects of his engineering department heads was nicely balanced by his thoughts on what a CO can and should do for the HOD. Brutally frank at times, Kyle questioned the effectiveness of MAREs who have too little sea experience to understand the problems associated with shipboard engineering and technology. As a case in point he described the bridge VDS lost-body indicator as a technically elegant, but useless, piece of kit. "What we really need," he said, "is a boxing glove that shoots out of the bulkhead and hits you in the face when you're about to lose your VDS body!"

Commodore Faulkner put it well when he told the Eastern Region audience: "The seminar...is an opportunity both for personal professional development, and to contribute to the building of (the navy's) future vision. Don't allow the seeds to fall on fallow ground — accept them and foster their germination." The sponsors and organizers of this year's naval engineering seminars deserve our congratulations for creating the environment in which these seeds were sown.

* * * * *

Finally, the *Journal* extends best wishes to **Captain(N) Hank Schaumburg** (Program Evaluation Director, NDHQ) who retired from the navy this summer. During 35 years of exemplary service as a MARS officer (1958-73) and MARE, Capt(N) Schaumburg distinguished himself through his dedicated contribution to the naval service of Canada.

As this is my last issue as editor (I'm off to language school and from there on to Japan as the CF naval attaché) I want to say a heartfelt "thank you" to the *Journal*'s production editor, technical editors and regional and NCM representatives for their excellent work and support in making our journal first class. I have very much enjoyed being part of this very professional editorial team and know they will serve the next editor, **Captain(N) Sherm Embree**, equally well. It's a long trip across the pond, but I know the distance won't seem so great when my copy of the *Journal* arrives in the mail. *Sayonara.*

The editorial committee extends its best wishes to Captain(N) Riis as he takes his leave after three years at the helm of the Journal. Thanks to his careful editorial direction the Journal has continued to flourish as an active, viable forum of the Maritime Engineering branch of the Canadian navy.

Letters to the Editor

MARE duality

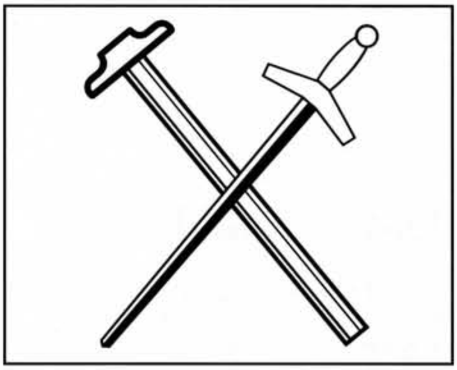
LCdr Adams is to be commended for his thoughtful article "The Duality of MARE" (*Maritime Engineering Journal, October 1992*). It is, I suggest, indicative of the intellectual health of any profession that its members are prepared to question, and to debate, its ethical foundations.

I daresay that most of us at one time or another have wrestled with the notion of duality. Most recently, I have come to believe that this duality is in fact a myth. Moreover, I submit that in propagating the notion of its existence, and particularly of its uniqueness to the MARE MOC, we demonstrate a continuing lack of confidence in our contribution to, and our equal membership in, the Naval Operations branch.

The concept of duality as we have argued it over the years implies an incompatibility between the codes of ethics governing the professional behaviour of naval officers and professional engineers. An examination of these codes reveals, however, that they are based in identical values.

This is not meant to suggest that a MARE will never be confronted with difficult technical decisions. Such decisions do not originate in any conflict of ethics, but rather in the conflict between physical law — or, more often than not, our interpretation of physical law — and operational requirements. Our obligation to the operational commander is to recognize and resolve such conflict before ship-system integrity has been violated or personnel safety jeopardized.

The potential for such conflict has always, and will always, exist. Equally, individuals may, as a consequence of such conflict, confront moral dilemma. The dilemma arises not because of a conflict between codes of ethics, but rather because



an individual may find it increasingly difficult to rationalize his professional behaviour within the system of values that is the foundation of the codes.

It is, I submit, presumptuous of us to think that we are unique in this regard. All professionals — such as doctors, civil engineers, accountants, our MARS colleagues — face equally the need to rationalize their professional behaviour within the same system of values.

If we can accept that there is no duality, then we can accept that we have but one profession; that is, that we are naval officers. We are equal partners in the Naval Operations branch and enjoy the right — and incur equal obligation — to exercise naval leadership. While it is important that we maintain a unique identity within the branch, that identity is based not on being "engineers second," but on a background that permits an objective application of physical law in the safe design, operation, maintenance and repair of ships and their systems.

While I do not deny the importance of adequate sea time — recognizing that "adequate" will vary depending on the needs of the MS, CS, NC or NA sub-MOCs — in the development of this essential background, our professional credibility is based in much more than this single factor. Indeed, as individuals, more important is our ability to live within the values that underpin our code of ethics. As MAREs, more important is our leadership of the naval technical community.

Nevertheless, some positions are better filled by individuals with more rather than less sea experience. But then, the requirements of any position can be defined uniquely. Accepting that individuals continue to grow throughout their careers, common sense suggests that we attempt to match people and positions to satisfy both immediate and long-term service needs, and to satisfy individual aspirations. Our principal currency in making any individual assessments, however, must continue to be merit.

(Cont'd p. 4)

Maritime Engineering Journal Objectives

- To promote professionalism among maritime engineers and technicians.
- To provide an open forum where topics of interest to the maritime engineering community can be presented and discussed, even if they might be controversial.
- To present practical maritime engineering articles.
- To present historical perspectives on current programs, situations and events.
- To provide announcements of programs concerning maritime engineering personnel.
- To provide personnel news not covered by official publications.

Writer's Guide

The *Journal* welcomes **unclassified** submissions, in English or French, on subjects that meet any of the stated objectives. To avoid duplication of effort and to ensure suitability of subject matter, prospective contributors are strongly advised to contact **the Editor, Maritime Engineering Journal, DMEE, National Defence Headquarters, Ottawa, Ontario, K1A 0K2, Tel.(819) 997-9355**, before submitting material. Final selection of articles for publication is made by the *Journal's* editorial committee.

As a general rule, article submissions should not exceed 12 double-spaced pages of text. The preferred format is WordPerfect on five-and-a-quarter-inch diskette, accompanied by one copy of the typescript. The author's name, title, address and telephone number should appear on the first page. The last page should contain complete figure captions for all photographs and illustrations accompanying the article. Photos and other artwork should not be incorporated with the typescript, but should be protected and inserted loose in the mailing envelope. A photograph of the author would be appreciated.

Letters of any length are always welcome, but only signed correspondence will be considered for publication.

Commodore's Corner

By Commodore Robert L. Preston

In the last Commodore's Corner I talked about the introduction of our new ships and the importance of this modern equipment to our navy. Since the last issue of the *Maritime Engineering Journal*, a number of successful trials have been conducted by ships of both the CPF and Tribal classes. The introduction of an area air-defence capability was proven when HMCS *Algonquin* successfully fired two Standard Missiles at targets on the U.S. missile range in the Puerto Rico area. This capability marks an important step in the evolution of the Canadian navy as we put into service an enhanced capability to command and protect a Canadian task group.

The last time that the Canadian navy introduced modern capability in a class of warships was in the early 1970s when the Tribal-class destroyers entered service. In that I was actively involved as Marine Systems Engineering Officer in HMCS *Athabaskan*, I thought it appropriate that I devote this Commodore's Corner to one of the "lessons learned" from that era.

There was a tendency prevalent in the navy at that time to look at the negative side of the introduction of that new capability. There was technology that not everyone understood, there were insufficient spare parts, not everything worked exactly as we wanted. That tendency had the effect of diverting attention from the improved capability that was being introduced. I hope that the same tendency does not exist among engineers today.

The most significant lesson that emerged from the early 1970s had to do with the time it took to identify deficiencies in the Tribal class, engineer solutions to these problems and implement the solutions in a timely fashion. If there is an area to which we MARE officers must turn our attention, this is it. A co-ordinated and deliberate approach will be necessary to identify and prioritize the few remaining technical issues in our new ship classes so that corrections can be engineered, developed and implemented to allow the full capability of these exciting new platforms to be realized.

I know that MARE officers will be up to this challenge.

(Letters cont'd)

While I accept as opinion the suggestion that MARE training is driving us relentlessly toward "engineering," I could not recommend that we yet accept this as fact. That sea time has been — and may further be — reduced is a fact. Whether or not adequate sea time has been built into the training program, however, can only be determined by objective validation. As such validation is realized, I ask only that we not lose sight of the substantive contribution made by all naval engineers, at sea and ashore, in delivering to the operational commander the capability that will allow him to defeat today's threat. This is the same professional engineering strength that will allow us to maintain and upgrade this capability to meet tomorrow's threat.

If we perceive the linkage between the MARE and the navy to be weaker now than in the past, then perhaps it is time that we set aside the notion of duality and accepted that we have but one profession. — **Cmdre D.G. Faulkner, Chief of Staff Materiel, Maritime Command Headquarters, Halifax.**

Forum

Assistant Head of Department: Should a job be an OSQ?

By Lt(N) C.G. Pitre

"The assistant HOD position on board a ship is a job and *not* a training billet!" A familiar phrase in the MARE community. Just the fact that we must constantly remind ourselves of this clearly indicates there is a problem understanding the role of the assistant within the department. Let's examine why it seems a bit unrealistic to affirm that it is not a training position, why we underestimate our abilities and how the system could produce the same results without an occupation specialty qualification (OSQ).

"Sub-MOC qualified officers have the tools they need to succeed as assistants. There is no need to make the A/HOD position an OSQ."

The role of the assistant as described in Ship Standing Orders (SSOs) is unclear. In the organization chart the position is derived from the HOD, connected by a dotted line and essentially not having any impact on the department. It also states that in the absence of the department head the chief shall assume responsibility for the department. Under the roles and responsibilities of the assistant, SSOs state that the A/HOD will assist the department head and be given tasks that provide progressively challenging development. Thus, a series of performance objectives must be completed to ensure a standard, and a Phase 7 HOD board convened to confirm the level of expertise. Technically, an assistant cannot take responsibility for a department until the OSQ has been completed. All these factors contribute to the doubtfulness of that position being a job and not training.

Should A/HOD be an OSQ? First let's take a look at a typical sub-MOC qualified lieutenant's posting such as CSEO/MSEO at the TRUMP detachment in Lauzon, Quebec. The responsibilities associated with these positions include being in charge of a division of at least four P1s and above, approving jobs of up to $70,000 each on ships, writing contractual technical letters, dealing directly with contractors and indirectly with unions, etc. Why do we allow newly sub-MOC qualified lieutenants to take on responsibilities ashore that sometimes exceed those of a department head in a ship, yet demand an OSQ for the job at sea? Is it fair to ask these same people to return to sea only to have a chief take over the department in the absence of the HOD because the lieutenants are supposedly not qualified?

I consider that an assistant has the same background as a head of department, but less experience. A learning process is inherent to every new job and sub-MOC qualified officers do have the tools they need to succeed as assistants. There is no need to make the position an OSQ. Department heads could be held accountable for ensuring that standardized A/HOD developmental objectives are met during an assistant's time on board ship. For that matter, certain of the existing performance objectives could be integrated with Phase 6 sub-MOC training as essential HOD validation criteria. Either way, specific roles could be assigned to standardize the job of the A/HOD position which would then appear at the same level as the deputy in the org chart. Finally, what better way to determine the ability of a candidate to return to sea than through the evaluation means of the PER.

The OSQ process makes the position of assistant head of department in a ship a fine line between a job and training. *Saying* that it is a job might not necessarily convince the right people. We need a system that can achieve the same goals as the OSQ, but which leaves no doubt as to the capabilities of the assistant. Eventually we'd be able to say we're here to share the load of the department rather than sign "reqs" off. Especially with the arrival of CPF and TRUMP, wouldn't this approach be more beneficial?

Lt(N) C.G. Pitre is A/CSE in HMCS Ville de Quebec.

DGMEM on A/HOD Employment

By Commodore Robert L. Preston

At the East Coast MARE seminar in March, the A/CSEO in HMCS *Ville de Quebec* raised a question concerning the duties and responsibilities of the assistant head of department in a ship. My response to her at the time included a commitment from me to look into the issue. In the interim, Lt(N) Pitre submitted her question to the *Journal*. I want to take this opportunity to say a few words on the issue of responsibility and qualifications in general and then outline the future of A/HOD employment.

The issue of qualification is fundamental to the practice of engineering, not only in the navy but universally. To this end we support an extensive certification program for our engineering officers and technical tradespersons. The final part of this qualification process for officers is employment as an A/HOD in a ship. This job has the elements of both employment and training and to attempt to categorize it as one or the other underestimates its importance and complexity. The knowledge one is able to consolidate while working as an A/HOD is a fundamental ingredient in the ability of the certification process to state unequivocally that an officer is competent to execute the technical and management responsibilities of an engineering head of department at sea. We must remember that we are not training for peacetime operations — the head of department must be able to lead the operation and maintenance effort under the most demanding conditions of combat. That is a dimension which is quite different from even the most technically difficult shore posting.

"The issue of qualification is fundamental to the practice of engineering. To this end we support an extensive certification program."

That is not to say that the issue of A/HOD employment should not be reviewed to ensure that it meets current requirements. As was announced at the MARE seminars this past spring, the MARE occupation will undergo an occupational analysis (OA) in the next year. I have already passed a number of our concerns, including the question of A/HOD employment in a ship, on to the OA staff of ADM(Per) as action items for the analysis. Each of you will be invited to respond to a questionnaire that the OA team (which includes two MARE officers) will administer to the occupation at large in the Jan./Feb. '94 time frame. I invite you to be frank and open in your responses. As the information you provide will form the basis of the conclusions drawn, it is critical to the success of the OA that your answers be as honest and forthright as possible. Once this process has been completed I will inform you of its outcome, particularly with respect to the issue of A/HOD employment.

Be assured that I appreciate Lt(N) Pitre's initiative in raising this very pertinent question. Through the OA we will do our utmost to respond to it objectively, taking into account the interests of the navy, the engineering branch and individual MARE officers.

No life like it!

