CANADIAN FORCES CANADIENNES

MARITIME ENGINEERING Journal

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The Maritime Engineering Journal is an authorized unofficial publication of the Maritime Engineers of the Canadian Forces. It is published bi-annually at National Defence Headquarters and is given wide distribution to the Maritime Engineering Community. Views expressed are those of the authors and do not necessarily reflect official opinion or policy. Correspondence can be sent to the Editor, Maritime Engineering Journal, Directorate of Marine and Electrical Engineering (DMEE), National Defence Headquarters, Ottawa, Ontario, K1A 0K2.

Cover: This is an unofficial MARE crest which originated in the DGMEM organization. You are encouraged to comment on this crest, suggest improvements, and/or submit a completely new design. All inputs will be considered and an official MARE crest will be completed and submitted for approval.

EDITOR'S NOTES

MARITIME ENGINEERING JOURNAL
WINTER EDITION, 1983

As we sit down to assemble this edition of our Journal winter is starting to fall on the National Capital. Outside activity is slowing down and preparation for a long winter is underway. We have just completed the CPF evaluations and that puts us one step closer to new hulls which everyone longs for. Unlike the "great outdoors" the pace in the CPF Program Manager's shop is picking up. However, Commodore Healey (PM-CPF) has taken time out of his busy schedule to write an article for the Commodore's Corner. I am sure you will find it of interest.

In this edition you will also find some of the articles that were produced for the 1982 MARE Conference but were not published in that documentation. Here is your chance to read these papers. In addition to these articles one of our staff has put together feedback of the 1982 MARE Conference. You may find this of interest to reflect on when thinking of submissions you want to contribute to future conferences or to the Journal. Plans are now being made for the next conference. The venue will be Upper Canada in the Spring of 84.

I am concerned about the future of the Journal. It is my understanding that there is enthusiasm for the Journal amongst our ranks at all levels, however, we have not received any papers or letters for publication from the general readership. I hope that everyone will give some thought to the Journal's layout and content. Does it suit your needs and desires? Is it necessary? Of course, it goes without saying that the Journal can only survive and thrive through the lively input of its readers. Comments and articles for the next edition should be submitted by June 1983.

COMMODORES' CORNER

By COMMODORE E.J. HEALEY
PROGRAM MANAGER CANADIAN PATROL FRIGATE

Commodore Healey has been the Program Manager for the Canadian Patrol Frigate since June 1980. Prior to this promotion to Commodore he held the National Defence Headquarters appointments of Marine and Electrical Engineering from July 1978 to July 1979 and Maritime Engineering and Maintenance from July 1979 to June 1980. During the DDH-280 Project he was the Canadian Machinery Trials Officer at the Naval Engineering Center, Philadelphia, U.S.A. Over his career he has served in various ships and on both the east and west coast. In addition, he undertook some of his engineering training with the Royal Navy.

I have long been an advocate of a Maritime Engineering Journal and I am delighted that one has finally appeared. I congratulate Commodore Ball and his staff for the foresight and dedication they have shown in producing this very worthwhile publication. I urge all of you to take a moment and contribute to your Journal.

As most of you know, I have been with the Canadian Patrol Frigate Program for over two years now and although at times it may seem like the "ships at the end of the tunnel" are not getting any nearer, I can assure you that we are making steady progress and we are indeed within striking distance of our immediate goal, which is a government decision to proceed with the building of the Frigates. That milestone is scheduled for the early summer of next year (1983).

A few weeks ago, the two competing contractors delivered their proposals to the Program Office. We received over 9 tonnes of material with one contractor having over 28,000 pages plus drawings and the other close to 39,000 pages plus drawings. As you can appreciate, the people in the CPF Office as well as DGMEM and CMDO staff, military and civilian, have been very busy indeed wading through all this mass of documentation. Needless to say I am very proud of the dedication and enthusiasm which all these people have displayed in an attempt to get this difficult task done efficiently and quickly.

The role of the Maritime Engineering classification in this new, novel approach to ship procurement has changed from that which we were used to under our previous in-house design practice. While the role has changed, I believe the need for good engineers and architects in the classification is now greater than ever. During this current process our naval architects, marine systems engineers and combat systems engineers have been intimately involved in not one but <u>two</u> major warship designs; their input to this process has been crucial to its eventual success. This process would be extremely difficult, if not too risky, without this knowledgeable and capable design team being available to bring its expertise to bear on the output of the two contractors. This is only now beginning to be appreciated by those who are working on the program.

During the implementation phase of the project the competition for the talent of the classification will intensify as we in the CPF Program attempt to obtain the numbers of people we need to man all the various functions we are going to have to perform for the next 8 to 10 years. I can promise you stimulating and rewarding work, but work it will be, with dedication and commitment required from each and every member of the team.

The maritime engineering fraternity faces this new challenge in the 80's and I am sure they will meet it with professionalism and the necessary will to win that cannot help but result in the procurement of fine new ships; doing not only ourselves proud, but the whole country proud in the process.

E J Healey

THE MEAN LOOK

PART II

LIEUTENANT COMMANDER G.N. WISEMAN

THE AUTHOR

LCdr G.N. Wiseman joined the RCN in 1961 as an Ordinary Seaman Apprentice (Hull Technician). He served in various HMC ships and worked in the DDH 280 construction project prior to attending Carleton University. He graduated with a B Eng Civil degree and worked in NDHQ for three years before receiving his MSc in Naval Architecture from the University of London. Over the last three years he has been associated with submarines, first as SO Sub CDLS London and since 1980 as Project Manager, Canadian Submarine Acquisition Project.

ABSTRACT

This article is the second of two parts, the first of which was published in the inaugural issue of this Journal. It is a rewrite of work prepared for the department specifically for the CPF design. The theory of lines of forces, Dunn Curve, profile, slope, flare, and interval were presented in the first part. This part contains an illustration of some applications of this theory. It must be noted that the CPF presented here is conceptual and may not bear any relationships to the current designs being produced by the contractors.

APPLICATIONS OF BASIC THEORY

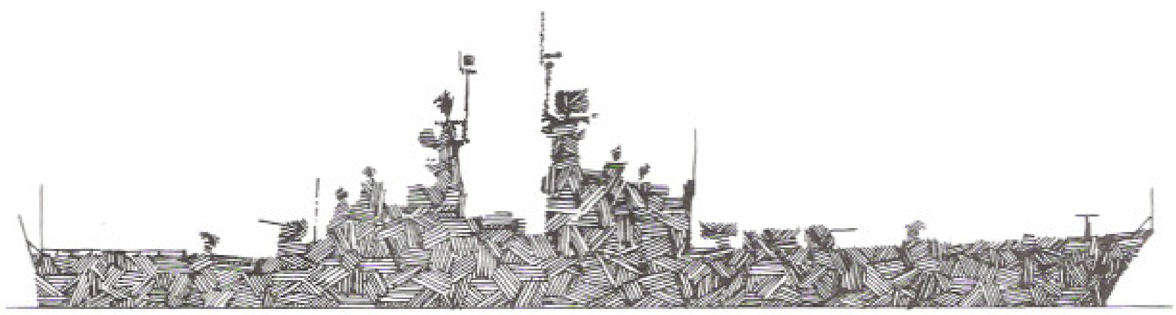
A warship should appear to be threatening, well armed, enigmatic, fast moving and seaworthy. To achieve this effect, it should be low in profile, have strong coordinated lines, styling which unifies the composition, and be covered with a variety of thorny projections. There are, of course, some expectations to these ideas, but in general the more effective appearing warships have the highest possible combination of these qualities.

Three current examples of the newest U.S. Navy warships can be used to illustrate the applications of our new aesthetics vocabulary; the CGN36 California Class nuclear-powered cruiser, the DD963 Spruance Class destroyer, and the FFG7 Oliver Hazard Perry Class frigate. Later we will contrast these examples with the CPF as reconfigured herein.

These are some general distinguishing qualities of the Profile and Lines of Force of the CGN36 California which are immediately observed as shown in Figures 5 and 6. The California has a highsided, chunky appearance. The superstructure is distributed vertically more than horizontally and confined almost to the center of the ship's length. Large voids are apparent from which proportionally small weapons project outward. The few projections on the California tend to be dwarfed by the mass of the superstructure and hull. The distribution of superstructure places the visual focus of the ship about midship and outside the Dunn Curve. Additionally, interest is split fore and aft giving the ship a Pushmi-Pullyu* effect of a ferry boat, lacking a defined sense of direction of travel. There are few horizontal parallel lines to give a sense of scale and the distance from water-line to the sheerline and the sheerline to top of superstructure is both enormous and unbroken. The large vertical blocks of the superstructure are predominant, giving the ship a solid, static appearance, one devoid of dynamic motion.

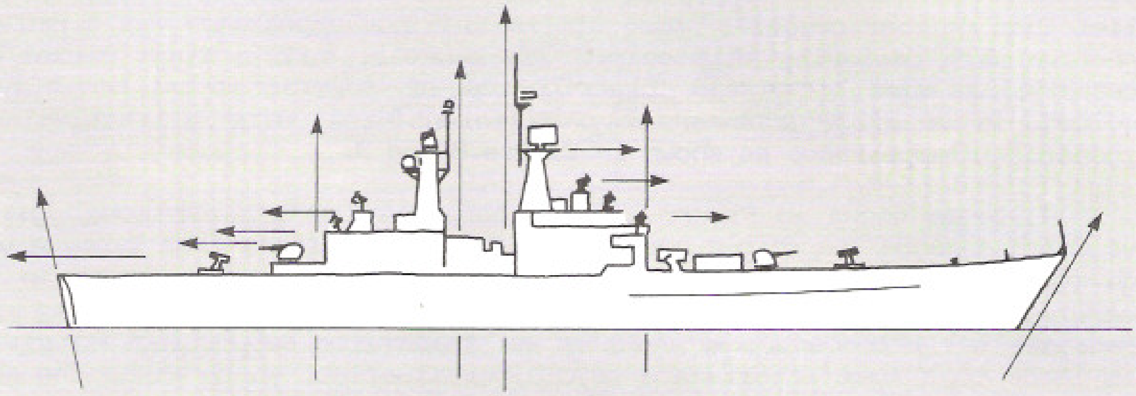
* From the story of Dr. Doolittle by Hugh Lofting 1920, Chapter "The Rarest Animal of All". The Pushmi-Pullyu was an animal with no tail but has a head at each end and no matter from which direction you approached, it was always facing you.

FIG. 5 PROFILE ENVELOPE/CALIFORNIA CLASS



Note large voids, small relative size of electronic and weapon systems and the concentration of the superstructure mass which gives a chunky appearance. Additionally, the forward and aft slope is broken and changes its rise abruptly. The California Class is only 26 feet longer and one foot wider than the Kara Class.

FIG. 6 PRINCIPAL LINES OF FORCE AS SEEN IN THE CALIFORNIA CLASS CRUISER



Note the number of strong perpendicular lines and the percentage of flat vertical surfaces.

The forward slope line drawn from the bow to the mast truck of the California describes a course which starts with a relatively slow incline, then runs parallel to the sheerline over the first set of weapons. It then abruptly jumps to the top of the bridge and flattens out again across the radars before accelerating rapidly to the top of the mast. The large voids have little which pushes back into the surrounding space and, therefore, give the ship the appearance of nudity and of being under-defended. Few shapes in the design seem coordinated with others in a compositional whole. The slabsides of both hull and superstructure and the building block appearance of unrelieved planes, devoid of surface articulation, give the ship a sense of being designed with a T-square rather than with an architect's ship curves. Finally, there are few convincing visual clues as to the contents of the ship relative to its enormous size or its ability to make war. One is left only with the impression of large size and uninteresting voids.