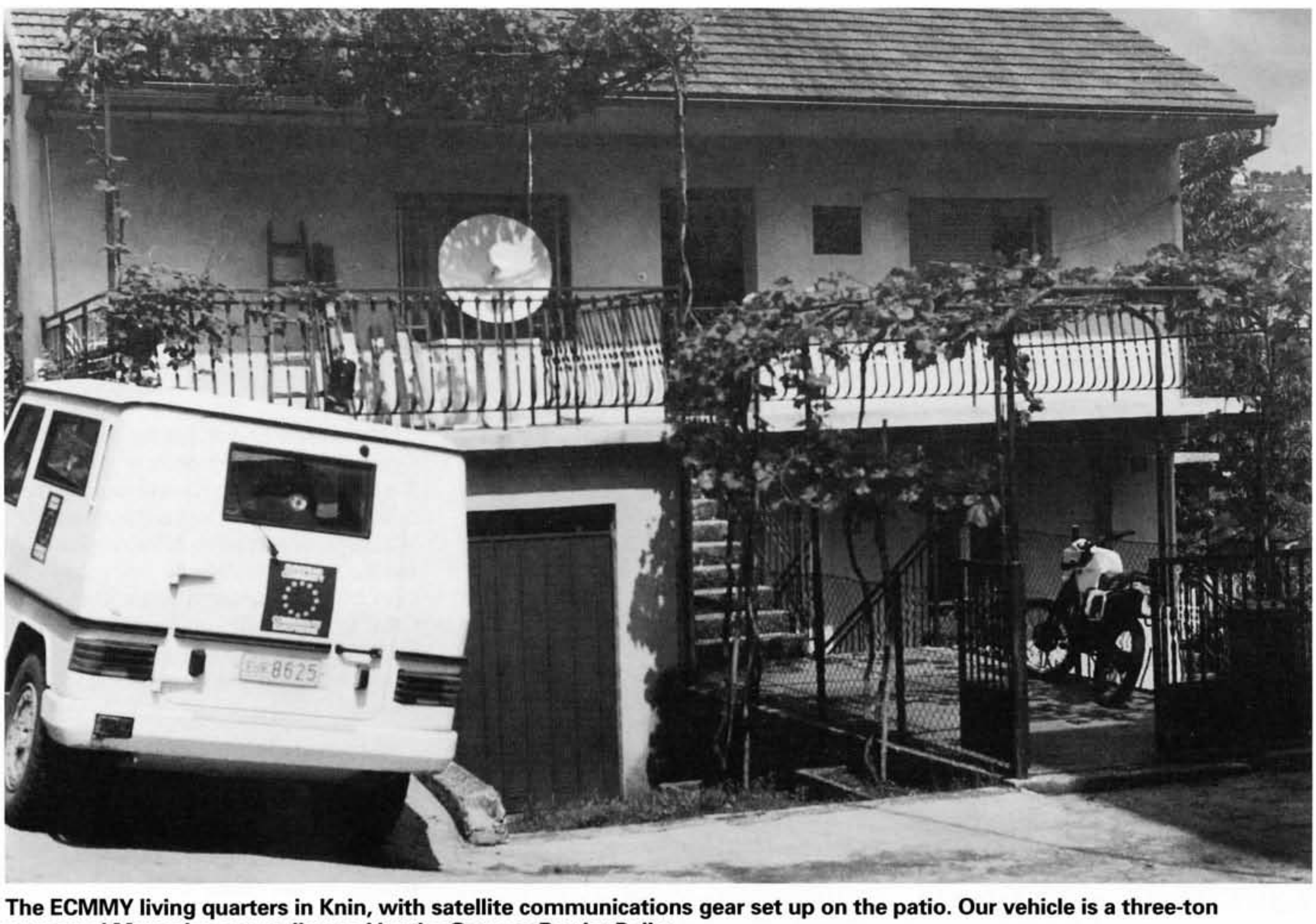
Peacekeeping with the European Community Monitoring Mission in Yugoslavia

Story and photos by LCdr Bryan Leask

Join the navy and see the world! That was the popular sign-on slogan when I joined the navy in the mid-60s, and over the years I have logged thousands of nautical miles and visited many countries bordering the Atlantic and Pacific oceans. In early 1992, during my fourth year behind a desk in Maritime Command headquarters, the desire to travel got in my blood again and I volunteered for peacekeeping duties. My opportunity to break the tether to the desk came in March 1992 in the form of a four-month tour with the European Community Monitoring Mission in Yugoslavia (ECMMY); Canadian code name — Operation Bolster.

The basis for the mission lies in a 1991 memorandum of understanding signed by the Federal Republic of Yugoslavia, the separate republics of the federation and the 12-member European Community. The initial agreement signed in July of that year mandated the ECMMY to monitor the deactivation and withdrawal of Yugoslav national army forces from Slovenia. On Sept. 1 the agreement was renewed and extended to include Yugoslav force withdrawals from Croatia, and extended again a month later to include Bosnia-Hercegovina.

At the request of the conflicting parties Poland, Czechoslovakia, Sweden and Canada were invited to participate in the mission alongside the European Community. Altogether the mission comprises approximately 330 unarmed military, civilian and diplomatic personnel, including 12 members of the Canadian Forces. Only Luxembourg does not have personnel involved in the mission.



The ECMMY living quarters in Knin, with satellite communications gear set up on the patio. Our vehicle is a three-ton armoured Mercedes, normally used by the German Border Police.

The Canadian ECMMY rotation team I was assigned to assembled in Ottawa for briefings on May 4, 1992. The team was composed of six officers, two each from the navy, army and air force. (A seventh member, an army officer, would join us later in Lahr.) The seriousness of our undertaking hit home early when our departure for Europe was delayed for two weeks after a Belgian monitor was shot in Mostar, Bosnia-Hercegovina. We eventually arrived in Lahr to complete a final kitting-out on May 21 before making our way to Graz, Austria — our jumping-off point for Yugoslavia. Since Croatian air space was not safe, we travelled for two hours by road through Slovenia to reach the ECMMY headquarters in Zagreb where all mission personnel report.

As monitors we would be arranging and taking part in negotiations between the opposing parties, monitoring handovers of civilians and bodies, monitoring prisoner-of-war exchanges and ceasefires, and attending to humanitarian affairs. One important point we had to remember was that monitors must remain impartial at all times. To that end, all ECMMY personnel wore plain naval white uniforms (i.e. without rank or country insignia) with blue EC armbands and baseball caps, and addressed each other as "Mister" or "Ms."

The air of war was obvious as we walked the streets of Zagreb — damaged buildings, sandbags for protection, and armed soldiers everywhere. We weren't there for long. Before leaving Canada each of us had been assigned to one of the ECMMY regional centres located in Zagreb, Split, Belgrade and Sarajevo (temporarily relocated in Zagreb until such time as it was deemed safe for teams to return to the Bosnian capital.) Two of us journeyed on to the port of Rijeka where we caught the overnight ferry to Split, Croatia. This city on the Dalmatian coast of the Adriatic Sea would be our base of operations for the next three months.

A soldier of the Territorial Defence Force of the Krajina reads a letter to an elderly woman in the Krajina region.

Operations

Unlike Zagreb, Split had not been damaged by the war physically, but the presence of soldiers and refugees reminded us of the ever-present threat. Much later we would experience the small hardship of electrical power rationing in Split. The Dalmatian coast obtains its power from hydro-electric generators, but war damage to the power grid and a dry summer eventually forced the city to ration its electricity. Each day one half of the city would receive power from 7 a.m. to 6 p.m., while the other half went without. We would see more evidence of power rationing in other areas during our tour, and I just couldn't help wondering what it would be like if the residents of a Canadian city had to go through the same thing.

The Split ECMMY operational area covered 350 kilometres of the Dalmatian coast from Zadar (Croatia) to Herceg-novi (Montenegro), including the Serb-controlled Krajina region of Croatia. My first week was spent on day-missions to become familiar with the standard operating procedures as a team member. Typically, our multinational team included two monitors, an interpreter and a driver. We attended meetings for the exchange of POWs and civilians, witnessed the exchanges and arranged meetings between diplomats of the European Community and senior Croatian Army officers. During this first week I saw the toll the war was taking on the population in terms of economic and personal hardship.

From then on our basic routine was to travel afield for one or two weeks, return to Split to resupply and head out again. The work was not without its hazards, and at times our patrols were limited by the danger from snipers, artillery and mines. (Mines had already been responsible for the death of two French officers and injuries to a Canadian UN team.)

On the first mission away we had to cross the front twice to reach the village of Nos Kalik, which had been overrun by the Territorial Defence Force of the Krajina (TDF) and later retaken by the Croatian Army. Our ECMMY team was there to ensure the safety of 19 Serbian villagers whose lives were virtually controlled by the Croatian soldiers. There was a lot of tension in the village as most of the soldiers had recently seen their own homes being burned in the nearby town of Drnis, now under TDF control. They were understandably less than enthusiastic about having to look after a bunch of Serbian villagers. During our five-day stay we lived with a Serbian couple (assigned to us by the Croatian Army). The Croatian Army supplied the village with food every day, which was delivered by boat and brought up from the shore by donkey at 2 p.m.

The Krajina

During one 13-day mission the team went out to the headquarters of the Krajina authorities in Knin to monitor the military and conduct humanitarian visits. We spent the first week delivering mail and medical supplies to the war-weary Croatian and Serbian villagers. The Croatian population consisted mainly of elderly persons who had been left behind to watch over the family homes and property.

Each day was eventful. Like the time a report came in concerning the plight of 2,500 Muslims attempting to escape Bosnia and enter Croatia at Van Kaluf. Although our orders were not to enter Bosnia, we discussed the situation with the French UN battalion commander and investigated the area under the protection

The village of Krusevo in the Krajina suffered extensive damage.

of one his units. From a position overlooking the valley we saw the forest where the refugees were known to be hiding. The ravages of war were plainly present as we saw houses being burned, and could hear small-arms fire coming from the valley and heavy artillery in Bihac 20 kilometres away. The French UN units were prepared when the refugees crossed over into Croatia some four hours later.

Another time we experienced an unnerving event during an exchange of civilians. After verifying the arrangements for the exchange on both sides, we were confronted by an angry TDF soldier (armed with an AK-47 rifle) who was determined the exchange should not take place. It took 20 minutes of on-the-spot negotiations to defuse the situation before the exchange could proceed in no man's land. All part of a day's work in the life of a monitor!

The second week was quite different. On the morning of June 21 a major battle erupted while we were monitoring troop and materiel movements around Knin. As we watched the artillery shells zero-in on the nearby army barracks, we established an escape plan should the Croatian Army attempt to take Knin. The battle delayed the rotation of teams to and from Split.

Dubrovnik

Dubrovnik was a combat zone, and just getting into this port city on the Adriatic 150 kilometres south of Split was interesting in itself. Accompanied by a police and military escort we left the main highway 20 kilometres north of the city to avoid TDF snipers who were known to be operating along the highway into Dubrovnik. (An ECMMY vehicle from an earlier mission had already been hit by sniper fire along this route. Fortunately, no one was injured.) We completed our journey to Dubrovnik by ferry. The city was under fairly constant shelling from the Yugoslav Army to the south and the Bosnian Serbs to the east, so our work for the next two weeks was somewhat limited.

One of the interesting tasks involved witnessing a humanitarian-aid mission to Cavtat, a Croatian town under Yugoslav Army control 15 kilometres south of Dubrovnik. Damage from mortar and artillery attacks had left the main road impassable, so the M/V *Astral* was chartered under the Red Cross, UN and EC flags to transport food to the town and carry back 20 Croatian Army POWs being released to the International Red Cross. It was a beautiful day, with the odd greeny coming over the bow — just what a sailor loves. The transfer of goods and POWs went without a hitch, but the propaganda machine still found something to chew on. During our return journey the POWs, ecstatic at being free, had tossed much of their captor-issued clothing into the sea. The press made the most of it after we docked in Dubrovnik, declaring: "Barefoot soldiers released."

Although the team's safety was always in jeopardy in Dubrovnik (several shells landed within 75 metres of our hotel) we did get a chance to walk around the old city. To the residents' credit, they never seemed to give up on clearing away rubble and effecting temporary repairs from shell damage. One family even invited us into their home, but it was sad to see from the attitude of the children that another generation of hatred was being bred.

We did have one particularly rewarding experience when we met with officials in Sibenik to see about rebuilding the water supply to Drnis in the Krajina. The Croats were hesitant, but we managed to convince them it was to their advantage and would meet one of requirements of the U.S.-brokered Vance Plan for returning refugees to their homes. The conflicting authorities eventually engaged in high-level meetings on the subject of the water supply.

Going Home

The war was causing a lot of grief to people from all sides. We soon discovered that it was a common occurrence for families to be torn apart because of intermarriage and allegiance to ancestry. One Serbian family's experience was typical. Of the three children, the son was driving for the TDF, one daughter was married to a Croatian (and living in Croatia) and the other daughter was missing and presumed dead.

But it is the young children who are the real losers in this mess. We investigated the situations of three Croatian children who had been placed in foster homes in the Krajina when that region was still under Croatian control. One, a three-year-old boy, was doing fine with his well-to-do Serbian family, but the situation for the two girls placed together in another home was deteriorating. The girls, aged one and two, were being looked after by a caring family, but the foster father had lost his job as a salesman in Zadar and ended up as a poorly paid private soldier in the TDF. It was a sad situation, but we had no choice other than to recommend the girls be returned to the orphanage in Zadar.

My final 18 days with the mission were spent in the Krajina, delivering mail and medicine, and checking up on people. It was simple until the Drnis authorities decided to open all mail for inspection prior to delivery. This sometimes called for delicate negotiations, but at other times we just ignored them and hoped for the best. They never did open the mail.

Probably our grimmest task involved witnessing the exhumation of 23 TDF soldiers killed two months earlier during

The two-masted M/V Astral, under charter by the Red Cross, the United Nations and the European Community, waits alongside the pier in Cavtat, Croatia for delivery of a group of POWs.

the battle for the Miljevci plateau in June. For two days the ECMMY team watched as the bodies were retrieved from a natural well 25 metres deep. The sunny, 42ºC weather did not add anything to our day as the body bags were winched to the surface and opened for identification. The bodies were eventually loaded onto a French UN truck and we escorted them back to the authorities in the Krajina.

Finally, on Sept. 3, I returned to Split to commence my out-routine and say goodbye to my colleagues. The Canadians from Split were flown to Zagreb by ECMMY helicopter, a four-hour flight. After two days of turnover briefings for the next rotation team (LCdr James Guilford of FMGA was the MARE relief) we headed for Lahr, returning to Canada on Sept. 10.

Postscript

Would I do it again? Yes! Working with a multinational organization in another country under trying conditions was an enlightening and rewarding experience. Something the average Canadian is not exposed to and about which television only tells part of the story. Meeting and negotiating with various levels of military and civilian authority on both sides of a conflict call for diplomacy, quick thinking and patience. Fortunately, the training and professionalism gained as an officer in the Canadian Forces are well-suited to this type of task. Apart from the stipulation that volunteers for monitor positions now be of lieutenant-commander rank, no specialized training is required. Any deficiency is quickly learned as a team member.

Am I married or still married? Yes! I was fortunate in that I had the support of my family before volunteering. My wife, Heather, well used to long periods of separation, was and continues to be very supportive on the home front. Our two daughters are both in their late teens and present no out-of-the-ordinary problems that she cannot handle. Midway through my tour I returned to Canada for a much-welcomed week of leave that is granted to all members of the Canadian ECMMY rotation team. This was certainly another positive aspect of my experience, but anyone considering volunteering for this type of mission should recognize the physical risks and weigh these against family situation and career aspirations.

LCdr Bryan Leask is the Senior Staff Officer for Engineering Plans and Policy in Maritime Command Headquarters. At the request of MARCOMHQ he returned to Eastern Europe (Albania, this time) at the end of February to relieve LCdr Guilford, there being no other MARE lieutenant-commander available from the MARCOM volunteer list.