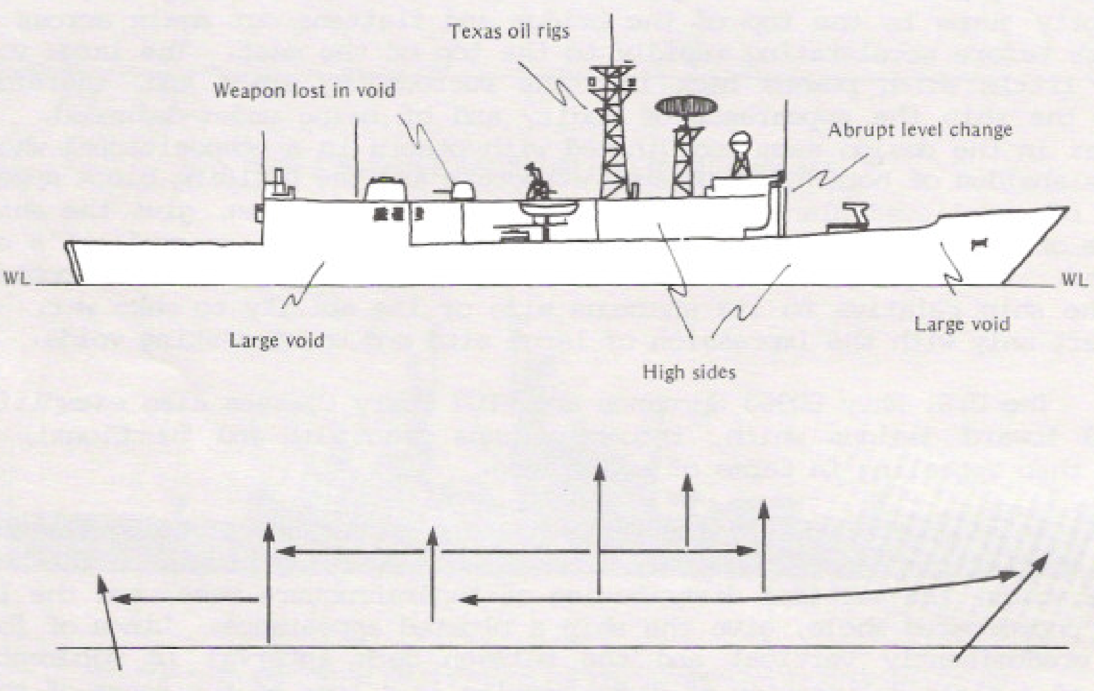
The U.S. Navy DD963 Spruance and FFG7 Perry Classes also exemplify a trend toward designs which, though perhaps practical and functional, are less than appealing in terms of appearance.

As shown in Figure 7 the Perry has the appearance of being assembled from modular components, squarely stacked like building blocks on the hull. Large voids, the vertical distribution of superstructure mass, and the lack of a coordinated whole, give the ship a bloated appearance. Lines of force are predominantly vertical and the between deck interval is monumental. Lack of a clear delineation of decks results in a loss of the sense of scale and makes it difficult to determine the actual size of the ship.

The Perry suffers not only from abrupt level changes in the superstructure, but also from the impression of having two Texas oil rigs for masts and a gun mounted on top of a barn. These factors contribute to the belief that neither creative space utilization nor appearance was a primary objective when designing this ship. If, however, such a large volume was necessary, a more horizontal distribution of superstructure might have resulted in a ship substantially different and more attractive and purposeful in appearance as shown in Figure 8 and 9.

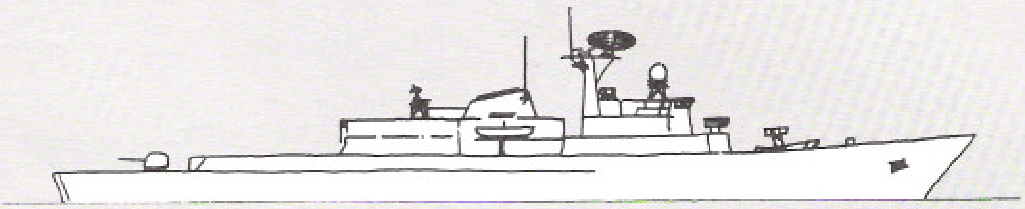
While as shown in Figure 10, the Spruance has organizational qualities which enhance the ship's appearance, it still suffers from large voids, high volume and small number of visible weapons. The abrupt break in the sheerline at the forward end of the massive superstructure has the appearance of a concentrated mass on an inadequate supporting structure. This leads to a most unfortunate psychological effect which gives the ship the appearance of being broken at this point. The Spruance might have been a visually stronger ship if the volume of superstructure had been horizontally distributed as shown in a radical reconfiguration of the Spruance illustrated in Figures 11 and 12. The examples shown provide a strong forward slope and distinctive placement of weapons.

FIG. 7 PRINCIPAL LINES OF FORCE FFG 7 OLIVER HAZARD PERRY



Note the lack of coordinated lines, the emphasis on the vertical. The ship has the appearance of an assembly of component parts.

FIG. 8 A RECONSTRUCTION OF THE FFG 7 PROFILE



This profile reconstruction represents only a slight departure from the current assembly of the major elements which comprise the FFG. However these elements which characterize the ship were reassembled to follow the principles of the Dunn Curve, forward and aft slope, interval, and the horizontal distribution of superstructure mass, thereby giving the illusion of a lower profile. This reconfiguration was based on the presumption that the appearance of a ship can start with an organic shape suitable for a vessel of this size and mission, which is also pleasing to overall appearance. The weapon and electronic suit was then configured and integrated to fit the shape rather than being added on as an afterthought. If the number of visible weapons were increased, a good looking ship would more effectively project warlike potential to the viewer.

FIG. 9 A RECONSTRUCTION OF THE FFG 7 USING A SMALL FRIGATE PROFILE

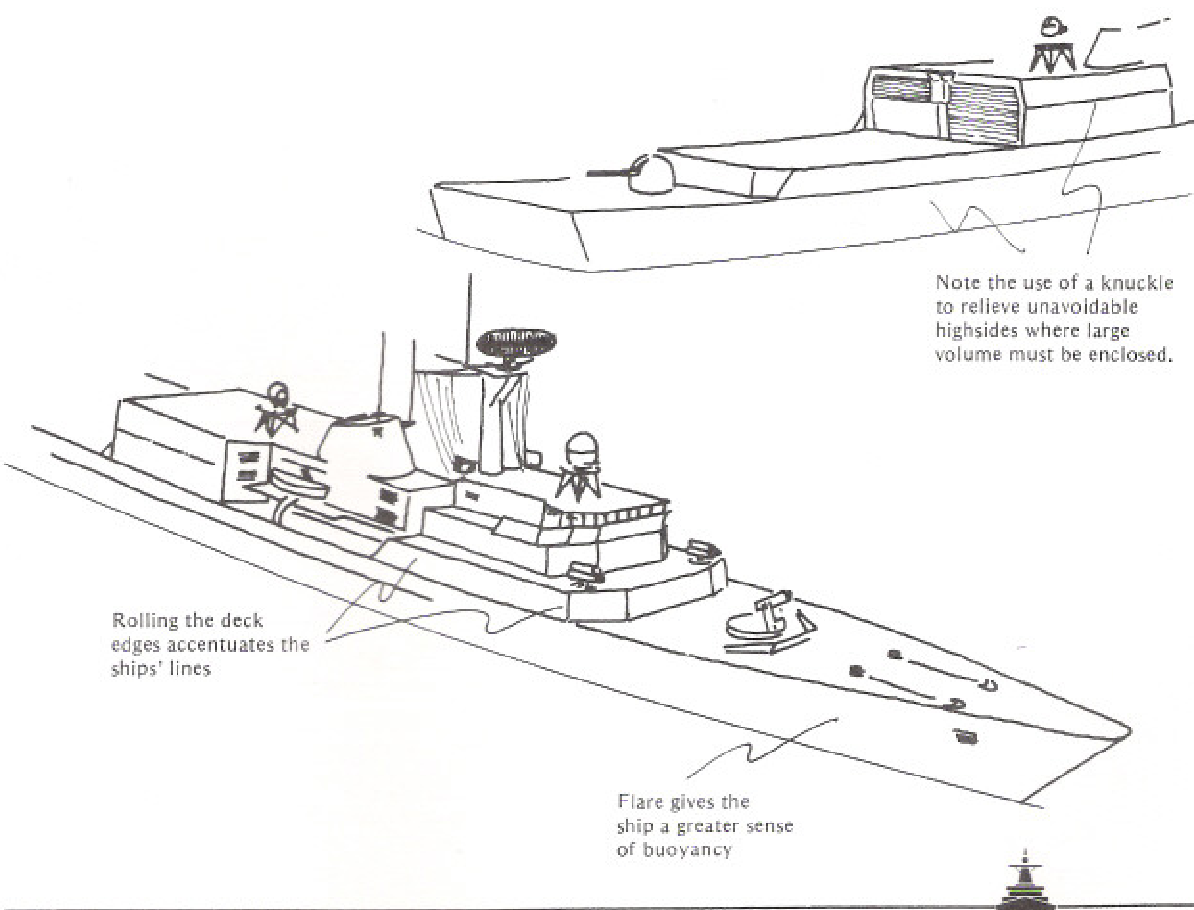
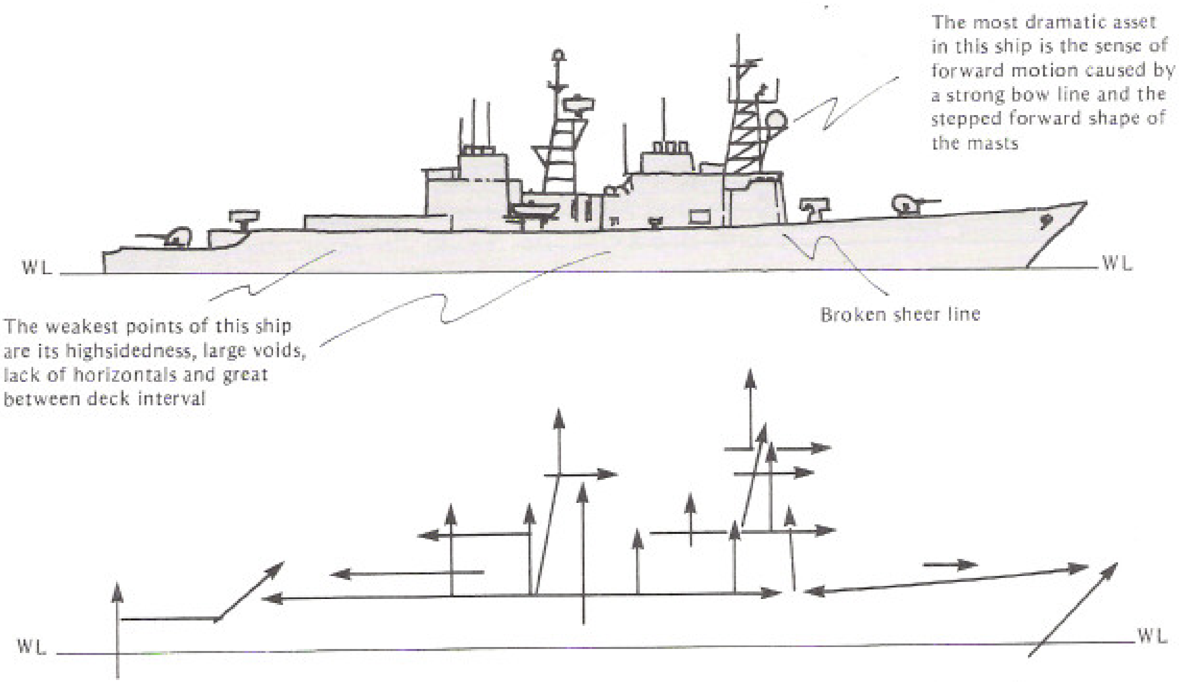
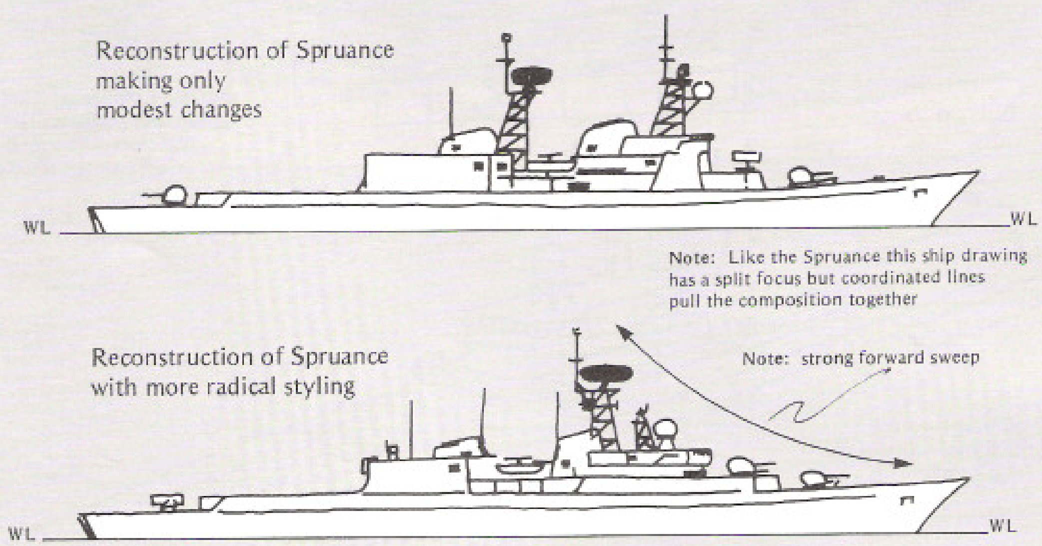