Target Evaluation and Weapon Assignment — A Generic Model

By Jean Berger

Introduction

The decision-making process in a naval command and control (C2) system is often complex, ill-defined, incomplete and partly misunderstood. Consequently, the identification of the various levels of abstraction and the precise definition of these levels represent a fundamental prerequisite for the development of future military decision-making systems.

The purpose of this paper is to propose a generic conceptual target evaluation and weapon assignment (TEWA) model. Section I introduces the basic concepts generally used for the analysis and design of C2 systems. Then, building on these concepts, a generic high-level defence model is depicted in section II. Based on this structure, section III presents the main process components of the proposed conceptual TEWA model. Subfunctions of each component are then hierarchically examined. This paper constitutes a condensed summary of a work performed at DREV on naval TEWA analysis[1].

I. Basic Concepts

Command and control is the process by which military and civilian commanders exercise authority and direction over their human and material resources to accomplish tactical and strategic objectives[2]. In this respect, three major processing stages can be identified:

Data Fusion refers to the continuous process of assembling a model of the domain of interest from disparate data sources[3,4]. In very general terms it may be seen as the production of a tactical picture from various data sources.

Situation Assessment refers to the inference of statements to support resource allocation decisions from the domain model created by the data fusion process[3,4]. The situation assessment interprets the tactical picture. Based on time-varying, incomplete, inaccurate and uncertain information, it evaluates (according to specific rules) the situation presented by the tactical picture in relation to the mission.

Resource Allocation refers to the determination of options and the selection of direct actions as a result of the situation assessment[3,4]. Resource allocation has to do with reaction generation, conflict resolution and reaction selection based on the analysis of the current situation.

II. High-Level Defence Model

A defence model is proposed as a framework to define TEWA. Based on a sense-act loop representation (*Fig. 1*), the model is made up of three elements: environment, system and context. The context denotes the set of specific conditions and assumptions (eg. political climate, location, etc.) within which the system and the environment exist.

The first block represents the combat environment, which includes a set of various entities surrounding a task force or single ship. The environment generates periodic and aperiodic stimuli such as evolving threats, incoming information for the force and changing meteorological conditions. The second block delineates the system unit and has to do with the system's "perception" of the real world. It includes six basic subunits for sensors, detection and data fusion, TEWA (connected to various C2 general databases (GDB)), engagement management, agents and effectors.

Target stimuli originating from the environment are detected by sensors, and the raw data is processed to produce or update target information. The process, performed by the detection and data fusion unit, might consist of a detection (data collection) phase, a track processing and correlation (data interpretation) phase, and finally a data fusion phase for gathering and assembling coherent information. A picture of the tactical situation finally emerges from this process and activates the TEWA component to initiate a new command cycle. Explained in more detail in section III, the TEWA process (a subset of situation assessment and resource allocation) accounts for plan elaboration and generates a high-level plan, defined as being a set of weapon/target allocation plans to be executed.

The high-level plan generated by TEWA is sent to the action manager. Directed by a battle strategic planner (TEWA subunit), the action manager is responsible for lower-level plan expansion, engagement management and control. The action manager transmits orders to subordinated agents and reports to TEWA on any unexpected changes as the situation unfolds. Plan execution is the responsibility of an agent, whose components include sensors, effectors, reflexes and a cognitive function (mental task planning, monitoring actions, etc.). Warship weapon operators and weapon computers might therefore be considered agents due to their control over weapon systems and fire-support resources. Effectors associated with physical elements or devices such as interceptors and/or illuminators are used to modify the variables of the environment.

III. TEWA Model

This section presents the basic subfunctions describing the TEWA function applied to naval command and control. In the literal sense, TEWA is a subset of the situation assessment and resource allocation (SARA) C2 processing stages. In effect, target evaluation is only a particular aspect of situation assessment whereas weapon assignment is a specific instance of resource allocation. For present purposes, however, the terms TEWA and SARA will be used interchangeably.

The model illustrated in *Fig. 2* is made up of two major components: the situation assessment module and the resource allocation module. The nature of the input is twofold — periodic, corresponding to synchronous events, and aperiodic, referring to asynchronous events. The TEWA output, on the other hand, is a set of high-level allocation plans.

Situation Assessment

The subfunctions to be considered are threat assessment, defence assessment and plan monitoring/assessment. The input consists of a complete list of tracks describing target kinematic parameters, identification information, source and quality of data. The output is a weighted threat list to be processed by the resource allocation module.

The **threat assessment** function generates a weighted list of threats to be processed by the resource allocation module. It comprises three functional sublevels: identification, threat evaluation and threat prioritization.

a. *Identification*: The goal of this subfunction is to gain or complement information on target category (allegiance), type and identification. The input is a list of target tracks, ESM sensor data, IFF transponder response data and intelligence reports. Allegiance assessment, based on specific algorithms and expert knowledges, is first carried out by classifying tracks as hostile, unknown or friendly. Statements regarding type and possible identification are then inferred to supplement the target picture. This knowledge is characterized by confidence factors which depend on uncertainty and incompleteness of the time-varying attributes attached to track data.

b. *Threat Evaluation*: From hostile tracks or unknown track identities, the threat evaluation subfunction defines track status. It determines if a track constitutes a threat or non-threat based on specific rules. Threat determination depends on mission doctrine, relative weights associated with blue force assets, target dynamics, lethality, identity, track history, target intent[5,6], electronic emissions, behaviour, intelligence, etc. The output is a list of tracks which represent threats posed to the force. Once again, confidence factors characterize the output.

c. *Prioritization*: This subfunction computes and lists weighted values for each threat posed to the force. Threat values are attributed according to a set of rules which depend upon static or dynamic properties attached to the mission doctrine of the force. Threat values rely on threat type and intelligence, current status, behaviour, kinematic parameters, closest point of approach and other threat attributes such as cross-section and IR signature.

The **defence assessment** subfunction evaluates the effectiveness of the defensive screen in countering hostile intruders moving against the protected zone. The input comprises the force's resource state,

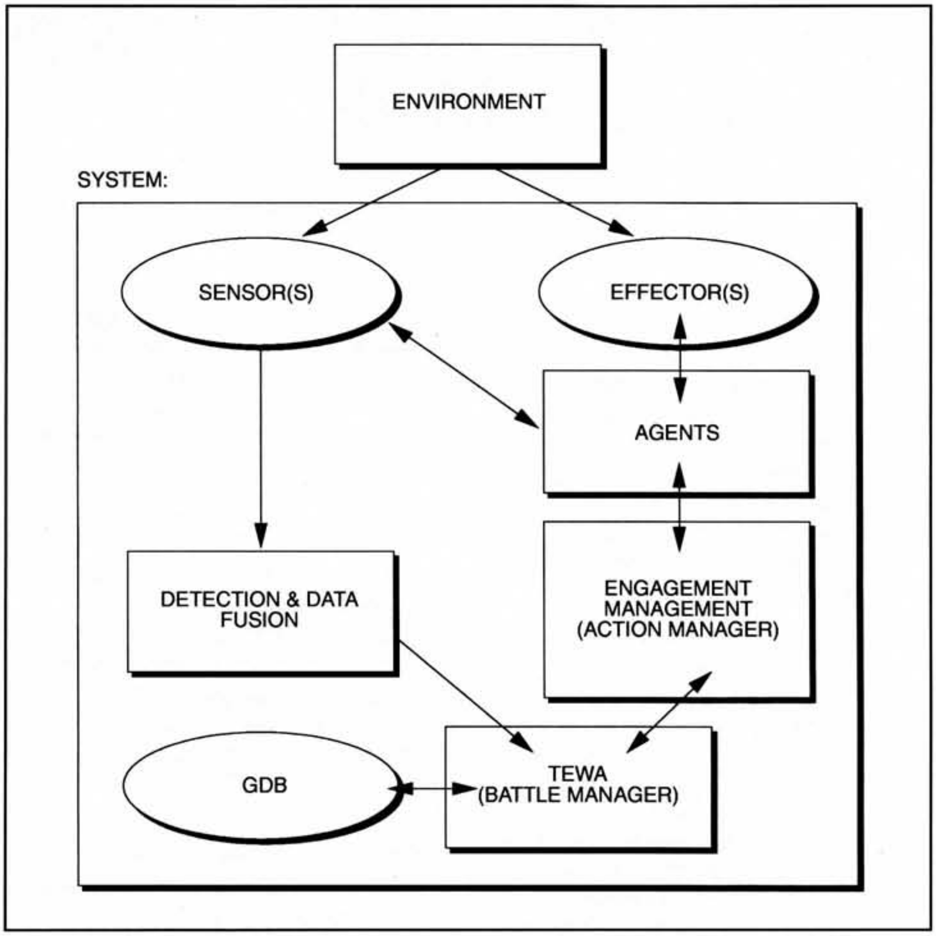


Fig. 1. High-level defence model

the threat list and the engagements which are ongoing or being implemented. The output is updated information on resource capabilities and abilities to establish an efficient defensive screen.

The objective is to monitor the effectiveness of a defensive screen against various kinds of threats as the tactical situation unfolds. Possible attack scenarios (identified in the threat assessment) are evaluated to identify changes or new opportunities for the force to improve its defensive shield. Some measures of effectiveness related to the use of the force's resources such as workload level, capacity, tactical state and responsibility, operational status and coverage are provided.

Output from the threat and defence assessments constitutes the input to the **plan monitoring and plan assessment** subfunction whose goal is to validate plans and identify potential need or opportunity for plan refinement. The function determines whether plans are being followed and, if not, alerts the strategic planner to any discrepancies occurring in a plan's execution. Plans are validated to determine if commitments made so far are likely to lead to a complete plan given the changing tactical situation.

Resource Allocation

The resource allocation module, known also as the strategic planning unit, is depicted by two subfunctions — plan generation and plan selection. Weapon allocation will be of primary concern. Data from the situation assessment module provides the input. The output is a reaction described as a mission plan and represented by a set of resource allocation plans.

The **plan generation** subfunction generates a set of feasible solutions through options and reactions, and characterizes them by a measure of effectiveness. The input to this subfunction is the data available from the situation assessment module.

Plan generation is divided into two major parts: reaction feasibility and reaction effectiveness. At first, a set of feasible reactions is determined, based on a combination of previous assessments and engageability calculations. Thereafter, each option or allocation plan generated is

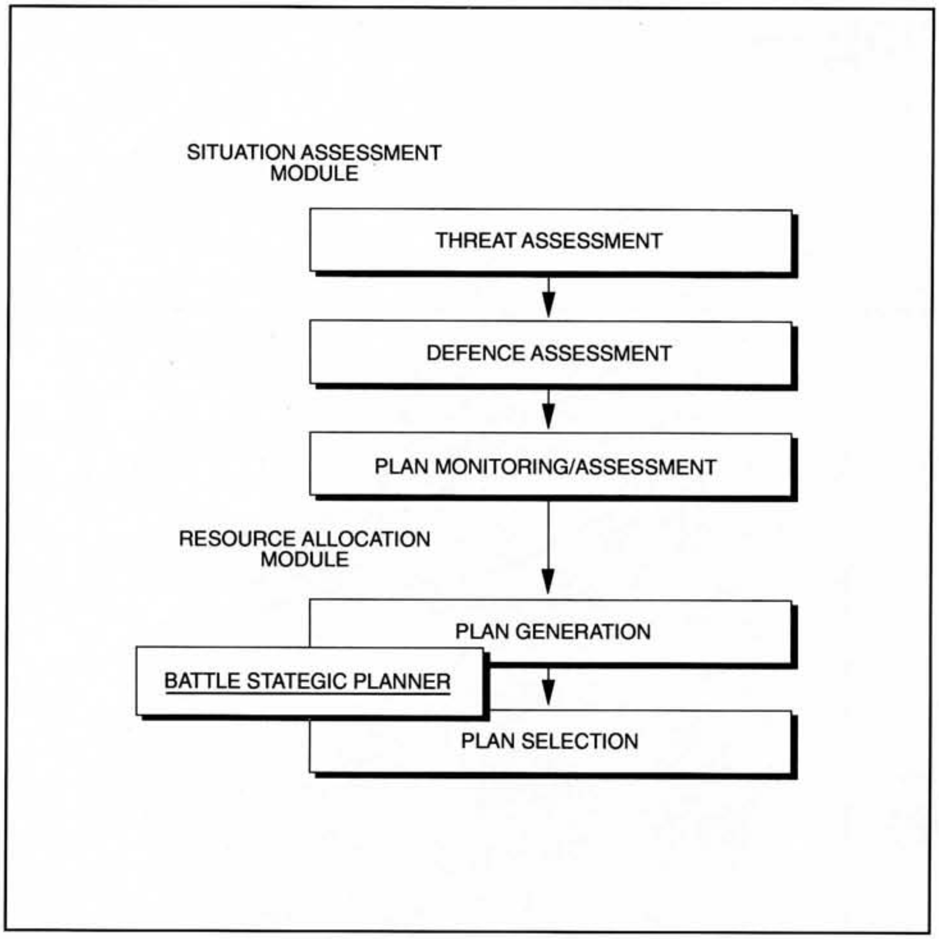


Fig. 2. Conceptual TEWA model

characterized by a measure of effectiveness through a prediction procedure based on different parameters. An allocation plan might typically consist of a combination of resources such as an interceptor (weapon) and fire-support resources (tracker or illuminator) committed to an incoming threat.

From this set of feasible, high-level allocation plans, the **plan selection** subfunction selects an appropriate reaction plan that will achieve the short- or long-term goals set by the force to fulfil its mission. Based upon mission doctrine, the battle strategic planner must determine the best mission plan for achieving the goals. Rules of engagement are used to narrow the search and find a solution. According to multiobjective optimization criteria, such rules attempt to predict the impact of the reaction on the combat environment and achieve optimal resource allocation subject to multiple constraints. Combining numerical and symbolic information, the chosen criteria are part of the doctrine, and their relative weights may change dynamically.

Replanning is required when new information invalidates the previous plan, or when unplanned situations arise during execution. A compromise between speed and optimality is then needed. In addition, situation uncertainty requires a trade-off to be determined between the predictability of the environment in which the plan is to be executed and the degree of reactivity which is necessary to successfully achieve the goals of the plan. Advanced planning, based on open-loop feedback and closed-loop strategies involving opportunistic look-ahead, and replanning represent major challenges for proper resource allocation and therefore constitute two key issues in constructing plans[7].

Conclusion

The decision-making process is critical to the success of a naval command and control system. As no theory of C2 is either universally or even generally well accepted, some problems arise in the design of a decision-making process to be embedded in a large and complex C2 system. There is a need to define and capture TEWA as a distinct process in C2 decision-making.

This paper attempts to provide a consistent and generic conceptual model for the TEWA function. It relies on the basic concepts of situation assessment and resource allocation. An in-house TEWA concept demonstrator (SARA) based on this conceptual model has recently been developed at Defence Research Establishment Valcartier. Following an evolutionary approach, the object-oriented simulation environment is intended to be used to investigate problem models and algorithms for weapon assignment.

References

[1] J. Berger, "Target Evaluation and Weapon Assignment (TEWA) Analysis — A Generic Model," *DREV R-4678/92*, October, 1992.

[2] J.S. Andriole, "Command and Control Information Systems Engineering: Progress and Prospects," *Advances in Computers*, 31 (Princeton: Petrocelli Books, 1990).

[3] C.J. Harris et al., *Application of Artificial Intelligence to Command and Control Systems* (London: Peter Peregrinus Ltd., 1988).

[4] C.J. Harris and I. White, *Advances in Command, Control and Communication Systems* (London: Peter Peregrinus Ltd., 1987).

[5] P.R. Young and P.E. Lehner, "Applications of a Theory of Automated Adversarial Planning to Command and Control," *IEEE Transactions on Systems, Man and Cybernetics*, SMC-16, No. 6, 1986.

[6] C. Applegate et al., "An Architecture for Adversarial Planning," *IEEE Transactions on Systems, Man and Cybernetics*, SMC-20, No. 1, 1990.

[7] W. Swartout, "DARPA Santa Cruz Workshop on Planning," *AI Magazine*, Summer 1988, pp. 115-130.

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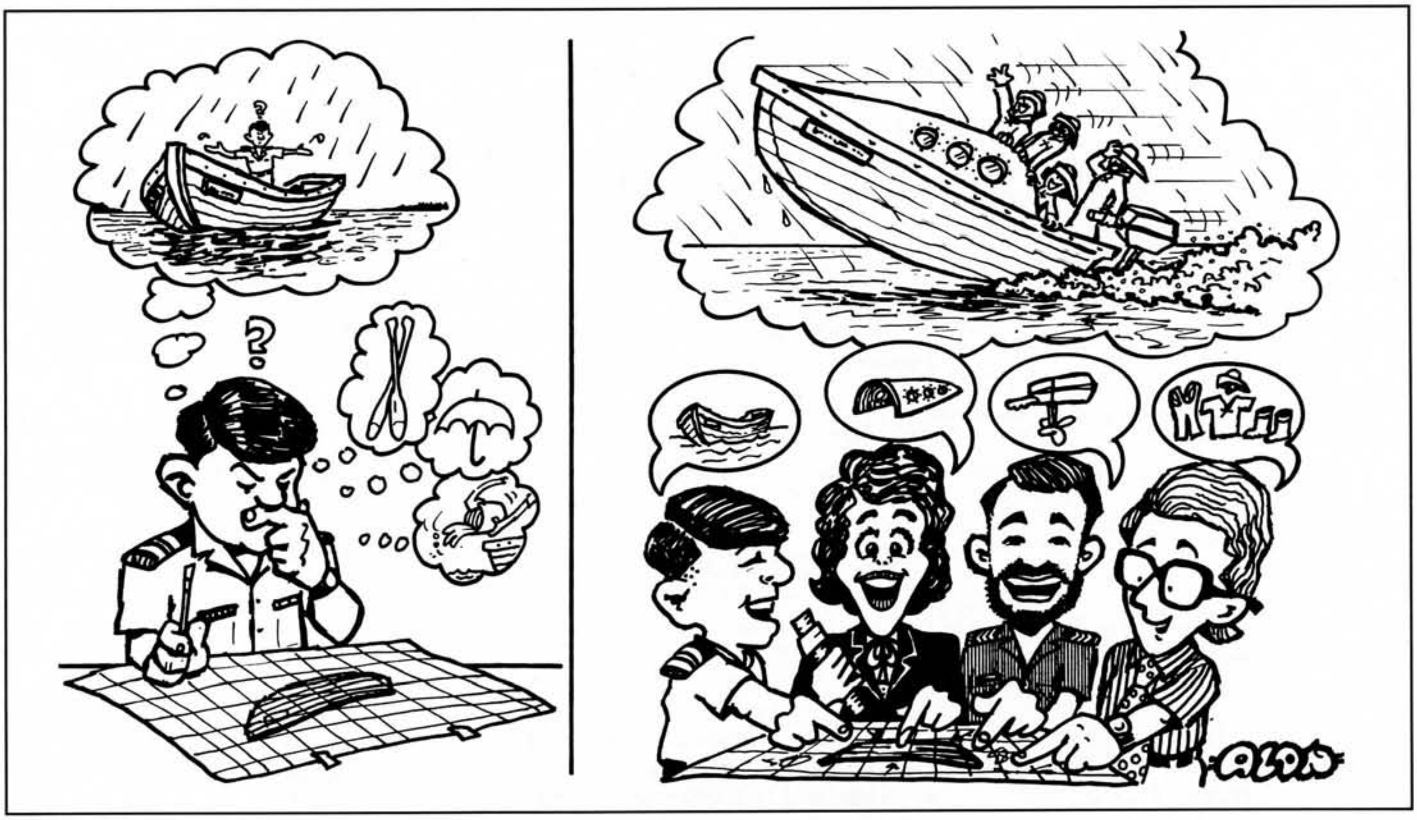
Naval Engineering — Synergy at Work*

By LCdr M.J. Adams, CD, PEng



* *Adapted from a paper presented to the Central Region Naval Engineering Seminar in Ottawa on February 18, 1993.*

Introduction

Canada's naval engineering team is entrusted with the responsibility of operating, maintaining, analyzing, designing, supporting and, among other things, modifying the ships of the navy. Since it is virtually impossible for one individual to be equally adept at each of these diverse fleet-support activities, several components of differing knowledge and experience are needed. Moreover, because of today's climate of downsizing and budgetary restraint it is imperative that the naval engineering team be able to maximize its effectiveness.

This paper introduces a possible strategy for increasing the effectiveness of naval engineering in general. It utilizes an upbeat principle of synergy, whereby the combined or co-operative actions of two or more agents together increase each other's effectiveness, to show how the benefits of Canada's great wealth of in-house naval engineering knowledge and skill can be maximized.

The Naval Engineering Team

The navy fulfils its engineering responsibilities through four distinct technical components (apart from an administration and support component) within the naval engineering team. Two are military and two are civilian, and each brings with it differing levels of experience and knowledge. These components are:

- naval officers, primarily Maritime Engineers (**MARE**s);
- civilian scientific and professional personnel, primarily engineers (**ENG**s);
- naval non-commissioned members (**NCM**s), primarily those in the "hard-sea" technical trades; and
- civilian technicians (**TECH**s), primarily of the electronics, and engineering and scientific support groups.

At the risk of oversimplifying the range of expertise available to the naval engineering team, the following summation is submitted:

- MAREs offer theoretical knowledge combined with generalized experience. They also offer hands-on knowledge of ship's systems, and leadership and organizational skills.
- ENGs offer theoretical knowledge combined with specialized experience, in addition to stability and corporate knowledge.

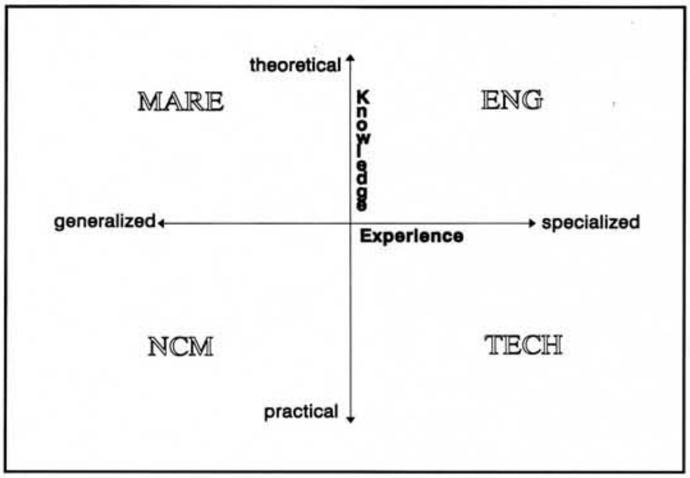


Fig. 1. Murphy's Domain

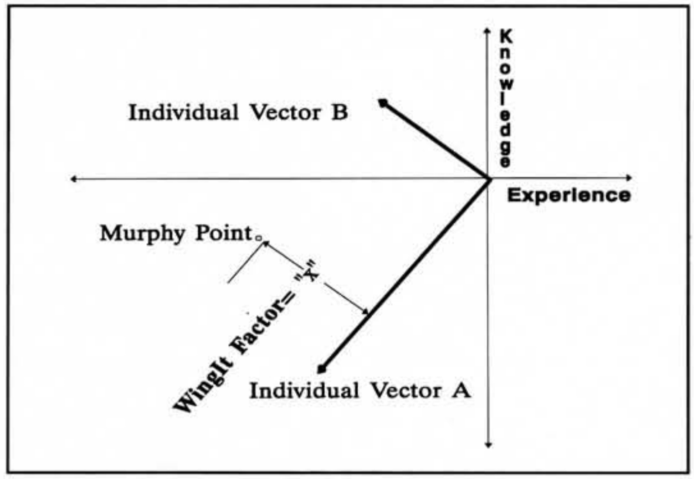


Fig. 2. Murphy Vectors

- NCMs offer practical knowledge combined with generalized experience. They also offer detailed nuts-and-bolts expertise and the most sea-time of the four categories.
- TECHs offer practical knowledge combined with specialized experience, as well as stability and corporate knowledge.

Synergy

Now that the four components of the naval engineering team have been identified, let's have some *fun* with synergy.

As mentioned, synergy is commonly defined as "the combined or co-operative actions of two or more agents that together increase each other's effectiveness." Since this is a naval engineering theme, the following engineering interpretation of synergy, hereby entitled "Murphy's Interpretation of Synergy," is offered.

Let's start with a real-world definition of what naval engineering is by defining the real world as **Murphy's Domain**, using the well-known Murphy's Law: "*Whatever can go wrong, will go worng* —" Now let us add the naval engineering corollary: "*— and we will have to fix it!*"

Using standard cartesian co-ordinates as shown in *Fig. 1*, let us define the horizontal axis as **experience**, ranging from generalized to specialized. And let's make the vertical axis represent **knowledge**, ranging from practical to theoretical. Finally, why not make the **origin** the starting point of an individual's engineering training.

In looking at these co-ordinates it becomes obvious that the right-hand quadrants can represent civilian experience, the left-hand quadrants military experience. Similarly, the upper quadrants can represent the professional knowledge levels and the lower quadrants can represent the technical levels. Thus, on a purely simplistic approach, the four components of the naval engineering team can be readily assigned as shown.

Now, using *Fig. 2*, let us define an **Individual Vector** as a vector representing an individual's current knowledge and experience. This vector would continue to grow as each individual gained more experience and knowledge. Let us define a **Murphy Point** as being a specific occurrence of the naval engineering corollary to Murphy's Law, i.e. a problem that we have to fix.

Finally, let us define the **Wing-it Factor** as being the distance between the individual vector and the Murphy point. This factor can represent the probability of error in an individual vector addressing a Murphy point, i.e. the farther the vector is away from the problem, the higher the likelihood the resolution of that problem by that individual will be unsatisfactory.

Now we can define exactly what synergy entails. Simply put, synergy frees up an individual vector's anchor point from the origin. As shown in *Fig. 3*, one vector can now use a second vector as its origin (i.e. one vector can move along another), thereby increasing the effective area covered and, at the same time, minimizing the wing-it factor — the probability of error. Of course, this being Murphy's domain, the wing-it factor can never ever be zero.

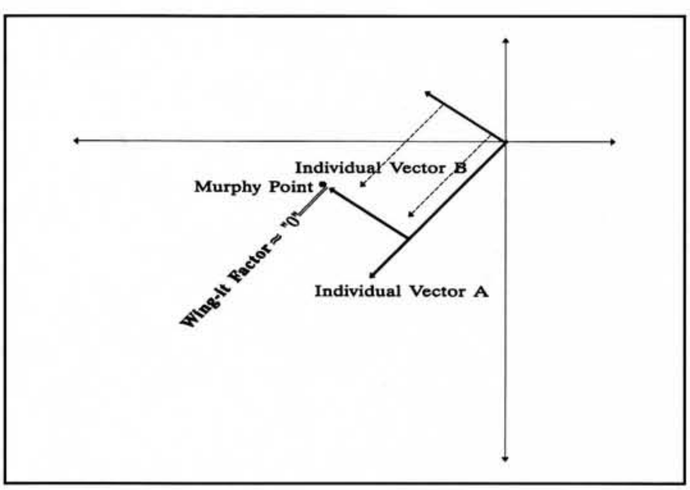


Fig. 3. Murphy Synergy

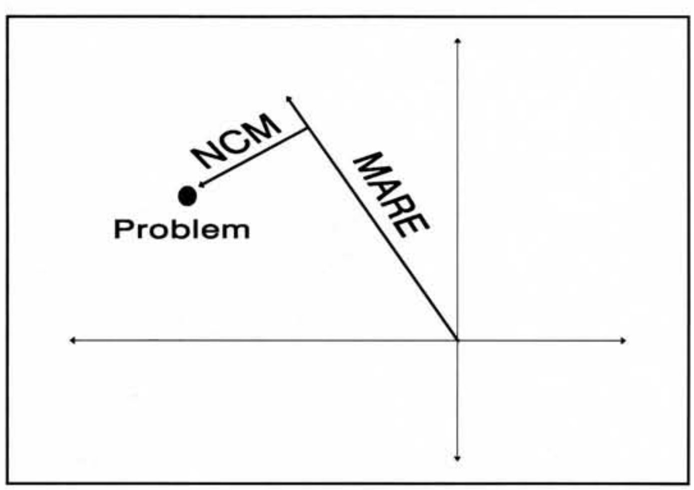


Fig. 4. Direct Synergy

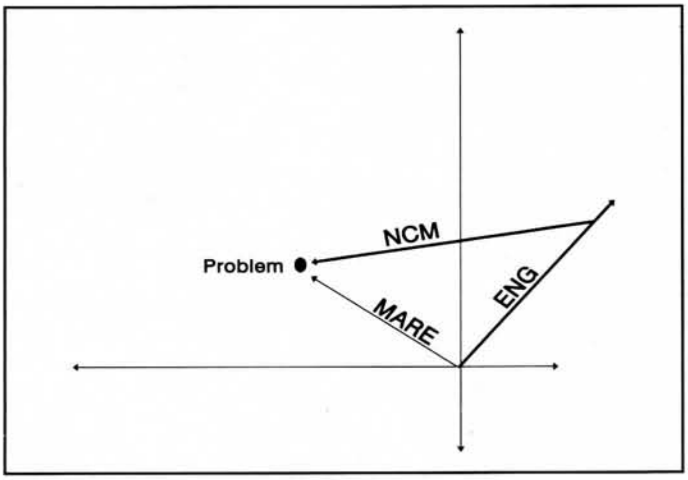


Fig. 5. Complementary Synergy

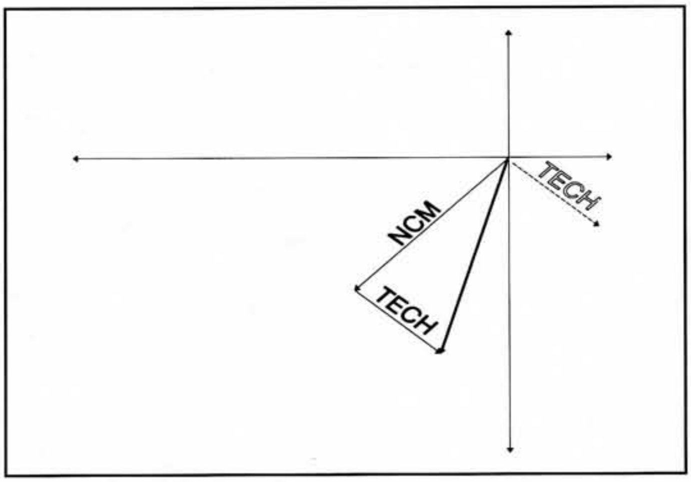


Fig. 6. Cross-pollination Synergy

Types of Synergy

There are many types of synergy available to naval engineers. The following examples are but a few of the more applicable ones for the naval engineering team:

- **Direct Synergy** (*Fig. 4*) is the simplest type and was the one used to introduce the overall concept of synergy. It is the pooling of effort and expertise from two individuals (for example, a MARE and an NCM) to address a problem that neither is comfortable attempting on his own.
- **Complementary Synergy** (*Fig. 5*) uses direct synergy to address problems that the usual problem handler, for whatever reason, is unable to address; for example, combining an ENG and an NCM to address a problem that a MARE away on French training would normally have handled.
- **Cross-pollination Synergy** (*Fig. 6*) occurs when a member of one component transfers to another (eg. an NCM retires from the navy and joins the TECH component). Instead of starting at the origin for the new component, the new experience and knowledge gained augments the original individual vector, thereby increasing the expertise of that individual.
- **Enhancement Synergy** (*Fig. 7*) is scalar in that the magnitude of a vector changes, not the direction. A good example of this is the synergetic relationship between computer hardware, software and "liveware." Hardware and software are basically useless by themselves, but when combined with an experienced operator they can dramatically increase that individual's effectiveness.
- a popular version of synergy is **Cumulative Synergy** (*Fig. 8*) which uses several individual vectors to address a problem (such as in a teamwork situation). It should be noted that this type of synergy can sometimes exceed the point of diminishing returns.
- which finally brings us to **Chaotic Synergy** (*Fig. 9*), a type of synergy to which committees are particularly prone. Basically, the more vectors that are applied to a problem, the more control is necessary to maintain the overall direction. In other words, with more and more vectors pulling in different directions, the overall progress in solving the problem at hand can be hindered (sometimes irreversibly). Thus, a key requirement of cumulative synergy is a clearly accountable manager who maintains sight of the goal and can optimally assign and monitor the vectors as needed.

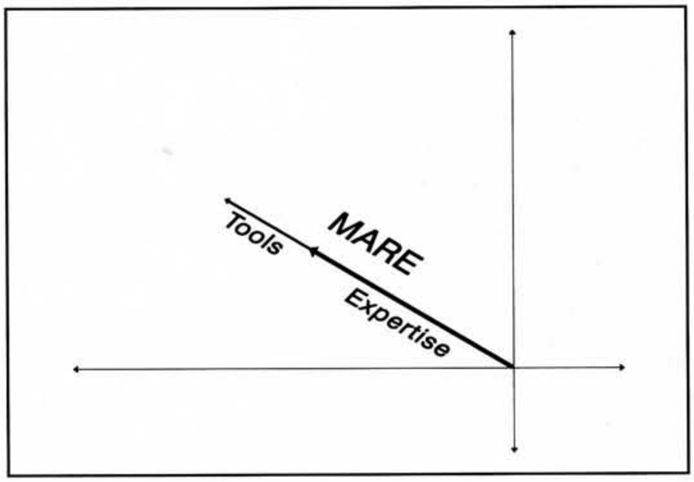


Fig. 7. Enhancement Synergy

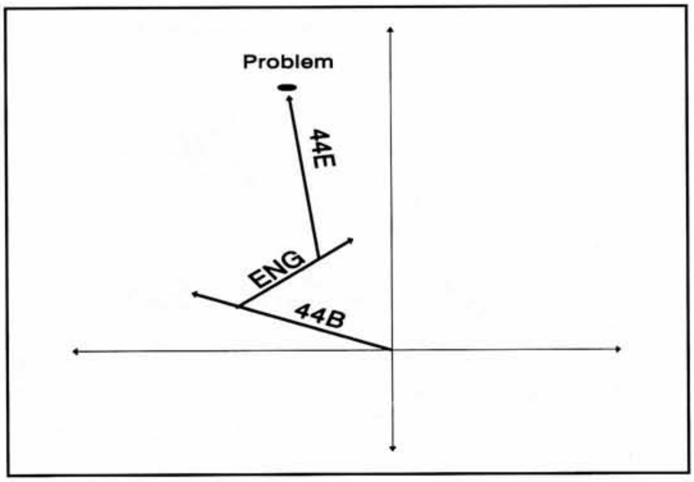


Fig. 8. Cumulative Synergy

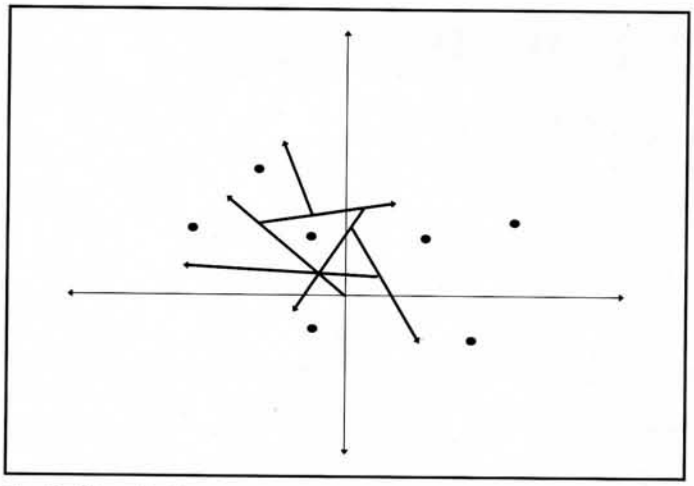


Fig. 9. Chaotic Synergy

Consequences of Large Wing-it Factors

Before we explore how we can apply these principles of synergy to naval engineering, let us reassure ourselves of the need for synergy. It is acknowledged that synergy is not essential for the day-to-day operation of the naval engineering team. Individuals working in isolation can and do achieve individual goals. But as the goals move farther away from an individual's area of expertise, the wing-it factor, or potential for error, increases. What are some of the potential consequences of large wing-it factors?

- Losses in individual productivity could occur as an individual attempts to learn new skills to address unfamiliar problems. While it can be beneficial for repetitive problems, it is not cost-effective for rarely occurring problems.
- It stands to reason that the tendency to procrastinate is directly proportional to the wing-it factor. In other words, individuals tend to address familiar problems first and let the unfamiliar ones accumulate, thus reducing our ability to meet objectives.
- Large wing-it factors could also promote the "pass the buck" syndrome. The laws of physics state that an object going from one point to another will take the path of least resistance. Given the choice of **A**: dealing with an unfamiliar problem; or **B:** sending it back for unnecessary clarification or to someone else entirely, it is likely that the latter would be the overwhelming winner, thus further reducing our capability to serve the fleet.
- A final consequence — potentially the most damaging to system efficiency — is the application of "best-guess" roulette. This game of providing guesstimate answers to problems is played by individuals who are insufficiently familiar with the problem in the first place. The probability of follow-on corrective action is directly proportional to the wing-it factor. The adage of "a gram of prevention is worth a kilogram of cure" is fully applicable in this situation. History has proven that problems caused by the inappropriate solution of an earlier problem often require corrective measures that are orders of magnitude greater than the correct solution to the original problem.

Now that we have a handle on what synergy is and why we would want it, we can now consider a few suggestions for implementing the principles of synergy in our workplace.

The Application of Synergy

The field of naval engineering is rapidly expanding, with new technologies, new strategies and new priorities. If we don't address new problems, we become a new problem. The naval engineering team has a diverse wealth of expertise upon which it can draw to support the fleet. Each individual within our organization has a different background, different strengths and weaknesses. Only by becoming aware of these attributes can one gain access to the benefits of synergy. How do we do this?

The recurring theme that stands out in discussions about synergy is that of *co-operation*. The only way that the individual vectors can shift their base from the origin is by co-operating with another vector. And since the most important element of co-operation is *communication*, we must communicate with our fellow workers. We can not afford the false luxury of working in isolation.

The catalyst for bridging the gap between the synergy elements and achieving synergy itself is *initiative*: we cannot wait for others to make the first move. It's simple. During coffee, lunch or a "sanity break," saunter over to your neighbour and start up a conversation. Before you know it there will be a two-way exchange of experiences, ideas and stories that will greatly enhance the way that we, as members of the naval engineering team, address new and old problems.

The application of synergy can greatly increase the effectiveness of the naval engineering team, but we must take the **initiative** to **communicate** with each other and learn what each other has to offer the matrix. Similarly, we must take the **initiative** to **co-operate** and help each other apply our hard-earned knowledge and experience in the best way possible. Working together we can increase the probability of finding the best resolution to the problem, we can make more and better contacts for future use and, who knows, we might even learn something in the process.

Synergy is the way we can increase our effectiveness in battling Murphy's domain without additional resources. That is how we can meet today's challenge in supporting tomorrow's navy.

LCdr Mike Adams joined the navy under the ROTP program in 1975, and since then has had ample opportunity to see naval engineering synergy at work. He has served as the Planned Maintenance Officer for NEUP, a project officer for the DMEE 6 frigate electrical propulsion studies and the SSN project, a ship's Engineering Officer and the Marine Systems section head at the Naval Officer Training Centre. He is currently the Dmee 6 project officer for air-independent propulsion systems.

Target Motion Analysis using Frequency and Bearing Measurements

By LCdr Stephen Rudnicki

Introduction

Passive tracking of a moving target is a routine part of modern naval operations. Analyzing a target's motion to determine its range, course and speed (i.e. the target solution) allows a tracking vessel to first localize the target, then predict its future position. Such target motion analysis (TMA), as it is called, is a necessary precursor to either collision avoidance or tactical action. Up until four or five years ago, operators performing TMA with passive sonar were limited to rough, "bearings only" data upon which they based their target solutions. Today, thanks to advances in passive sonar signal processing and digital computers, frequency data can be combined with bearing information to produce superior results in passive target motion analysis.

As the name implies, the *bearings-only* tracking method uses only the measured bearings to a target to estimate the target's range, course and speed. This is the most widely used method of TMA when operating passive sonar such as a towed array. Many approaches have been developed, but each requires the observing platform to change heading at least once for the target parameter solution to converge[2,3]. (Additional manoeuvres will increase the reliability of the target solution estimate.) In practice, this is not always desirable. The stability and linearity of a towed array are degraded as it travels around the corner of a turn, resulting in loss of effective beamforming capability and, occasionally, loss of contact. A target's signal might or might not be regained once the array has steadied up on the new course. Furthermore, having to manoeuvre the tracking vessel over a relatively large baseline to determine a target solution imposes unnecessary tactical restrictions and is a significant disadvantage of bearings-only tracking methods.

A relatively new doppler-bearing tracking (DBT) method for passive tracking has been proposed[4,5] that makes use of not only the measured bearings to the target, but the measured doppler-shifted target tonal frequencies as well. By simultaneously measuring source target bearings and radiated doppler frequencies, the doppler-bearing filter can estimate the target's position, velocity and source frequencies *without* having to manoeuvre the tracking ship. The results are usually significantly more accurate than those obtained with the bearings-only filter. The aim of this article is to introduce the reader to doppler-bearing tracking and to demonstrate its superiority over the traditional bearings-only techniques.

Background

Bearings-only TMA originated in the submarine service during the Second World War and is still useful today as a check on automated systems. Called 1936 or Ekelund ranging[7], manual bearings-only ranging uses a time-bearing plot, with bearings having been measured over at least two legs. As shown in *Fig. 1*, bearings are manually smoothed and extrapolated to an intersection point corresponding to the instant when the ownship observer is midway through the manoeuvre from leg 1 to leg 2. The relationship between bearing rate ($\dot{\beta}_k$), range (R) and tangential relative velocity (V_t) is

$$\dot{\beta}_k R_k = V_t \qquad (1)$$

and can be used to calculate the range at the time of bearing intersection. The relative velocity component tangential to the intersection bearing is taken as the difference between ownship and target tangential velocities. By estimating the bearing rates and ownship tangential velocities for each respective leg, the target range at the instant of intersection can be calculated as

$$R_I = \frac{V_{o_1} - V_{o_2}}{\dot{\beta}_1 - \dot{\beta}_2} \qquad (2)$$

where V_o is the ownship tangential velocity component. This method can provide a rough estimate of target range which in turn can be used to solve for the target's velocity. As with all bearings-only tracking algorithms, the bearings-only ranging manoeuvre requires that bearings be measured over at least two ownship legs to solve for the target solution.

Automated bearings-only algorithms use the same principle as the manual method to make a best estimate of a target solution given noisy measurements. Sophisticated signal processing techniques such as the Kalman filter and, now, maximum likelihood batch processing, are used in these automated systems[3]. The batch

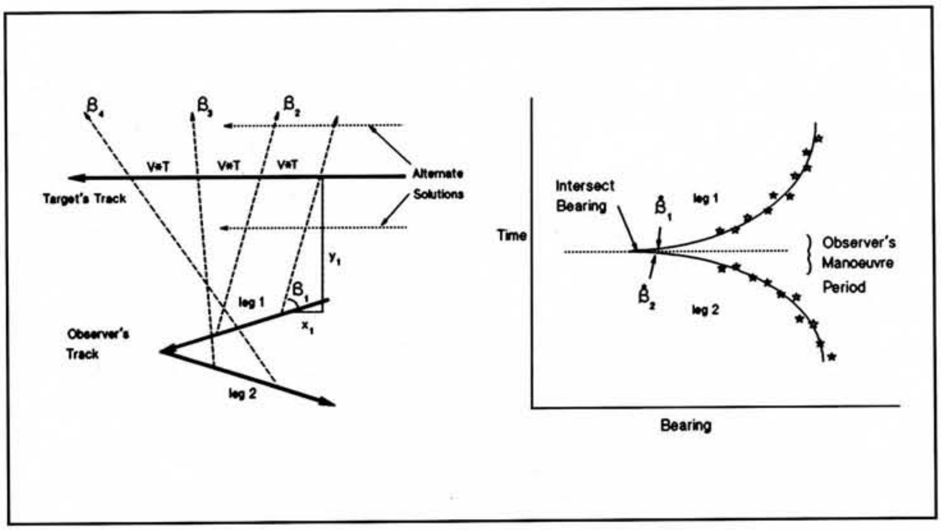


Fig. 1. Manual bearings-only tracking

method is a non-recursive approach in that all measurements are used concurrently to calculate the most up-to-date target solution. In contrast, a recursive method uses only the previous estimate and the current measurement(s) to calculate the current target solution.