FIG. 10 PRINCIPAL LINES OF FORCE SPRUANCE CLASS



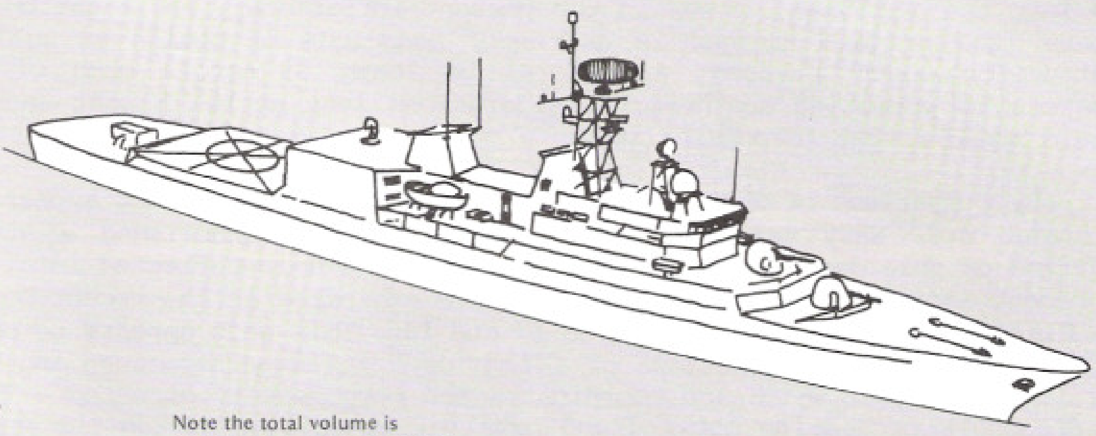
Note: Superstructure falls outside Dunn curve and splits focus forward and aft. There are large voids and highsided planes. Despite some of these factors the ship's composition does have a sense of organization. Its appearance is better than it might have been had function alone been driving the design as appears to be the case in the FFG 7.

FIG. 11 RECONSTRUCTION OF SPRUANCE DD 963



Note: In both drawings approximately the same volume is maintained as in the current 963 class, but the ships drawn here have a profile adjusted to appear more horizontal than vertical. Additionally weapons are more prominently displayed.

FIG. 12 PERSPECTIVE DRAWING OF RADICAL STYLING FOR 963 CLASS



Note the total volume is approximately the same as the current 963 but distributed horizontally in order to give the ship a lower profile

In discussion with engineers who are presently engaged in the design of new U.S. warships, and who in many cases were also involved in the design of early post WWII ships, relative to their concept of the importance of aesthetics in warship design, the comment heard is always "Yes, of course we appreciate the importance of producing good looking ships. However, there are many fact in the current design atmosphere that tend to relegate aesthetic considerations to a lesser role than they have occupied in the past."

It has already been pointed out that warship design, as is the case with the design of most other objects today, is no longer the product of the talents of just one man. In place of the single senior naval architect, who used to sign his name on all plans over such a title as "In Charge of Work", we now have project managers who coordinate the efforts of many specialists. Not since the ships designed under the practiced eye of John C. Niedemair (1940-1959) have U.S. Navy warships had a strong advocate for appearance.

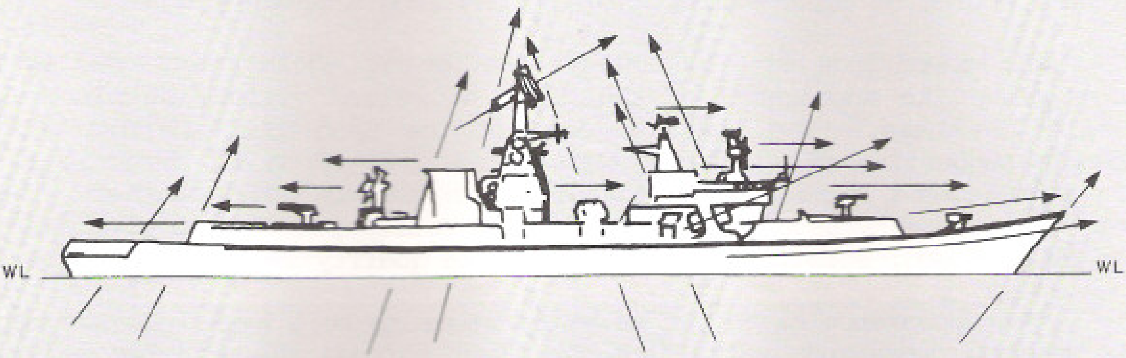
In the U.S. Navy during the feasibility and preliminary design stages, the computer is now used extensively, not only to perform most of the tedious individual calculations previously done by hand, but also to produce early stage conceptual designs. Thus the extent of human involvement in the design process has been greatly lessened. The project manager is in the unenviable position of having to provide answers to the seemingly endless, "What if?" questions that must be answered during the early design stages. Thus, while the computer should have saved time, and permitted such things as aesthetics to be given greater consideration, it has instead resulted in the escalation of the number of early stage studies from the tens into the hundreds. Also, in the present inflationary and tight budget climate, the project manager is extremely conscious of design as well as construction costs and may, therefore, be loath to devote much of his resources to promoting aesthetic considerations lest he be thought lacking in hard nosed fiscal responsibility.

By comparison of what is judged to be the relatively poor appearance of recent U.S. Navy warships, the Soviet Navy has established a strong tradition of ship design aesthetics preferences which is reflected in all of the recent additions to the fleet. Many are exhibited in the recent Soviet Kara Class Cruiser as seen in Figures 13 and 14. This ship appears to be in the crouched, low profile stance of a fighter. Its superstructure and hull show lines of force which are coordinated and purposefully directed. There are diagonals projecting outward and parallel lines reinforcing the sheerline. There is a sense of internal motion in the design. Large masses were kept low and the high points surrounded by an aura of spiny stinger-like projections. Its weapon and electronic systems appear larger than life as they stand out relative to the ship's size.

Rather than aligning the axis of a weapon or electronic system over a platform or with the ship's centerline, these objects were often centered to the extreme sides and dressed to the forward edge of the platform. This practice acentuates an upward thrust. As a result, the forward slope drawn from the bow to the highest point of the Kara passes smoothly through all of the ship's primary war-making equipment and never once touches the opaque outline of the ship's superstructure. From nearly every viewing angle, the ship appears to be covered with thorns. The Kara's superstructure has tumblehome and very few vertical surfaces. There does not seem to be a straight line anywhere in the ship. Flare in the hull and numerous bevels and turns in the funnel, deck edges, bridge, radar mast, and throughout, make a highly articulated and stimulating surface. The roll of the deck edge catches the sunlight and the strong repetitions parallels to the sheerline. These lines give the ship a sense of scale while accentuating a horizontal appearance that gives the illusion of holding down the profile. There is a heavy concentration of lines of force which gives a visual focus around the ship's bridge and radar mast, thus giving the ship a strong compositional theme and area of high visual interest. Though the Kara does not conform to the Dunn Curve, there is nonetheless a well defined forward and aft slope which more than makes up for this one defect.

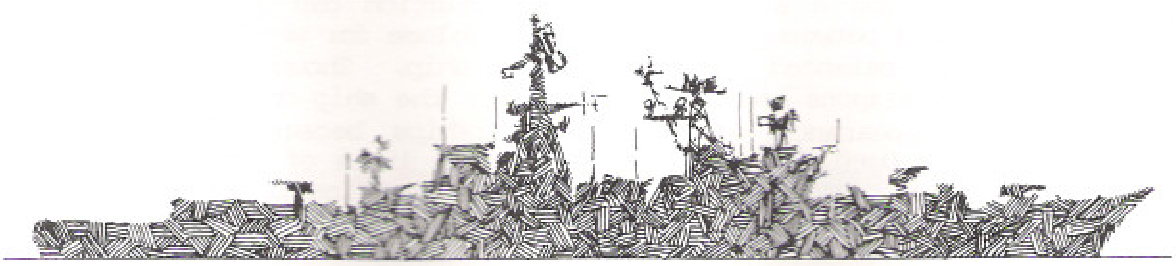
The Kara's strong dominant sheerline, supported by flare in the hull, is a fast moving thematic curved line which drops back quickly from the bow, eases itself under the superstructure and runs the length of the ship before briefly popping up again at the fantail. Considerable flare in the project-

FIG. 13 LINES OF FORCE SEEN IN THE KARA CLASS CRUISER



Note the principal Lines of Force which give the Kara class a dynamic quality. Lines of Force unite the composition and direct the eye. Note the heavy concentration of lines around the ships' bridge and the radar mast.

FIG. 14 KARA CLASS CRUISER PROFILE ENVELOPE



Note the aura of thorny projections surrounding the ship and the relatively low profile of the superstructure mass. Significant electronic and weapon systems are placed in prominent locations or high points and tend to be large relative to the ship's size. Note too, though the ship does not conform to the Dunn Curve there is still a strong visual interest centered around the ship's bridge and a well defined Forward and Aft slope.

ing bow casts a strong shadow and sense of solidity, while the elliptical bow has a sharknosed appearance reaching far out over the water ahead of the ship. This makes the waterline run seem finer than it is, as well as providing a source of color variation along the length of the hull.

The appearance of a strong projection is again reinforced by the posed cobra-like appearance of the pilot house and visions of pincer-like missile launchers. The tentacle eyes of the Headlight illuminators are strongly suggestive of a menacing insect creature. From all directions, the Kara represents a formidable appearance which did not come together by accident. Far too many associations seem deliberately intended to give the ship a sense of speed, stability, and stinger-like quality in its silhouette.