The principle behind doppler-bearing tracking is straightforward. The frequency as seen by the observing platform is doppler-shifted as a function of the relative radial velocity between the observer and source target. Bearing measurements then resolve target course and allow for the range to be estimated. A doppler-bearing tracker also provides an estimate of the source frequency (or frequencies), which is of course useful for target classification.

The manual doppler-bearing method[5] provides a useful insight to the doppler-bearing problem and demonstrates how an ownship ranging manoeuvre is not needed for calculating target solution. Doppler-bearing ranging does require that both the observer and the target have constant course and speed, and that the radiated source frequency (f_o) be constant over the tracking period.

As the target is tracked, manual or semi-automated time-doppler and time-bearing plots are maintained. The time-doppler plot is the primary aid for manual doppler-bearing ranging. Once the closest point of approach (CPA) to the target has been passed, a "doppler range" may be taken. As *Fig. 2* illustrates, the CPA can be identified by an increasing to decreasing transition (or vice versa) in the rate of change of the received frequency. The received frequency (f_r) will equal f_o when the target is at CPA, as θ, the angle between radial and relative velocity vectors, is 90 degrees. The measured doppler-shifted frequency, as seen by the observer, is approximated as

$$f_r \approx f_o \left(1 + \frac{V_r}{c}\cos\theta\right) \tag{3}$$

where V_r is the relative velocity and c is the speed of sound in water. Once f_o is known it is a relatively simple operation to extrapolate backward in time to find the asymptotic frequency where the doppler shift is due to the entire relative velocity component as θ approaches zero degrees. At this point

$$V_r \approx \frac{c}{f_o}(f_r - f_o) \tag{4}$$

By taking the derivative of (**4**) with respect to time at CPA, and substituting in the relationship between bearing rate and range (**1**), the range at CPA can now be determined as

$$R_{CPA} = -\frac{V_r^2}{c}\frac{f_o}{\left(\frac{df_r}{dt}\right)_{CPA}} \tag{5}$$

Thus the doppler range may be calculated without requiring the tracking vessel to conduct a ranging manoeuvre as is the case with bearings-only tracking. For automated doppler-bearing algorithms, an ownship manoeuvre will serve to increase the quality of the target solution as will an increase in the number of frequencies tracked. In a similar fashion to the bearings-only algorithms, doppler-bearing filters have been recently proposed that make use of maximum likelihood batch processing[1,4,5].

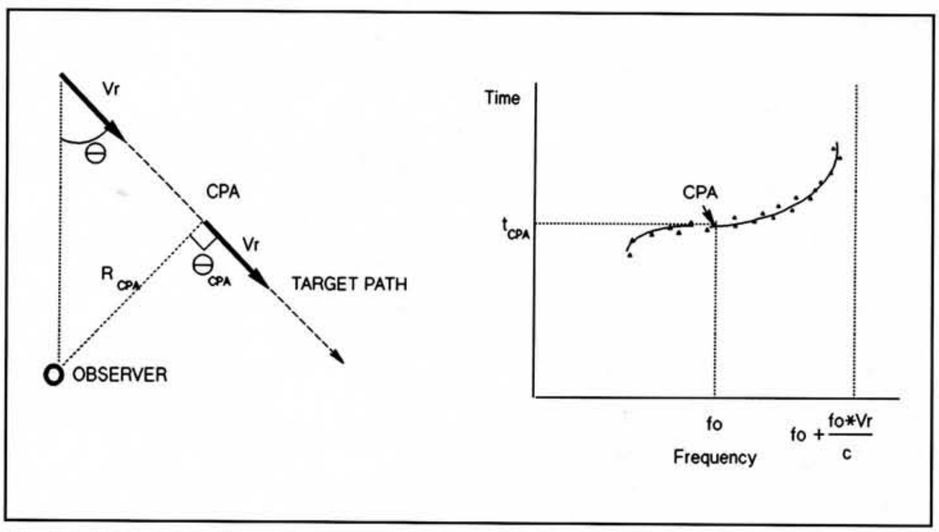


Fig. 2. Manual doppler-bearing tracking

Development of the DBT System Equations

The doppler-bearing equations will be developed here to show the inherent simplicity of the system and provide some insight to a typical algorithm. The difficulty with all passive tracking filters stems from the non-linear nature of the system equations. This has been overcome by making use of what is called the pseudo-linear formulation of the doppler-bearing problem[5]. The non-linear estimation problem will be linearized by multiplying the target position and velocities by the source frequency.

The first equation of the doppler-bearing tracker is based upon the relationship between the receiver doppler-shifted frequency fr_k^i, the source frequency f_0^i, and the radial relative velocity V cos θ_k, which is

$$fr_k^i = f_o^i\left(1 + \frac{V}{c}\cos\theta_k\right) \tag{6}$$

where c is the speed of sound in water and θ_k is the angle between the target velocity vector and the bearing line (*Fig. 2*). This equation can be expressed in terms of the x and y components of the target and ownship velocities, so that

$$fr_k^i = f_o^i\left[1 - (\dot{x}_{t_k} - \dot{x}_{o_k})\frac{\cos\beta_k}{c} - (\dot{y}_{t_k} - \dot{y}_{o_k})\frac{\sin\beta_k}{c}\right] \tag{7}$$

where β_k is the bearing to the target measured from the positive x axis at time index k. The received doppler-shifted frequency can now be written in terms of the target solution parameters as

$$fr_k^i = \left(f_o^i\right)\left(1 + \dot{x}_{o_k}\frac{\cos\beta_k}{c} + \dot{y}_{o_k}\frac{\sin\beta_k}{c}\right) - \left(f_o^i\dot{x}_t\right)\frac{\cos\beta_k}{c} - \left(f_o^i\dot{y}_t\right)\frac{\sin\beta_k}{c} \tag{8}$$

The second equation is based upon the relationship of the measured angle to the positions of the ownship and the target,

$$\tan\beta_k = \frac{\sin\beta_k}{\cos\beta_k} = \frac{y_{t_k} - y_{o_k}}{x_{t_k} - x_{o_k}} \tag{9}$$

Cross-multiplying (**9**) and multiplying through with f_o^i gives the final form of the second equation,

$$0 = \left(f_o^i\right)\left(x_{o_k}\sin\beta_k - y_{o_k}\cos\beta_k\right) - \left(f_o^i x_{t_k}\right)\sin\beta_k + \left(f_o^i y_{t_k}\right)\cos\beta_k \tag{10}$$

Thus the doppler-bearing system can be described with two equations. As there are in this case five unknowns, at least five

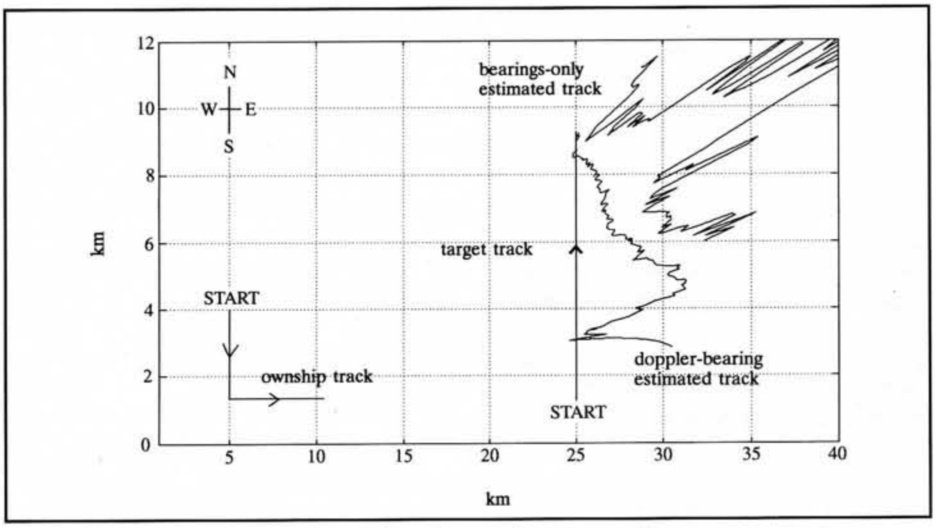


Fig. 3. Bearings-only and doppler-bearing tracker comparison

measurements of bearing and doppler-shifted frequency will be needed to calculate the target solution. In practice there is noise in these measurements and hence many measurements are necessary for a good estimate. These two equations (**8** and **10**) form the heart of the automated, pseudo-linear doppler-bearing algorithm.

An Illustrative Example

To compare the performance of the bearings-only and doppler-bearing tracking methods, a typical passive tracking scenario was simulated using an automated estimation algorithm developed in [6]. As shown in *Fig. 3*, the tracking vessel commences the run (steering south at 16 knots) at a range of over 20 kilometres from the target which is steering north at 16 knots. Measurements are taken five seconds apart for a total of 180 discrete measurements over 15 minutes. After five minutes the tracking vessel alters course to the east. Measurement noise for bearings and frequency measurements were arbitrarily chosen as 1 degree and .3 Hz standard deviation respectively. The target was radiating a single 300-Hz tone.

Figure 3 shows the ownship and target tracks on a cartesian plot. The estimated target solution for both the bearings-only and the doppler-bearing filters, given identical bearing measurements, is shown for a single run. It is clear that the doppler-bearing method provides a much more accurate position estimate than bearings-only at a significantly earlier time. The statistic of root-mean-square percent range error for 30 runs is plotted against time in *Fig. 4* for both the bearings-only and the doppler-bearing filters. The smooth lines are the Cramér-Rao lower bound which represents the minimum theoretical variance attainable. Note that the bearings-only tracker does not provide a solution until the manoeuvre at five minutes. After 10 minutes of tracking, the expected bearings-only range error is 35 percent while the doppler-bearing is 13 percent. At 20 kilometres, this represents an expected error of 7000 metres for the bearings-only tracker compared to only 2600 metres for the doppler-bearing tracker.

From this example it is clear that the doppler-bearing tracker provides considerable improvement over the bearings-only method. In general this is always the case when sufficient doppler is present in the measurements. A scenario where the doppler-bearing tracker would perform only as well as a bearings-only tracker is that of a radially moving target (for example a stern chase) where there is negligible doppler-shift in the frequency measurements.

Conclusions

By measuring both target bearing and radiated frequencies a target may be successfully tracked without the need for an ownship ranging manoeuvre. Doppler-bearing tracking can provide high-quality target solutions that are more accurate than those previously possible using the more traditional bearings-only techniques, and in significantly less time. Furthermore, the doppler-bearing tracker provides the operator with an optimal estimate of the target's radiated source frequency or frequencies. This new approach promises to become an effective signal processing tool in the ongoing problem of underwater passive tracking and shows potential for application with such diverse sensors as towed arrays and sonobuoys.

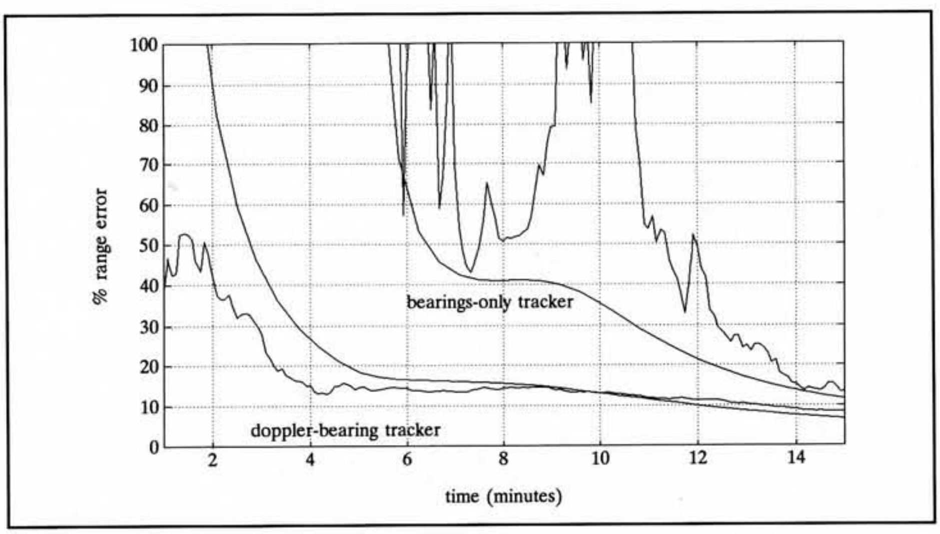


Fig. 4. Percent range root-mean-square error for 30 runs

References

[1] Jauffret, C. and Y. Bar-Shalom, "Track formation with bearing and frequency measurements," *IEEE Transactions on Aerospace and Electronic Systems*, Vol. 26, No. 6, November 1990, pp.999-1009.

[2] Nardone, S.C. and V.J. Aidala, "Observability criteria for bearings-only target motion analysis," *IEEE Transactions on Aerospace and Electronic Systems*, Vol. AES-17, No. 2, March 1981.

[3] Nardone, S.C., A.G. Lindgren and K.F. Gong, "Fundamental properties and performance of conventional bearings-only target motion analysis," *IEEE Transactions on Automatic Control*, Vol. 29, No. 9, September 1984.

[4] Passerieux, J.M., D. Pillon, P. Blanc-Benon and C. Jauffret, "Target motion

analysis with bearings and frequencies measurements via instrumental variable estimator," *Proceedings of the International Conference on Acoustics, Speech and Signal Processing*, Glasgow, May 1989.

[5] Passerieux, J.M. et al, "Target motion analysis with bearings and frequencies measurements," *Proceedings of the 22nd Asilomar Conference*, Pacific Grove, California, November 1988.

[6] Rudnicki, S.W., "A new method for bearings-only and doppler-bearing tracking," Master of Engineering Thesis, Royal Military College of Canada, Kingston, Ontario, May 1991.

[7] Taylor, D., "Tactical considerations for Ekelund ranging with towed array systems," *Defence Research Establishment Pacific, Note 88-9*, July 1988.

LCdr Rudnicki is the AN/SQS-510 sonar project manager in DMCS 3.

Greenspace: Maritime Environmental Protection

Naval Engineering Test Establishment

Asbestos elimination: Testing asbestos-free gasket and packing materials

By Nabil Shehata

Concern over the health hazards associated with the use of asbestos fibre has created an interest in finding substitutes for asbestos-based gasket and packing materials. Under the direction of the Directorate of Ship Engineering (DSE 6), the Naval Engineering Test Establishment (NETE) in LaSalle, Quebec is testing a variety of asbestos-free materials for shipboard applications.