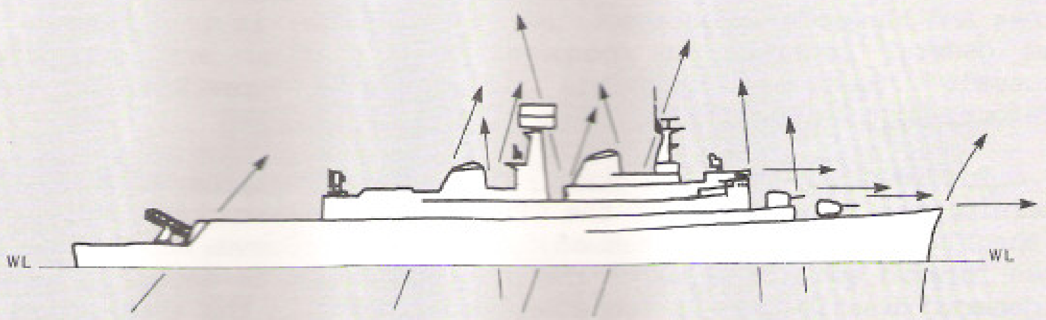
The appearance of Soviet warships seems to be a conscious attempt to take maximum propaganda value from the fleet through the artistic medium of design styling. Recent Soviet warships like the Kiev, Moskva, and Krivak speak of the concern for overall appearance and appear to have been designed with some fundamental ideas of what looks effective. It is known that the Soviet Union uses a national design body, the All-Union Research Institute for Technical Aesthetics (VNIITE), as a source for coordinating the appearance of industrial products. Among the six artistic design bureaus in existence in December 1970, one belonged to the Ministry of the Shipbuilding Industry which is responsible for designing and building naval as well as merchant ships. The head of this bureau, O. Arnal'd, has written at length about how a ship's silhouette is formed and has stressed, in particular, the importance of the angular characteristics of a ship's extremeties.*

The last non-Canadian example used herein is the British County Class cruiser introduced in the early 1960's, as shown in Figures 15 and 16. This ship illustrates how a successful design solution can be achieved with a minimum compromise between maintaining high volume for weapons systems while achieving a well balanced and good looking ship. Though the County has a small number of weapons and electronic gear, the ship does avoid the slab-sided, static appearance of the U.S. warships because it follows the principle of the Dunn Curve and uses balanced lines of force, tumblehome, flare and knuckle, coupled with a minimum of perpendicular lines.

The County Class is obviously less pretentious than the Kara and seems to represent the restrained style of a refined British attitude toward shipbuilding. The balance was carried out so well that this ship seems deceptively larger than it is and very purposeful in appearance.

* Footnote - Dr. Raymond Hutchings, Soviet Design Practices and Their Influence on the Design of Soviet Warships, London, England, unpublished, 1977.

FIG. 15 PRINCIPAL LINES OF FORCE IN A COUNTY CLASS CRUISER



Note the intervals of parallels to the sheerline and that very few perpendicular lines are to be seen. All the Lines of Force are coordinated to give the ship an harmonious appearance. Though not as dynamic as those of the Kara, the design does convey a sense of motion.

FIG. 16 PROFILE ENVELOPE OF A COUNTY CLASS CRUISER

Note the horizontal distribution of the superstructure mass along the length of the ship. There are few abrupt verticals and the ship piles evenly following the Dunn Curve. The design shows a good compromise between a need for high volume and desire for low profile. It is a well proportioned ship which appears to be larger than it really is.

ASTHETICS IN THE CANADIAN PATROL FRIGATE

In considering the baseline CPF (Canadian Patrol Frigate),** the design was an attractive ship to start with, compared to recent U.S. designs. There are many strong points which contribute to the CPF design's success and handsome appearance. Because of these, it is difficult to draw broad general contrasts as compared to the other examples previously discussed. Some subtler points affecting the appearance in the CPF, therefore, must be addressed.

In Figure 17 there are some important observations which can be made concerning the arrangement of the CPF masts, superstructure, hull, knuckle and sheerline, the ship's lines of force and Dunn Curve. In Figure 18, the broken forward and aft slope of the original design is apparent, as well as the general distribution of tophamper which peaks in the after third of the ship's length, outside the Dunn Curve. This is primarily because of the high mainmast and a split visual focus between the area of the AN/SPS-49 located above the hangar and large stack and the forward end of the ship.

Figure 19 shows the principal lines of force of the original ship, notably the strong vertical generated by the mainmast and the distractive and noncomplimentary conflict of a divergent hull knuckle line and main deck sheer line.

** With respect to the CPF - The baseline design referred to here was that produced by the Director of Maritime Engineering and Maintenance staff for the feasibility studies. It may not bear any relationship to the final design.

FIG. 17 CANADIAN PATROL FRIGATE BASELINE
NO. 5 JAN 79

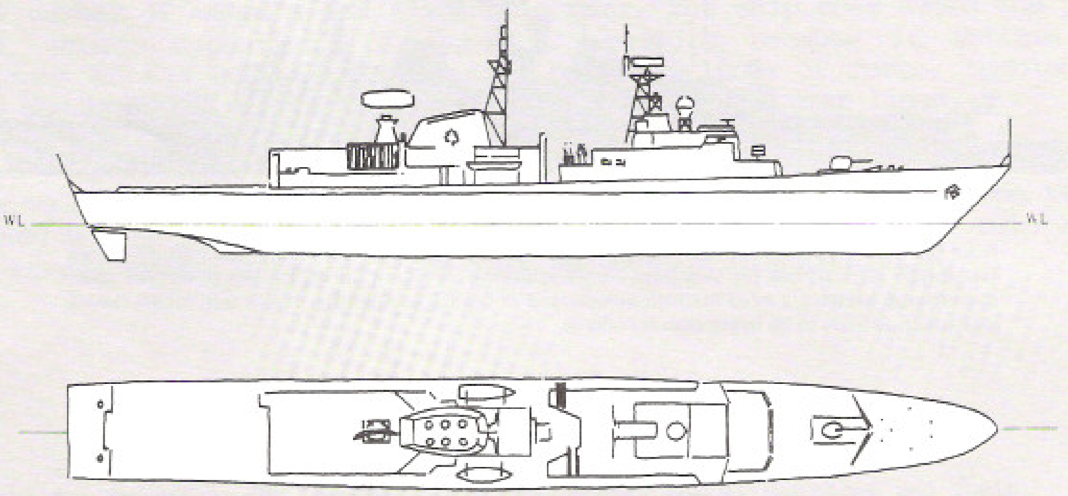
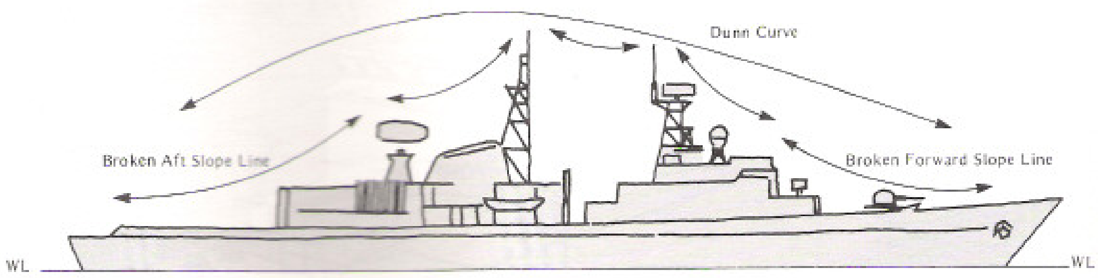
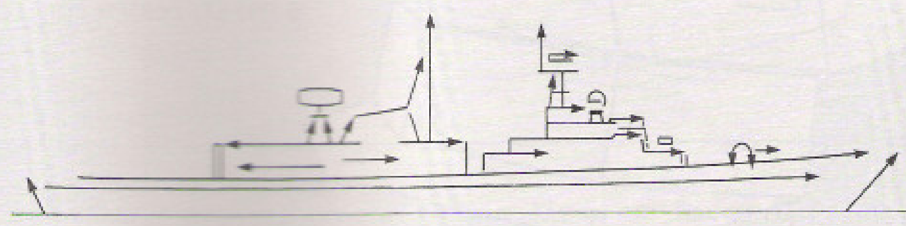


FIG. 18 CPF PROFILE



Note: Because of the Large Stack, mast arrangement, and distance between Pilothouse and stack, there is split focus which pulls the eye aft towards the stack and AN/SPS 49 Radar. This effect makes the ship appear to be slower than if the focus were forward.

FIG. 19 LINES OF FORCE BASELINE CPF

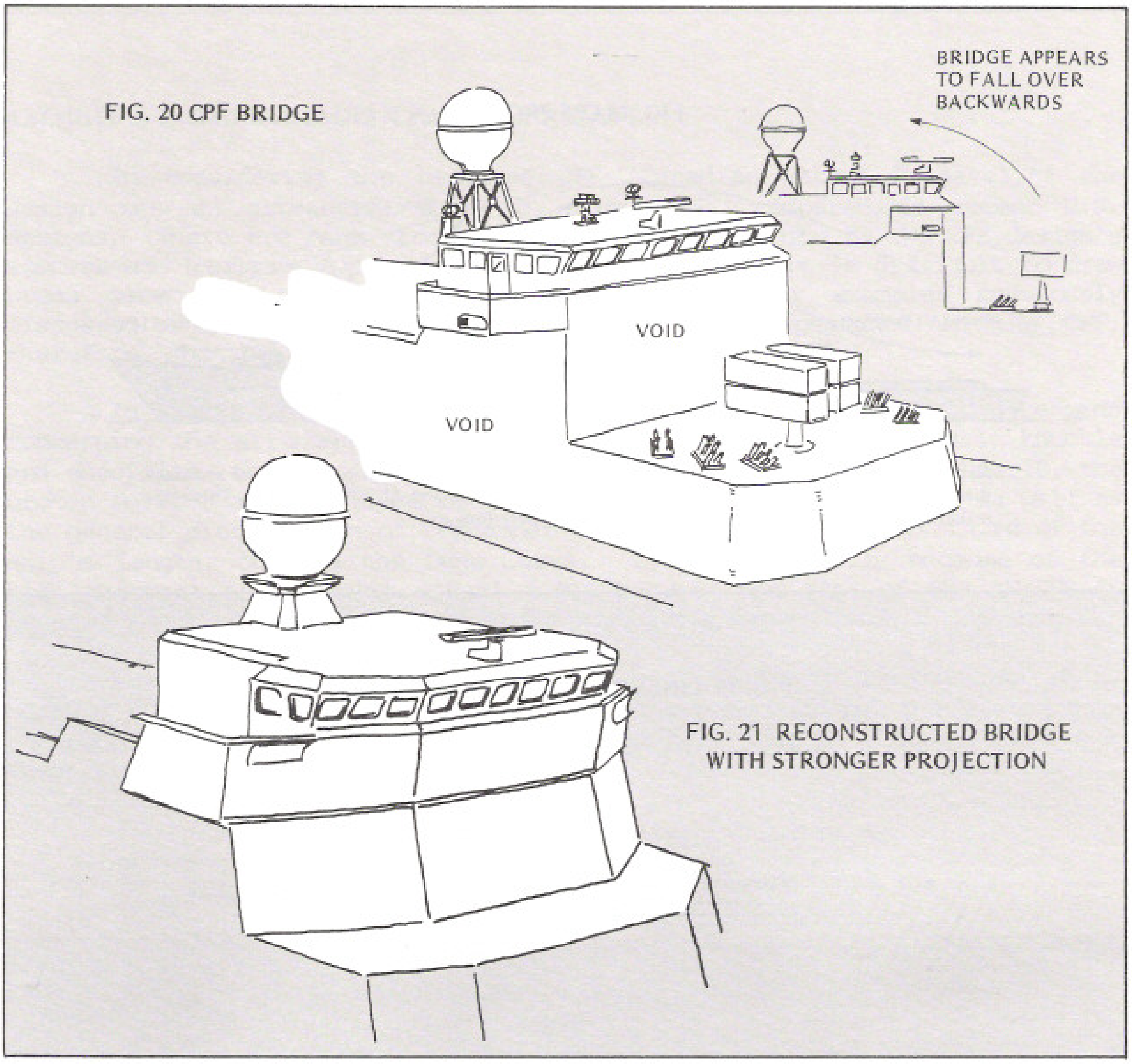


In order to attempt to improve the CPF aesthetic appearance the following changes were made to the design:

a. Figure 20 shows the current pilothouse, its large flat front and the appearance of falling backwards upon itself. Therefore the pilothouse and associated deckhouse were moved forward and modelled to accentuate a horizontal thrust as seen in Figure 21. Care was taken not to provide an abrupt change in silhouette and the impact of interval was carefully addressed.

b. The ASMSDS Launcher was relocated aft over the hangar replacing the AN/SPS-49 antenna.

c. The foremast was moved aft but kept well aligned with bulkhead supports below.