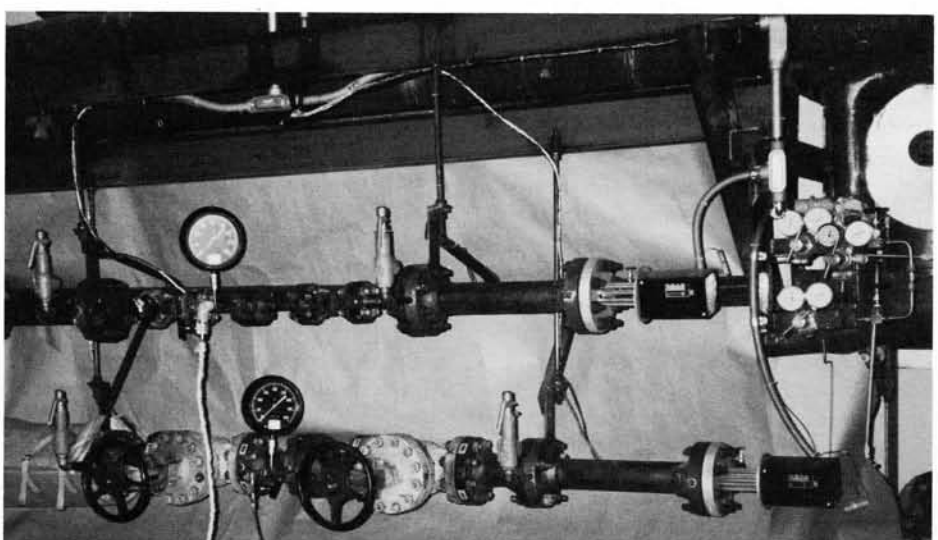


PHOTO: MICHAEL BERGIN, NETE

Asbestos-free gasket and packing materials are tested on this low-pressure, hot-air test rig operating at 200 psi and 550 degrees F. The rig is capable of simultaneously testing eight gasket materials and four packing materials. Blankets of fibreglass are used to insulate the test rig.

Materials slated for steam service are being subjected to a 1,000-hour superheated steam endurance test, followed by a high-impact shock test and another 100 hours of steam exposure. Similar tests, using hot air as the test medium, are conducted on asbestos-free materials intended for low-pressure air service.

To date, NETE has completed two test runs on materials slated for steam service, and a test run on materials intended for air service. Among the many materials tested for steam service, flexible graphite appears to be the most promising. The shock test shed light on the previously unknown behaviour of this material under shock loads. The data generated from the tests is being shared with other NATO member navies through an official information exchange program.

Nabil Shehata is a project engineer for asbestos elimination at the Naval Engineering Test Establishment.

1993 Eastern Region MARE Seminar

By LCdr Dave Ireland

This year's Eastern Region Maritime Engineering Seminar, held at the Maritime Warfare Centre in Halifax, March 31 to April 1, drew record numbers of naval and civilian engineering personnel. The theme, "Fleet Support: New Challenges, New Thinking," was supported both by formal presentations and by a series of think-tanks focusing on MARE training, resource management initiatives and ship signature management. Cmdre David Faulkner (COS MAT) welcomed the assembly, stressing that the occasion was designed to be a professional opportunity to learn, contribute and enjoy.

PHOTO: CFB HALIFAX BASE PHOTO

The 1993 Eastern Region Maritime Engineering Seminar was officially opened by (left to right) Cmdre R.L. Preston, RAdm L.G. Mason and Cmdre D.G. Faulkner.

In his opening remarks, Commander Maritime Forces Atlantic, RAdm Lynn Mason cautioned that, while our new frigates were conceived in the Cold War, the radical political changes the world has experienced over the past few years have not necessarily made for a situation any less threatening to global stability. As a maritime nation, he said, Canada will need the capabilities manifest in its new fleet. Cdr Carl Doucette (on behalf of DCOS Plans and Operations) later explored the navy's operational future, reviewing defence policy objectives and the likely nature of naval missions in light of current and potential budget cuts.

The MARE Branch Adviser, Cmdre Robert L. Preston (DGMEM), outlined the status of the navy's engineering resources, including personnel, organization and equipment — all of which he considered to be in good health. He cautioned, though, that the process by which priorities are set and work is executed requires attention. In an open forum later, he and sub-MOC advisers Capt(N) David Riis (DMEE), Capt(N) Yvon DeBlois (DMCS) and Capt(N) Peter Child (DSE) joined a panel including Cmdre Faulkner and MARE career managers LCdr Bob Chenier and Lt(N) Spencer Collins to discuss MARE personnel concerns.

The formal presentations covered a broad range of topics and were extremely well received. Seminar chairman Capt(N) David Marshall, CO NEUA, spoke of various resource management initiatives designed to improve the quality of engineering services being provided to the fleet. He described how the impact of a salary-wage-envelope (SWE) operating budget and total quality leadership concepts were intimately associated with NEUA's strategic business plan.

HMCS *Iroquois* engineers LCdr Gerry MacLean (CSEO) and LCdr Ernie Nash (MSEO) related their experiences of the past year in bringing their ship to its current operational status. Despite the many engineering difficulties still to be put right, they spoke with obvious pride about a ship that represents an unprecedented leap in Canadian warship capability. Lt(N) Paul Shaw's excellent presentation on ship signature management — one of the major topics of the two days — provided a good preamble to the syndicate discussion that followed. Equally impressive was a series of short, frank presentations made by six junior MAREs serving in their first working tours.

With respect to NCM developments, LCdr John Bottomley reported on the findings and recommendations of the Naval Electronic Technician Occupation Restructuring Project. Bottomley, the NETORP project leader, reported that while divisional briefings will address the issues this fall, it is clear that changes to training, establishment and management are needed to address the difficulties being experienced by the affected NET MOCs.

NDHQ perspectives got good representation from a number of speakers. DGMEM LCMM staff Ron Lajoie and Steve Lamirande discussed the provision of in-service support technical data packages currently making their way into the fleet and its various support agencies. They pointed out that much work has yet to be done to satisfy the full mandate of this prodigious undertaking. DMEE 4 LCMM representative Réal Thibault made a strong case for adopting certain progressive ADP database management measures to improve life-cycle support for the new fleet. On a lighter note, DMEE 6 engineer LCdr Mike Adams regaled the audience with his novel "synergistic" approach to increasing the probability of finding effective solutions to otherwise intractable problems.

That the challenges the navy faces are not unique unto itself was made very clear by keynote speaker Capt(N) (Ret.) Bruce Baxter. Baxter, vice-president of naval programs for Paramax Electronics Ltd., provided the audience with his view as to where defence-related civilian industry stands with respect to its perceived future. Dramatic changes are pending, he said, and aggressive innovation will be needed to compete successfully in a shrinking marketplace.

Dr. William Tolles, associate director of research at the Naval Research Laboratories in Washington, DC, completed the list of formal seminar speakers. Ribbed as being the technical mole for Tom Clancy's techno-thrillers, Tolles provided a fascinating insight to the world of emerging technology that defence agencies might wish to explore.

Cmdre Faulkner closed the proceedings by congratulating the people responsible for bringing CPF and TRUMP to reality. He emphasized the need for strong leadership within the MARE community to provide direction and definition in the transition process leading to the efficient support of our new fleet.

All told, the objectives of the seminar were met. The event was an unqualified, professionally refreshing success.

LCdr Ireland is the Above Water Systems Engineering Officer at NEUA.

Looking Back

HMS Captain — A disaster from the past

What went wrong? This combined sail and steam battleship weathered storms during her acceptance trials in 1870 only to be blown down in a gale months later with calamitous results.

By LCdr Derek W. Davis

When she was completed in January 1870 the RN battleship HMS *Captain* had the dubious distinction of having the least range of stability of any ship in the British fleet. Before the year was out she would take most of her crew to a watery grave. With hindsight the calamity can be seen as a result of complicated shipbuilding contractual arrangements, lack of trust in admiralty designers and an inadequate understanding of stability.

HMS *Captain* was built as a direct result of intense public attacks on the admiralty, in particular on it's design department, by one of the original inventors and advocates of the gun turret system, Captain Cowper Coles. As a Royal Navy officer on half pay during the early 1860s, Coles repeatedly criticized the admiralty for not building enough ocean-going, turret-equipped warships. The admiralty at the time was still undecided on the merits of the turret system, and had been approaching the idea cautiously by testing the system first in coastal defence ships.

Progress was not swift enough for Coles and by 1865 he and his allies in parliament, the press and even within the Royal Navy were demanding that an ocean-going turreted battleship be built. Bowing to this pressure the admiralty agreed to build such a ship, HMS *Monarch*, and employed Coles as the design consultant for the turret systems. Far from satisfied with the design, especially *Monarch*'s "high" freeboard, Coles badgered away at the admiralty design department, directing his invective at Chief Constructor Reed. Finally, to stop the barrage of criticism and to settle the issue of sea-going turreted ships, the admiralty in April 1866 authorized Coles to choose a private shipbuilder (who would be paid by the admiralty) to design and build an ocean-going vessel to his specifications. The vessel was to be named HMS *Captain*.

Understandably, certain precautions were taken to ensure that neither Coles nor the shipbuilder could blame the admiralty for any problems with the ship. In a highly unusual move the admiralty stipulated that complete design responsibility would rest with Coles and the shipbuilder (as design authority). The admiralty would only accept responsibility for the inspection of workmanship and quality of materials.

The arrangement didn't last. Coles fell ill in late 1866, forcing the admiralty to assume some supervisory duties. Reed, however, endeavoured to keep the design authority with the shipbuilder by stamping all design changes with "No objection would be offered," rather than the customary "Approved." Ultimately, responsibility was to remain with Coles even though he was unable to supervise the construction of the vessel and the incorporation of the many design changes.

The lack of direct supervision became especially evident in 1867 when admiralty inspectors noted that the shipbuilder was being overgenerous in his use of materials. This confirmed the misgivings of Reed who, in 1866, had written to the shipbuilder expressing his concern over the initial calculation of weights and centres of gravity. The shipbuilder responded by sticking to his numbers: the vessel's stability would be satisfactory.

When *Captain* was floated out of the building dock at Birkenhead in 1869, the ship had only 6 feet 11 inches of freeboard — 13 inches less than originally called for. Reed immediately pronounced the ship "utterly unsafe,"[1] but to no avail. To the contrary, as the ship was fitted out and a hundred extra crew were added, things got even worse. By the summer of 1870 *Captain*'s freeboard was down to 6 feet 7 inches.

The effect of the overweightedness and low freeboard was amply demonstrated during the ship's inclining experiment in July 1870. Calculations showed that the ship's deck edge would go under at 14 degrees of heel. The maximum righting moment occurred at 21 degrees, while the angle of vanishing stability (the point beyond which the ship could not recover) would occur at 54 1/2 degrees. Overall, the range of stability was less than that for any other ship in the Royal Navy. (Present-day studies[2] show that these figures were optimistic and made no allowance for dynamic effects such as wind.) Despite *Captain*'s overweight design and poor stability, the ship was deemed safe as long as prudence were used in sailing her, especially since she had already weathered rough conditions on her acceptance cruises. The ship successfully completed her sea trials, final payment was made to the shipbuilder and the battleship was accepted into service by the Royal Navy.

On Sept. 6, 1870, HMS *Captain* was at sea with the Mediterranean Fleet when Admiral Milne boarded her for an inspection. He was surprised by the curious "sensation of stepping out of his cutter directly onto a warship's upper deck."[3] The admiral stated his concern over the ship's sailing qualities and low freeboard, but did not press the point with Captain Coles (who was on board as a privileged observer). After completing his inspection he returned to his flagship, just as the weather began to turn dirty.

Shortly after midnight, with a moderate gale blowing, the ship appeared to be hit by a heavy gust. The captain desperately tried to reduce sail by ordering the topsail halyards cut, but before this could be done the ship heeled over and sank.[4] The ship took 472 men with her, including Captain Coles and the son of Mr. Hugh Childers, First Lord of the Admiralty. (Childers had appointed his son to the ship "as a measure of appreciation of her novel fighting qualities in opposition to the Chief Constructor's views."[5]) There were only 18 survivors.

The subsequent admiralty investigation concluded that the ship was probably lost as a result of poor stability, close sailing and an overly heavy sailing rig. The other lessons which took longer to learn were those of the need for professional, rather than amateur ship designers; the need for weight control, including inclining experiments; and the need for a proper understanding of stability. The *Captain* incident in particular led to the beginning of what have now evolved into present-day intact stability standards.

References

[1] Stanley Sandler, *The Emergence of the Modern Capital Ship* (Newark: University of Delaware Press, 1979), p.217.

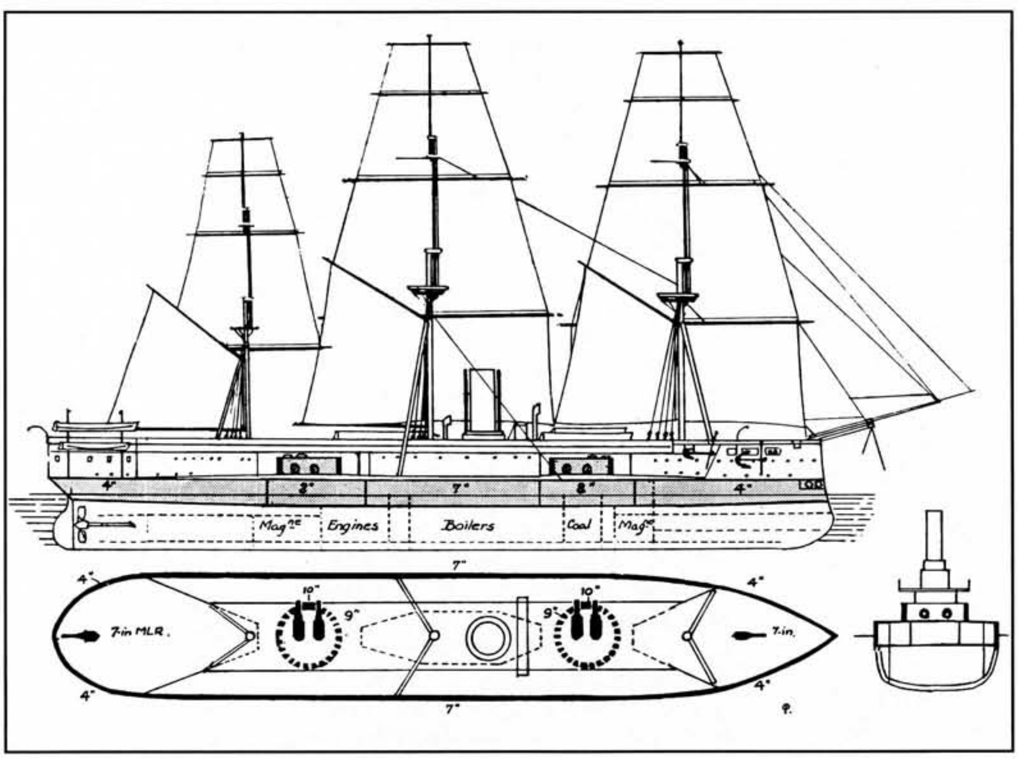
[2] DK Brown, "The design and loss of HMS Captain," *Warship Technology*, No.7, 1st Quarter, 1989, pp.31-37.

[3] Stanley Sander, p.225.

[4] DK Brown, p.32.

[5] Oscar Parkes, *British Battleships, A History of Design, Construction and Armament* (London: Seeley Service & Co. Ltd., 1966).