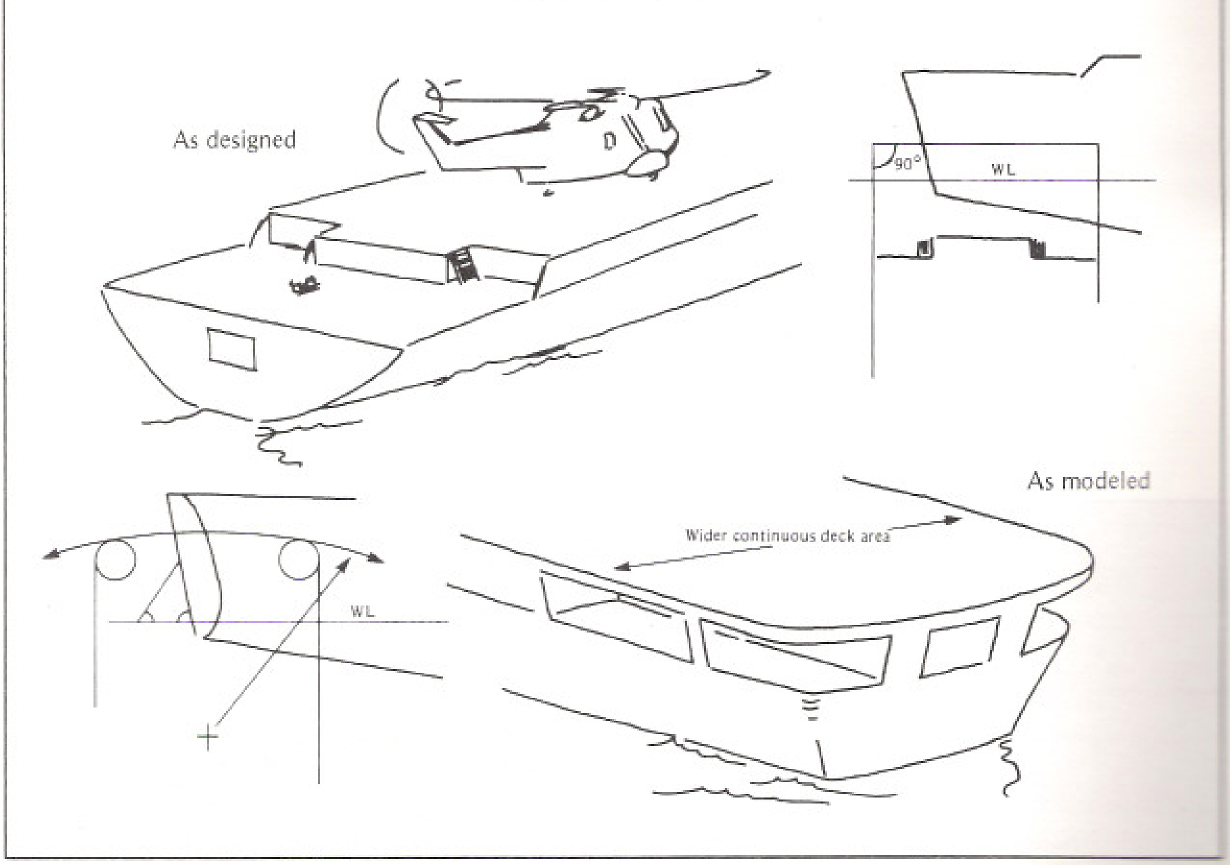
d. The AN/SPS-49 was tiered between the WM25 dome and the foremast on a stylized stub deckhouse which was integrated with the ECM antenna supports.

e. The Harpoon quad launchers were relocated outboard P/S providing forward thrust and an increased degree of ominousness.

f. The Flight deck was made flush to the transom which was reshaped as shown in Figure 22. Recessed Line handling areas were provided below on the Second Deck. The Knuckle Line was dropped down to line up with these openings and followed the run of the Second deck forward with a slight rise at the bow.

g. A stylized fiberglass shield was developed for the 76 mm gun mount to improve its appearance.

FIG. 22 CPF STERN

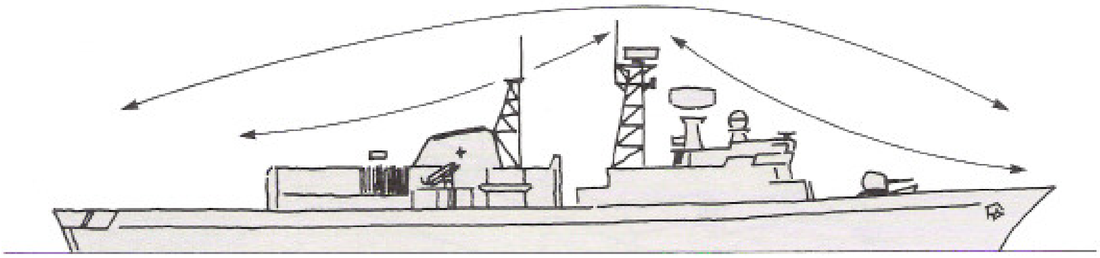


The resulting changes to the ship's lines of force and Dunn Curve are shown in Figures 23 and 24, and the comparative silhouette (before and after) are shown by Figure 25.

Other possible styling changes were considered but not included in the new design. For example, as shown by Figure 26, a flat plane knuckled stack might provide an interesting alternative to the current configuration. Figure 27 illustrates the possible use of MACKS (combined/mast/stack) in lieu of the truss work structures initially selected.

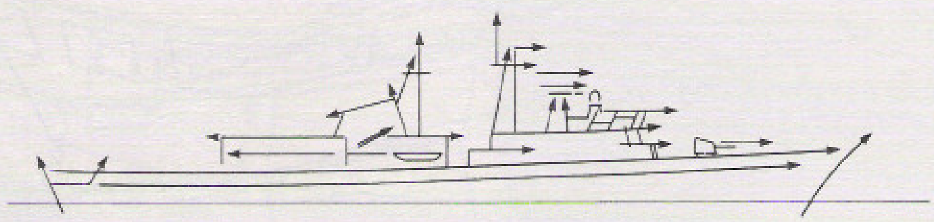
From an engineering standpoint it is judged that most of these changes will have a negligible impact. Indeed, as proposed, the weapon and sensor coverages, particularly for the WM25 and ASMSDS, are substantially improved. All sensor masts and deckhouses are located over transverse bulkheads in the superstructure and hull. One problem might be the provision of adequate vertical and lateral structural support along the proposed deck house front from the 01 to the 03 levels. While aligned with a web frame this does not presently align with a hull bulkhead located below the main deck. This might cause problems for the required transfer of lateral nuclear air blast loads and accordingly require further study.

FIG. 23 REALIGNMENT OF SUPERSTRUCTURE TO FOLLOW THE DUNN CURVE



Note: 1. Center of focus is concentrated in area of Pilothouse and the AN/SPS-49 Radar
2. Improved forward & aft slope despite mizzen mast
3. Coordinated knuckle and sheerlines relieve highsides and accentuate horizontal Lines of Force
4. Forward thrust of Pilothouse seems to pull the ship forward

FIG. 24 LINES OF FORCE STRENGTHENED



Note: Lines of Force visually pull the ship forward and give the ship a more dynamic quality

FIG. 25 COMPARATIVE SILHOUETTE

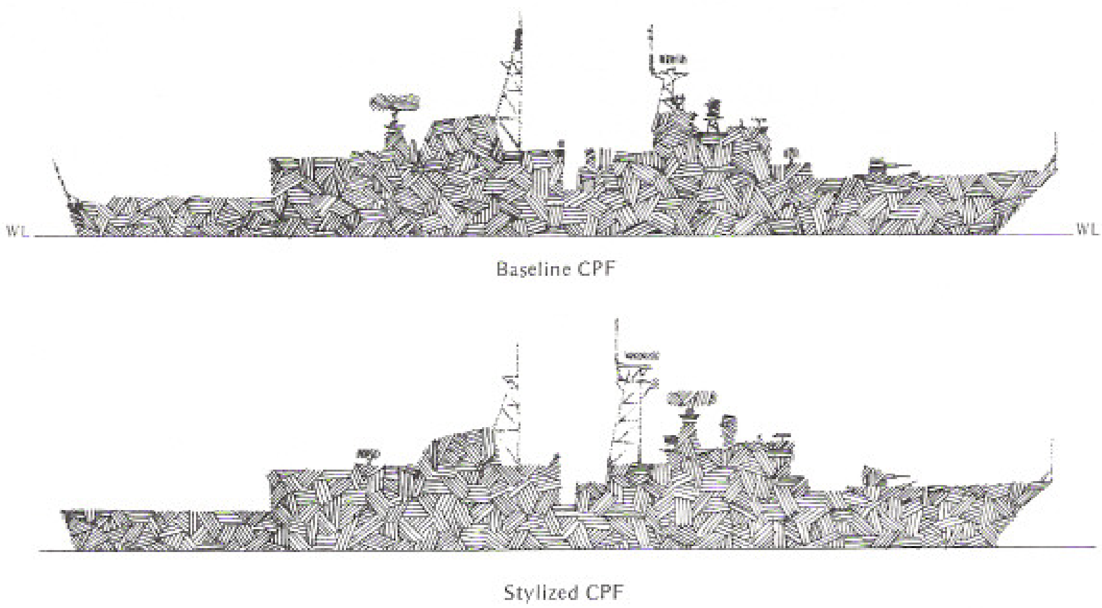


FIG. 26 CONFIGURING A GAS TURBINE STACK

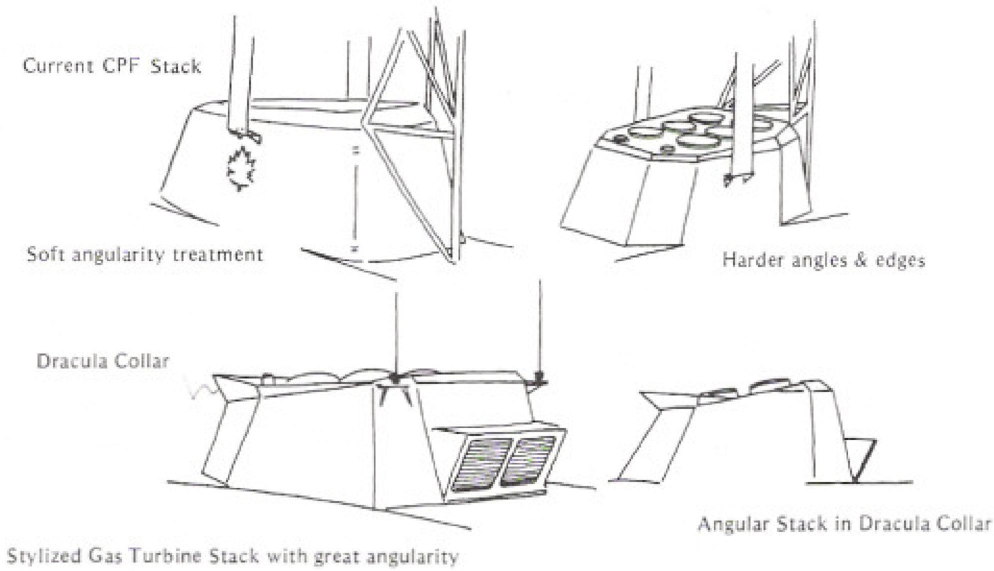
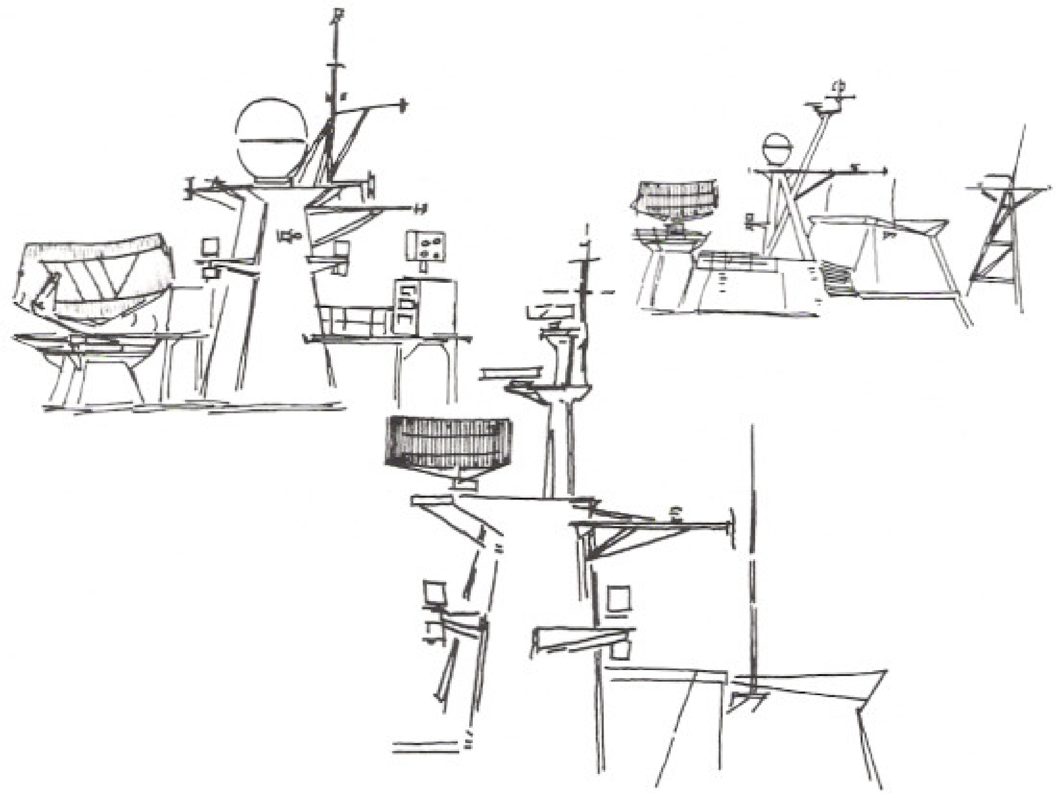


FIG. 27 LIGHT PLATED MACKS & STACK ARRANGMENTS



THE IMPACT OF AESTHETICS ON FUNCTION AND COST

Appearance cannot be bought like so many nuts and bolts. It must be engineered into the design from the very beginning and not as an added on feature or afterthought. For this reason, employing stylists who can only deal with the superficial and not the engineering concepts as the design evolves should be avoided.

It is our judgement that within narrow constraints, improved appearance, including major changes to the inboard profile, can be obtained at relatively low cost. There is an impact - but it is small, relative to the total ship cost. Appearance can be bought, but only if it is a stipulated customer requirement.

Why then is it that many recent warships appear to fall short of these ideals? There are perhaps several reasons which contribute to the problem. One is not having appearance as a goal. In conversation with aval architects it is so often said: "If we could only put some more visible weapons on the ship, it would look so much more impressive." The frustration expressed may really be one of not having a clear idea as to what a modern warship should look like, because there is yet to be established a firm lexicon of design solutions, the use of which can lead to an effective appearance in warship design. But the biggest impediment seems to be the idea which some engineers use as common justification for appearance, that "form follows function."

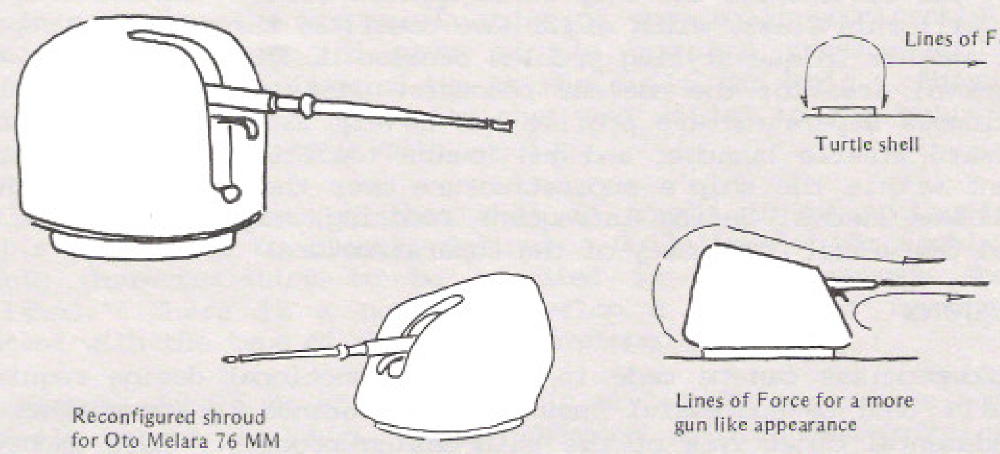
In advanced technological societies there is a strong cultural bias for such a myth. For example, there is "beauty in that which is functional." Unfortunately, should we fail to grasp the significance of a purely functional form, our opinions are dismissed as being ignorant of what constitutes good design. This attitude tends to ignore the fact that not everything that is functional is beautiful, or that people do have preferences and expectations of forms to perform certain functions.

The idea that form follows function is the result of an overly simplistic defensive attitude that if it is "right" in functional engineering terms then it is necessarily aesthetically right in form. This point becomes further confused by the coincidental beauty which we may discover after the fact in some objects, and more often out of our natural desire to see something beautiful in every object, even if it isn't. Form does have its roots in the functional, but aura is demanded if the form is to have appeal. What is lacking in the equation "form follows function" is that only some forms follow certain functions. To be appropriate, an object must have an emotional relevance to the viewer.

An illustration which may make this point clearer as to what seems appropriate is the new Otto Melara 76 mm gun currently mounted on the CPF. As shown in Figure 28 it is a design which is meant to function as a gun but which gives an impression of being an overturned coffee cup with a soda

FIG. 28 BOLT DOWN SHROUD FOR

THE OTO MELARA 76/62 ANTI-SHIP ANTI-AIRCRAFT MOUNT



straw stuck through it. The lines of force work against each other and a strong, lethal compositional theme is not generated. Had the shape of the gun been designed to convey a visual message of being capable of great harm, the shape would be more like an Army Leopard tank turret instead of a coffee cup. The lines of force of the 76mm gun could be redirected by developing a new shroud which better conveys the message of being a gun.

There is one last point to be made about achieving an appropriate appearance to project an image. The inner cohesiveness of a composition, whether it is a 76mm gun or a ship design with many parts, is a function of these parts. Large or small, a design must seem to work together if a successful result is expected.

There are several other factors which appear to influence a ship's appearance. One consideration is the apparent bulk of our ships, or as some would say, "They no longer have a long, low, sleek look." An examination of the relationship between total enclosed volume and displacement, e.g., the density of newer ships, indicates a definite increase in volume per ton of displacement. Lengthening a stocky appearing ship may improve a poor appearance but length is the most expensive dimension to increase and hence is avoided whenever possible. It is thus little wonder that some warships have grown much higher, faster than they have grown longer. It should be noted, however, that in a few instances where a fixed power plant is the only one available, such as a nuclear or gas turbine plant, and a relatively high speed is required, the hulls of war ships have, of necessity, retained the longer proportions.

An example of this for gas turbine propelled ships is the U.S. Navy Perry Class. However, because of the way the superstructure mass and weaponry was distributed the ship still appears bulky. Nuclear ships, such as the California Class, which might have benefited through long proportions present another unique styling problem because of the need to have a clear core removal area for the nuclear reactors. This resulted in a high and discontinuous superstructure profile and a very large clear deck area for the forward missile launcher and gun mount. Judicious placing of internal equipment within the ship's superstructure over the reactors, which would have allowed removal during infrequent recoring, might have significantly improved the visual continuity of the superstructure.

CONCLUSIONS

Compromises can be made in a ship's functional design requirements which will lead to successful results if appearance is accepted as one of the fundamental objectives of the ship design process. More importantly, the appearance of a warship as a credible force with deterrent value serves as a convincing affirmation of national determination and sincerity of foreign policy. In other words, a warship should represent the most convincing commitment, for no matter how sophisticated or primitive the viewer, or how subjective his opinion, the world sees shipbuilding examples and, in turn, forms opinions about the pride and sincerity of the builder.

In order to accomplish this, an effort must be made to reduce a ship's profile. Distribution of the superstructure following the principle of the Dunn Curve, and driving large volume into the hull by stressing horizontal space utilization instead of vertical, is demanded.

Another factor is the constant fight for centerline placement of weapon systems, whereby each weapon system is stacked one higher than the other to secure the widest field of fire. The navigation bridge is then placed in the highest position. All of this contributes to the static verticality seen in some warships. Use of relatively low cost weapon systems, such as torpedo tubes, short range gun mounts, missile cannister launchers, etc., located port and starboard, with the ship's appearance keyed to making these systems highly visible would thwart these tendencies towards static designs.

Another area of immediate improvement in appearance would be to change the idea that all ship surfaces must be flat and weld points made at 90 degree angles. The assumed enhanced producibility and cost effectiveness of these measures cannot be fully substantiated in terms of the overall cost of the ship. By using tumblehome, flare, knuckles, rounding deck edges, and turning corner, the blocky appearance of warships could be improved and their harsh lines softened.

Laying out warships to follow more closely the design principles of the forward and aft slope and Dunn Curve or making the between deck interval, a function of the freeboard would produce a significant improvement in appearance.

In addition, the propaganda value of once again prominently placing the seal of the ship and navy on the bow and transom would leave no doubt in the viewer's mind as to who built the ship. These simple decorative devices could be easily cast and welded to the hull for life as an appropriate touch to a worthy design.

It is also necessary that what is sought to be achieved from a warship's appearance be clearly defined. Guidelines which spell out the desirable characteristics to be embodied in its appearance should be established. There is a need to develop a lexicon of favoured forms consistent with the type of ship being developed.

Weapons should be more consciously styled for appearance and placed prominently aboard the ship. Longer Weapons which appear more effective than those which are blunt, i.e., objects which project, catch attention, and shape the profile of the ship.

Still another beneficial effect which might result from improving the appearance of warships could be the improved confidence of the men who man a good looking ship. A sailor wants to be proud of his ship, and a ship which conveys a sense of purpose and ominous capability is easier to be proud of than one which does not.

Lastly, it must be remembered that an effective warship design is meant to persuade. The warship is a political tool and its greatest weapon is to persuade effectively. Aesthetic concerns reinforce the persuasiveness of a warship, adding credibility to national policy.