LCdr Davis is the DSE 5 naval architect for surface ship systems



HMS *Captain*

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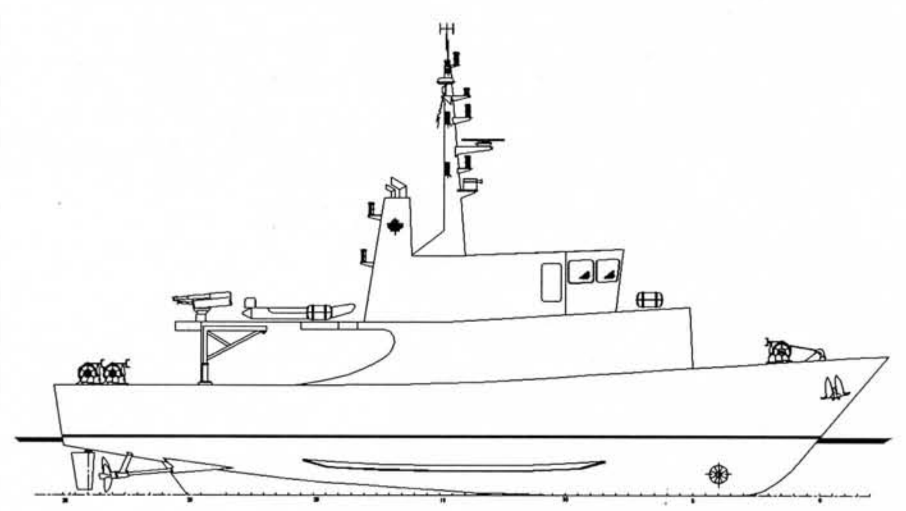

Diving Tender Design Option

This 33-metre, 290-tonne variant of the torpedo and ship ranging vessel (TSRV) is just one design option the navy is looking at for its new diving tender. The combination of twin screws, bow thruster and four-point mooring capability would make it easier to position the vessel on station than is now possible with the YDTs built in the 1950s and '60s.

Diving tender replacement

There is good news for the fleet diving units. The Directorate of Naval Requirements (DNR) and the Directorate of Maritime Engineering Support are now in the development phase of a new-vessel project to replace the navy's five diving tenders which have been in service for more than 30 years. The new tenders, which will be designed and built to commercial standards, are expected to be in operation by 1999.

The timing couldn't be better. The original life-expectancy of the tenders now operating with the FDUs should have seen them being phased out this year and next. As it is, the navy will have to coax them along until the replacements are available.

According to tender replacement Project Director LCdr Henry Mark, staff officer for diving and EOD in DNR, the three wooden-hulled vessels, built between 1955 and 1958, and two steel-hulled tenders built in 1962 cannot be economically maintained beyond 2000. "The vessels are getting so old and so decrepit and so hard to maintain — they're spending five months in refit (every two years)," he said.

Mark produced a document that described the state of one of the wooden-hull tenders as alarming. Broken main beams in the engine-room have allowed the main deck to sag under the centre of the superstructure by several inches. The steel-hulls have their own problems. During a refit late last year one tender had to have 130 square feet of severely corroded plating replaced.

The limited capability of these small, 85- and 135-tonne vessels in modern diving operations has been apparent for some time. The new twin-screw tenders, at approximately 30 metres in length with a displacement of 250-300 tonnes, will offer a vast improvement in capability, seakeeping and endurance. No decision has been made on the number of new vessels that will be built.

Designed for shallow-water diving operations, the new tenders will be capable of supporting underwater search and salvage operations, explosive ordnance disposal, and a broad range of underwater inspections and maintenance. At a cruising speed of 10 knots they will have a range of 1200 nautical miles, and carry enough stores to sustain their mixed-gender crews of 17 for up to two weeks.

Specialized equipment for the tenders will include a recompression chamber, side-scan sonar, HP air compressors, a remotely operated vehicle (ROV) and a

The navy is looking to replace its five diving tenders by 1999. Three of those being replaced are wooden-hulled vessels such as YDT-6 shown here.

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three-tonne deck crane. By all accounts navy clearance divers will be getting the main features they want in a tender. "They're looking for mobility, a recompression chamber on the main deck and an effective mooring capability," Mark said.

The diving tender replacement project goes to program development proposal (PDP), an in-house option-selection process, in August 1994. One option the navy will be considering seriously involves building upon the hull design and machinery arrangement of the torpedo and ship ranging vessel (TSRV) delivered to the navy in 1991 (*MEJ*: January 1992, page 25). "We're going on the assumption that the TSRV option will be our best bet at this stage," Mark said. **— with files from LCdr Mark Read and Lt(N) Bill Haydock, DMES 3.**

Datatrap for CPF

Procurement is now under way for a CPF-version of the Datatrap 9000N automated machinery condition data collection system already fitted in major Canadian fleet units. The Datatrap, manufactured by Beta Monitors and Controls Ltd. of Calgary, is the latest development in shipboard machinery condition monitoring using vibration analysis. The CPF version is virtually identical to existing systems, but will feature a greater VdB range tailored to meet the needs of inherently quieter ships.

The major advantages of using the Datatrap for condition monitoring are significantly increased machinery availability and reduced ship maintenance costs. Thanks to the Datatrap's simple PC-based operation, shipboard and shore-based technical staffs will have an easier time diagnosing machinery problems and looking for system-wide improvements. At the moment, Datatraps and their associated shore infrastructure are in place for all submarines and major ship classes except CPF. Datatraps for both the *Halifax* and *Iroquois* classes will eventually be interfaced with ICEMaN — the navy's Integrated Configuration and Engineering Maintenance Network.

Technical investigation and acceptance testing for the Datatrap were conducted at the Naval Engineering Test Establishment in LaSalle, Quebec in conjunction with DMEE 7 and DSE 6.

Portugal: AN/SQS-510 sonar acceptance trials

DMCS 3 personnel travelled to Portugal in March to conduct final acceptance trials of the AN/SQS-510 sonar on board the Portuguese frigate NRP *Vasco da Gama*. The trials were conducted under the auspices of a 1980 NATO project to provide military assistance to Portugal (*MEJ:* April 1987, page 30). Under the project Canada is supplying three complete AN/SQS-510 sonar suites for Portugal's new *Vasco da Gama*-class frigates. Final acceptance trials in NRP *Alvares Cabral* were completed last December, and the last will be conducted in *Corte Real* this fall. Successful completion of the trials will mark the end of the project.

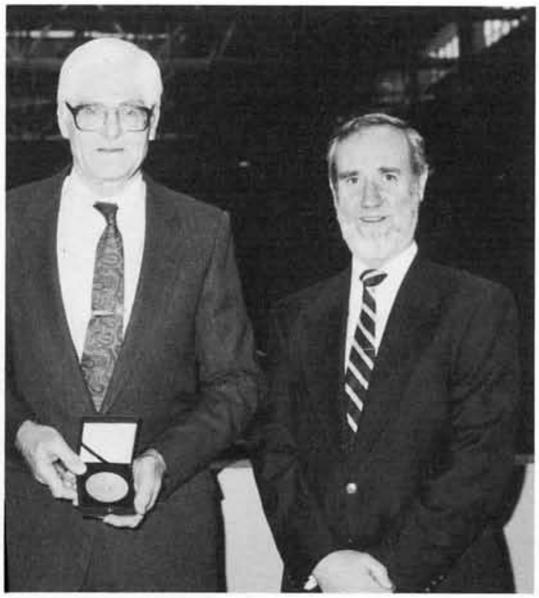
PHOTO: LT(N) J.B. McLACHLAN

NRP *Corte Real*

The recent acceptance trials comprised two days of alongside testing of the interface between the AN/SQS-510 sonar and the STACOS Command and Control System, and one day of sea acceptance trials against a submarine target off Lisbon. Final delivery, installation and set-to-work of the sonar equipment for the three ships were completed in the spring of 1991, with the final software development being completed last November. The ships have been operating pre-production software in the interim.

The AN/SQS-510 sonar is manufactured by Computing Devices Canada of Nepean, Ontario and is currently in service in a hull-mounted configuration in HMCS *Nipigon*, and fitted in a VDS configuration in *Terra Nova*. The 510 sonar is also being considered for retrofit in the *Halifax*- and *Iroquois*-class ships. The Portuguese navy is procuring five additional sets, one for a shore-based trainer and four for installation in their *Joao Belo*-class frigates.

45 years of service!



PHOTOS: CFB OTTAWA BASE PHOTO

Mk 12 IFF project manager John Joe Reilly (centre left) and radar systems engineer David Castleman (c-r), both from DMCS 4, were awarded 45-year service medallions in February by Sr ADM(Mat), R.N. Sturgeon (left); with Cmdre Robert L. Preston, DGMEM.

Kuwait Liberation Medal

PHOTO: CFB HALIFAX BASE PHOTO

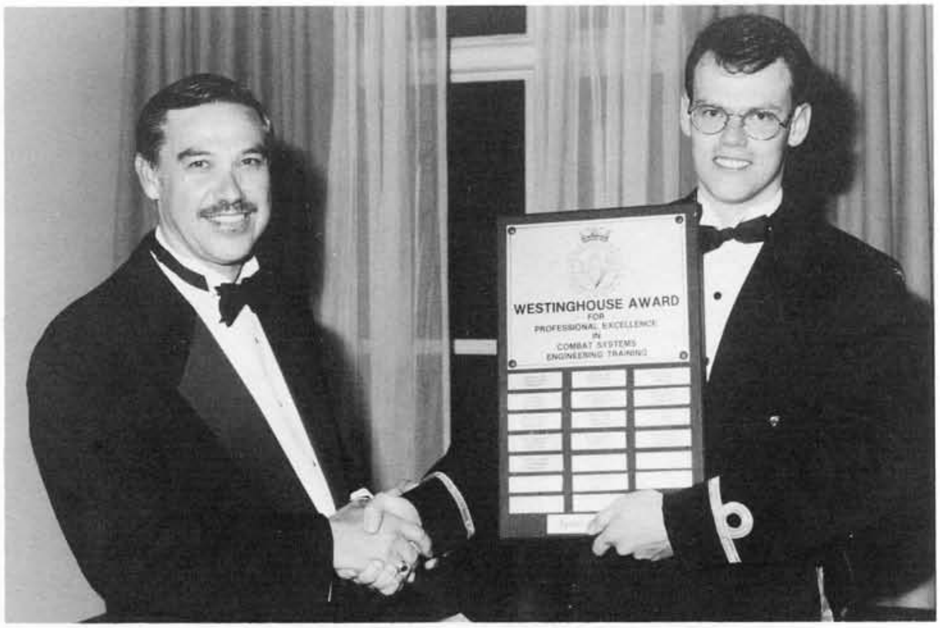
In January Cmdre David Faulkner, Chief of Staff Materiel in Maritime Command, presented the Kuwait Liberation Medal to CPO2 Robert Bussières and Lt(N) David Coulter of the Materiel branch technical readiness section. Both had served in HMCS *Terra Nova* during Operation Friction — Coulter as MSEO, Bussières as the engineering Chief Regulating PO. The medals were a gift of the government of Saudi Arabia to mark the liberation of Kuwait in 1991.

1992 MARE awards

Bravo Zulus go out to the recipients of the 1992 MARE awards. On the Marine Systems side of the house, **Lt(N) Al Cook** picked up the Peacock Award for graduating with the best overall aggregate marks from the start of his MARE 44B training. **SLt Mike Bonnah** received the CAE Award as top academic student in the MARE 44B applications course shore phase.

On the Combat Systems side, **Lt(N) Martin Torn** won the Paramax Award for top CSE officer achieving MARE 44C qualification in 1992, and **SLt Bruce Martin** received the Westinghouse Award for professional excellence in CSE training.

Congratulations to the winners and finalists.



Robert Dufault of Westinghouse presents the 1992 Westinghouse Award to SLt Bruce Martin.

CSE Awards

Paramax's Capt(N) (Ret.) Bruce Baxter (inset) presents a naval sword to 1992 Paramax Award winner Lt(N) Martin Torn. Earlier, the five award finalists had posed for a photo with the senior MAREs who made up the award's selection board: (L to R) SLt Langlois, Cdr Ralph, Lt(N) Prokopiw, Lt(N) Hardy, Capt(N) DeBlois (chairman), Cdr McVicar, Cdr Wilson, Cdr Tremblay, Lt(N) Holbourn and 1992 winner Lt(N) Torn. Board member Cdr Eldridge is absent.

News Briefs

MSE Awards

Brian Emo, president of Peacock Bros. Ltd. presents a naval sword to 1992 Peacock Award winner Lt(N) Al Cook.

PHOTOS: CFB HALIFAX BASE PHOTO

CAE senior marketing manager Wendy Allerton presents the CAE Award to 1992 winner SLt Mike Bonnah.

Naval reserve MAREs

Regular force Maritime Engineers thinking about retirement might want to take a close look at the naval reserve. The reserves are once again recruiting MARE(R) officers, this time to fill an approved establishment of 90 positions by 2002. The current MARE(R) strength is 34 officers, with 10 new positions opening this fiscal year.

The uncertainty that has plagued the reserve MARE program was dispelled in April when the Naval Personnel Working Group sanctioned specific roles proposed by Naval Reserve Headquarters. MARE(R)s will be employed primarily as engineering department heads in naval reserve divisions, responsible for such things as ADP management, environmental activities and safety, and in technical support functions with the Maritime Coastal Defence organization. During periods of national mobilization MARE(R)s will augment staffs in the navy's shore technical units.

The naval reserve is expected to take delivery of 12 new maritime coastal defence vessels by 1999. The approval of the newly defined MARE(R) roles was an essential step in preparing for the Total Force MARE occupational analysis, scheduled to begin in August, and the subsequent production of integrated occupation specifications.

Canadian Naval Historical Conference, Halifax, Nova Scotia, October 8-9, 1993

Maritime Command is hosting its second Canadian Naval Historical Conference at the Maritime Warfare Centre in Halifax this fall. Twelve papers supporting the theme "In Quest of a Canadian Naval Identity" will be presented at the conference and produced in a commercial publication. The objective is to examine the social history of the Canadian navy and its evolution as a national institution.

For this year's conference, three papers will be presented on each of the following study areas: Roots of the RCN (1867 to 1914); Global Wars (1914 to 1950s); the Era of Violent Peace (1950s to 1990); and the Navy Today and the Next 40 Years. The aim of the Canadian Naval Historical Conference, as it was established in 1990, is to encourage serving members and young scholars of naval affairs to examine the historical and contemporary record and write papers.

10th Ship Control Systems Symposium, Ottawa, Ontario, October 25-29, 1993

The 10th edition of the Ship Control Systems Symposium, a triennial international event, is being sponsored this year by the Canadian Department of National Defence. The theme of the 10th symposium is: "Application of Modern Ship Control Technology in the 1990s and Beyond." As new developments continue to emerge in ship automation and control, the symposium permits those who are involved with ship control systems to meet in a professional atmosphere to exchange useful, technical information.

Additional details may be obtained by contacting: **Lt(N) C. Zaidi, Coordinator, 10th Ship Control Systems Symposium, DGMEM/DMEE 7 (3 LSTL), 101 Colonel By Drive, Ottawa, Ontario, Canada K1A 0K2**; Tel: (819) 997-2493; Fax: (819) 994-9929.

Adventures in Black Water

Coming up in our next issue