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RECENT DEVELOPMENTS IN CONVENTIONAL SURVEILLANCE RADARS

LIEUTENANT COMMANDER G.A. BUCKINGHAM

THE AUTHOR

LCdr G.A. Buckingham received his BSc in Electrical Engineering from Laval University in 1969. He served in HMC ships GATINEAU and YUKON as Combat System Engineer and in NEU(P) as an EW project officer. From 1980 to 1982 he was radar project officer in National Defence Headquarters (DMCS 4). He is currently employed in the Directorate of Technology Application (Maritime) a "Development" division of the Chief of Research and Development (CRAD) Branch in NDHQ.

ABSTRACT

Although the current electronics literature is replete with technically feasible proposals for new surveillance radars, only a few of these ideas have actually been incorporated in production models over the past decade. Of course, there have been major developments in the Western World such as the United States Navy's AEGIS system which incorporates an impressive display of technology and a prodigious amount of signal processing. However, there are significant technological developments which have been included in the design of smaller radar systems. It is the intent of this paper to focus on three specific developments which have contributed to the marked improvement in performance of shipboard surveillance radars.

The first of these is the Travelling Wave Tube, which because of its excellent performance over a wide band of freqencies at moderate power has lead to the inclusion of frequency agility in several modern radars. Secondly, the use of pulse compression in the receiver has assured the efficient use of average power available in the radar target return. This reduces the requirement for high peak power and the receiver vulnerability to interfering signals that differ from the coded transmitted signal. Finally, the introduction of automatic detection has greatly improved the decision-making ability of a radar system as to the presence or absence of a target in heavy clutter and noisy environments. This paper will provide a brief description of each of these developments and the impact they have had on radar performance.

INTRODUCTION

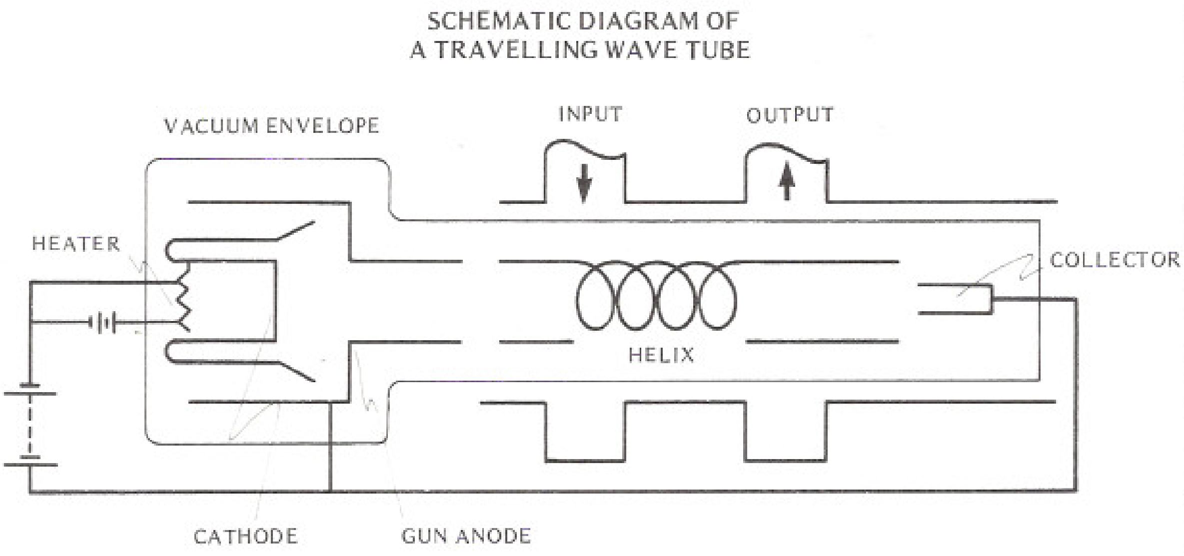
The majority of Combat Systems Engineers in our Navy have, by virtue of their training and experience, obtained a firm grasp of the principles of a basic radar system. However, unless they have specialized in this field, their knowledge is by and large limited to the standard radars fitted in our own ships. Unfortunately, most of this equipment has long since been rendered obsolete by rapid advancements in both radar and electronic warfare technology. In addition, the reduction in the size of air targets (e.g., the radar cross section of anti ship missile is typically 0.1 square meters) and the ever increasing capabilities of Soviet ECM (Electronic Counter Measures) have imposed new criteria on the design of naval surveillance radars.

Recent technological developments have affected every sub-system of the radar set, ranging from the mundane but ever troublesome power supply to the most exotic phased array antenna. However, it is in the less visible areas between the power supply unit and the antenna that many significant changes have taken place. They include the new generation of RF power output tubes, the use of a variety of waveforms and the seemingly endless permutations of signal processing techniques. These are the aspects of modern radar technology which are now being incorporated in surveillance radars with great effect. This paper reviews three specific examples and describes their contribution to improved radar performance.

RF POWER TUBES

For some 40 years the magnetron has been the primary RF (Radio Frequency) output tube used in most naval radars. It is a resonant slow wave structure in which standing waves of electrons are formed by the action of a magnetic field at right angles to a dc electric field. For this reason it has been classified as a crossed field device. Its main advantages have been its compact size, low weight, low operating voltage and high efficiency, in addition to its low cost. However, its disadvantages include the lack of pulse coherence which is required for MTI (Moving Target Identification). This lack of pulse coherence also precludes combining the outputs of two or more for greater power.

While the magnetron will continue to be used in many surface search and navigation radars, it has been superseded in air search radars by the klystron and the TWT (Travelling Wave Tube). Both of these are classified as linear beam tubes, because the magnetic and electric fields coincide. In these tubes the RF fields interact with the electrons causing them to "bunch" as they drift down the body of the structure. In other words the density of the electron beam current is modulated by the change in velocity of individual electrons. Thus, an electromagnetic wave propagates along this distributed circuit with a phase velocity in the axial direction which is small compared to the speed of light.



In the klystron the electron beam passes an input resonant cavity where the input signal modulates the velocity of the electrons. A resonant cavity at the output extracts the RF power from the density modulated beam and delivers the power to the waveguide. In the TWT the RF interaction circuit which is known as the slow-wave structure is either a helix or a coupled-cavity circuit. Use of the latter (i.e. the coupled cavity circuit) has blurred the distinction between klystrons and TWT's and indeed one manufacturer has combined the best properties of each and named it a Twystron.

Although klystrons have seen wide application in radar due to their gain, power levels and efficiency, the TWT has one chief advantage which makes up for its higher cost and slightly lower operating parameters; that is its relatively wide bandwidth. At the power levels required for air search radars, bandwidths of 10-20% are typical. This type of capability is necessary for good range resolution and for frequency agility.

Frequency agility, or the ability of a radar to change its frequency from pulse to pulse in an unpredictable fashion, has the following important advantages:

a. it will fill in the nulls of the elevation radiation pattern;

b. it will decorrelate target echoes which increases the probability of detection; and

c. it is an effective ECCM (Electronic Counter Counter Measure) against spot jammers.

The TWT with its simple modulation and stable operation lends itself to combining MTI (Moving Target Indication) and frequency agility. MTI requires several pulses to be transmitted on the same frequency so that the doppler shift can be compared to a reference signal. The phase coherence of the TWT allows the first of these techniques to be implemented and its large instantaneous bandwidth permits the frequency agile mode of operation.

The following brief survey of naval surveillance radars currently in production or under development attests to the practicality of the TWT in medium power applications. Not surprisingly, the klystron is used in the long range AN/SPS-49 because of its greater power capability. However, both the British RN-1030 and the Dutch LW08 achieve comparable ranges using TWT's. Recent developments in solid state amplifiers may result in more radar transmitters being built around CFA's (Cross Field Amplifier) which are, at present, limited by their lower gain even though their bandwidths compare favourably with TWT's.

WAVEFORM DESIGN

Once the power output has been specified for a surveillance radar, there are a number of techniques which can be employed to ensure the efficient use of the transmitted energy. These include the forming of the RF pulse in the transmitter and the demodulation of the target echoes in the receiver. The parameters to be determined from the target returns are the range (time delay), the range rate (doppler velocity) and the angle of arrival. The amplitude might also be measured, but it is usually only the relative value with respect to the noise level that matters. In order to optimize these radar measurements, the characteristics of the transmitted pulse can be adapted to provide the required accuracy. In conjunction with waveform design, the method of extracting the information in the receiver must be considered as an integral part of the RF subsystem.

Most surveillance radars have the capability to transmit using more than one pulse width. This permits a trade-off between higher power using a longer pulse and range resolution, as well as other properties, using a shorter pulse. To overcome this "either-or" conundrum, the relationship between time and bandwidth can be utilized to combine the best characteristics of both. This is done by modulating each pulse either in frequency or phase to increase the bandwidth of the transmitted signal. Then, using a matched filter in the receiver, the long pulse is compressed to a duration of 1/B, where B is the modulated pulse, spectral bandwidth.

This ingenious concept in waveform design can be used wherever a long pulse must be employed to obtain a large radiated energy simultaneously with good range resolution and range accuracy. Therefore, the radar manufacturers are able to increase their average power (and their advertised range) without a major increase in peak power. Of course, the price that must be paid is the large bandwidth inherent in the transmission of short pulse widths. This is an obvious application for a TWT and it is hardly surprising that this winning combination of RF tube and transmission mode are given top billing in many glossy brochures.

Without delving into the intricacies of ambiguity diagrams, autocorrelation functions and matched filters, two of the more common methods of pulse compression are discussed here. Linear FM, or chirp, is a widely used technique in which a rectangular pulse of constant amplitude is modulated by a linearly increasing frequency. In reception the frequency modulated echo is passed through a matched filter, which is designed so that the velocity propagation through the filter is proportional to frequency. In simpler terms, this is a delay line which slows the lower frequencies at the leading edge of the pulse and speeds up the higher frequencies at the trailing edge. The device primarily used to perform this conversion in radar applications is the SAW (Surface Acoustic Wave) delay line, although charge-coupled and electromagnetic devices have been considered. The advantage of the SAW dispersive delay time are its simplicity, low cost, small size and ease of manufacture.

Another form of pulse compression is accomplished by dividing a long pulse into N sub-pulses and selecting a phase of either 0° or 180° for each. The selection may be done randomly or in accordance with a predefined sequence such as the Barker Code. With moving targets the phase-coded pulse requires a bank of contiguous matched filters covering the expected range of doppler frequencies; whereas the chirp waveform is doppler tolerant in that a single pulse compression filter can be used. The phase-coded pulse is more effective in an EW environment since the coding can be changed to counter repeater jammers. However, the chirp waveform provides a wide bandwidth and most important of all, it is easier to implement.

SIGNAL PROCESSING

Having ensured that the RF sub-system is as efficient as technology and cost will allow, the next stage is to extract as much or as little information as required from all the radar returns. Clutter, whether from land, sea, rain, snow or chaff, presents a major problem in that there is too much information; most of it being undesirable. In the older radars this was combatted by hardware alone, using IAGC (Instantaneous Automatic Gain Control), STC (Sensitivity Time Control) and analog MTI (Moving Target Indication). Of course, one must not forget the stochastically variable, non-linear, adaptive system which still performs the decorrelation of clutter, the integration of target returns and the updating of target tracks aboard our own ships ie, the Radar Plotter with the MK 1 eyeball.

In many applications MTI and pulse doppler techniques used in search radars have been quite similar. The delay line canceller has been widely used in MTI radar as a means for separating moving targets from stationary clutter. This is simply an example of a time-domain filter which rejects the d-c component of clutter. However, it also rejects energy in the vicinity of the prf and its harmonics due to its periodic nature. This gives rise to the problem of blind speeds which can be negated by the use of staggered - prf MTI or even multiple prf's. On the other hand, frequency-domain bandpass filters of conventional design are used to sort the doppler-frequency-shifted targets; however, the filter configuration must be designed to eliminate the "smearing" produced by narrow band filters which will destroy the range resolution. This can be countered by range gating, which is simply the quantization of the range (time) into small intervals and the technique is known as Range-Gated Doppler Filtering.

Once again, there is a trade-off to be made; this time it is whether the radar application is more tolerant to ambiguities in range or relative velocity. By lowering the sampling rate (ie, a low prf) range ambiguities are avoided, whereas by raising the sampling rate (ie, a high prf) doppler frequency or relative velocity ambiguities are avoided. A compromise has to be made which generally leads to the distinction between MTI and pulse doppler radars. MTI usually refers to a radar in which the prf is chosen low enough to avoid ambiguities in range, but with the resulting blind speeds caused by frequency ambiguities. The pulse doppler radar, on the other hand, has a high prf that avoids blind speeds but experiences ambiguities in range ie, blind spots. One additional complication occurs when the motion of the radar relative to the clutter must be taken into account, as is the case with shipborne radar. This necessitates additional velocity compensation circuitry, which is usually referred to as a variable clutter rejection notch.

As in so many other areas of technology, many functions previously performed by hardware or the human operator are now done by digital techniques. For example, a digital MTI processor does not, in theory, do any better than a well-designed analog canceller; however, it is more dependable, requires fewer adjustments and can do some tasks easier. This is simply due to the fact that digital delay lines are not affected by changes in temperature or critical gains. The real improvement in performance is derived from the sophisticated signal processing that can be done once the A/D conversion has taken place.

Although digital signal processing has been applied successfully to other sensors, notably sonar; the high data rates inherent in radar have only recently been accommodated by faster, more powerful processors. As a result Automatic Detection circuitry is only now beginning to appear as an integral part of a radar set. Automatic Detection is normally done in the following stages:

a. the integration of the pulses received from the target;

b. the detection decision, which may use an adaptive threshold to maintain a CFAR (Constant False Alarm Rate); and

c. the determination of the target's range and bearing.

The next stage in this digital processing is, of course, the provision of automatic tracking, which can be initiated after a couple of scans of the antenna. The combination of these two features is referred to as ADT (Automatic Detection and Tracking) and can be expanded to incorporate the outputs of two or more radars, in which case it is called IADT (Integrated Automatic Detection and Tracking). The provision of automatic detection and tracking will overcome some of the limitations of an operator, notably fatigue, boredom and overload. In addition to the actual enhancement of target detection in clutter afforded by MTI or pulse doppler, ADT will improve the overall effectiveness of a surveillance radar system.

CONCLUSION

There is always a time lag between the discovery of new electronic components or techniques and their implementation. However, in the case of shipborne radars both the technology and the equipment are available now. Modern radars which incorporate all the advances discussed in this paper, are coming into service. The first of the new generation of radars to be fitted in Canadian warships will be the CMR 1820 Air Search Radar being developed by Canadian Marconi for the DELEX program. Thereafter, we can look forward to the radars being proposed for the Tribal Class Update and the Canadian Patrol Frigate.

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VARIABLE DEPTH SONAR THE WAY AHEAD

MR. H.O. BAKER

THE AUTHOR

Mr. H.O. Baker joined the RCNVR as an ordinary seaman in June of 1942. His naval career included serving as a Radio Artificer in HMCS ALGONQUIN, as a Radio Technician in HMCS HAIDA and HMCS MICMAC and HMCS MAGNIFICENT, and as a commissioned officer in HMCS MAGNIFICENT and HMCS CRESCENT. While he was in CRESCENT, he was heavily involved in the experimental work being carried out on the AN/SQS 504 Variable Depth Sonar and Interim Handling Gear. Subsequently he was appointed to the Variable Depth Sonar Project Team in the Directorate of Maritime Combat Systems in National Defence Headquarters where he presently works on the Senior Technical Officer in the Underwater Detection section. He is the inventor of a D/F Trainer and a portable accelerometer, both patented; co-author of a report on Shallow and Deep Water Theodolite Tracking Ranges; and a recipient of several departmental awards.

ABSTRACT

In the ASW scenario surface ships must now be able to detect and attack enemy submarines at ranges out to the first convergence zone. In general methods to achieve this are known but difficult to implement. A development plan for the AN/SQS 505 variable depth sonar is presented which will, if successful, considerably improve Variable Depth Sonar performance.

INTRODUCTION

The requirement for active VDS (Variable Depth Sonar) remains apparent when one considers today's sonar developments and the functions performed by sonar in the changing ASW scenario. This paper will discuss one possible active sonar development path that would enhance the VDS performance.

HISTORY

The first Canadian VDS was developed in the late 1950s and early 1960s. In 1960 a crude VDS system, developed by DREA using HMCS Crusader, was installed in HMCS Crescent. During the early sixties various towing and sonar trials were carried out in this ship and many improvements added to the total system. In conjunction with these VDS trials the Design Authority proceeded to let contracts for production systems of both the handling gear and the sonar. Most of the lessons learned during the trials carried out in Crescent were incorporated into the production system, however, the Navy was on the bottom of the learning curve, so that the production equipment experienced many inherent problems.

This production equipment was entitled the AN/SQS-504/AN/SQA-501 VDS system, the first of which was installed in ST LAURENT. While still low on the learning curve with the AN/SQS-504 system, 1963/64, the AN/SQS-505/AN/SQA-502 variable depth sonar was designed. Terra Nova received this much larger lower frequency system during the 1966/67 time frame and carried out a series of trials over the next few years.

The AN/SQS-505 sonar proved to be a great improvement over all the existing sonars but there were still many problems appearing in the towing system. Some of these problems were in the design, a number caused by the technology of the day and a number caused by lack of knowledge of both how to handle the equipment and the limits to which it could be stressed. By 1970 the Design Authority was preoccupied with solving the various technical problems and the requirements people were somewhat disillusioned with VDS, in part because of these problems, so major efforts towards development of newer and better systems came to an end. A shortage of money also contributed to the situation. Only eight ships were fitted with the new hull mounted and variable depth sonars, leaving a hodge-podge of museum vintage systems in the remainder of the ships.

During the 1970s various towing trials and technical evaluation were carried out by the Design Authority, greatly assisted by the National Research Council of Canada. The Defence Research Establishments and the Naval Engineering Units on both coasts made contributions, as did a number of people from Industry. The problems of handling towed sonar systems came to be much better understood, and modifications to the present AN/SQA-502 Hoist systems were developed, along with appropriate instrumentation. HMCS RESTIGOUCHE has received the first modification kits and these along with instrumentation now out to contract will be fitted in all AN/SQS-505 VDS ships as fast as circumstances will permit.

In the seventies technology advanced at an extremely rapid pace. Computers became smaller, more powerful and many times less costly. Programming languages and techniques allowed a vast increase in the application of computers to controlling systems and analyzing data. The development of practical fibre optic systems is causing an explosion in the field of data transfer. The development of new sensors, hydraulic components and materials has also gone ahead and the technology of the 1980s will appear revolutionary compared to that of the 1960s.

VDS IMPROVEMENTS

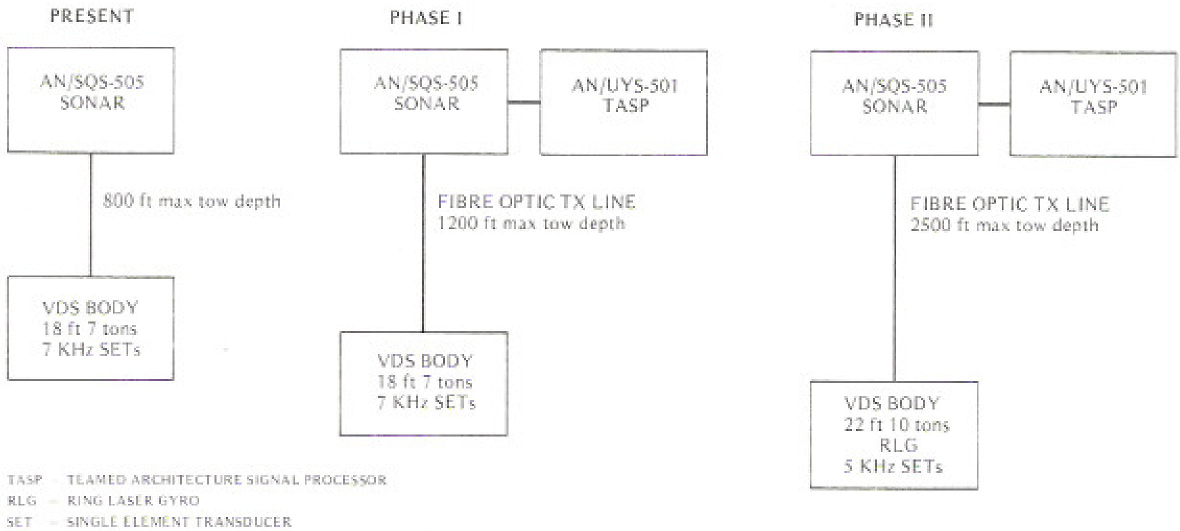
Recently the Design Authority has commissioned studies of new concepts with relation to sonar. Some of these concepts are related to the improvement of the present AN/SQS-505 sonar system, others to the development of a complete new system. The first improvement has been the introduction of the AN/UYS-501, a powerful signal processor built by ESE Ltd which can analyze sonar signals 6 to 8 dB below those detectable by the present AN/SQS-505 receiver. A further improvement can also be expected by the use of fibre optics in the cable. It appears that this change would make it possible to send the received signals from the VDS transducer without cross talk, copper heat losses or electron noise generated in the copper affecting the return signals.

The use of fibre optics in the cable will require that the receiver pre-amplifiers be in the body. This is feasible and, in fact, there is room for a pre-amplifier for each SET (Single Element Transducer). This again will improve the receiving system as the signals will be amplified before any amount of electron noise is added. After amplification it will be necessary to multiplex the 360 SET signals before sending them through the optical fibres in the cable to the ship. It is intended to initiate a design study for a multiplexing system in the near future. As multiplexing of data has become a fairly standard technique, design problems are not expected to be serious.

After multiplexing the signal must be transformed from electrical to optical signals. Recent advances in LED and LASER technology make this requirement more of a fit and form development rather than a new technique development. Also today's lasers and fibre optics have gigahertz bandwidth. The AN/SQS-505 sonar signal transmission requirements are for about 120 megabits per second. In addition to the 360 SET signals received the AN/UYS-501 will require data as to the perpendicularity of the transducer face at the time the signals were received. A study had been commissioned to investigate the use of a RLG (ring-laser gyro) system as a replacement for the present heading gyro. This would allow the attitude of the body, both in pitch and roll, to be known at all times. The pitch and roll information, multiplexed with the sonar signals, would allow the AN/UYS-501 to process the received signal beams, removing the effects of body pitch and roll. A tremendous improvement in VDS receiving ability, especially in the fore and aft directions, is expected in rough weather and shallow towing conditions through the use of the beam forming technique.

As the RLG can sense the attitude of the body to within fine limits it is intended to develop a transmitter inhibit circuit that will allow sonar transmissions only when the body attitude is correct, reducing the effect of roll and pitch. This will keep the sonar beam in the intended plane and will greatly improve VDS detection capabilities, especially in the fore and aft directions during rough weather and under shallow towing

VARIABLE DEPTH SONAR
DEVELOPMENT PLAN



conditions. The RLG is basically an inertial navigation sensor. It is therefore envisaged that it will be used to measure its position, ie, direction and distance, from the ship's tow point. This information will be used to give a more accurate fire control solution as well as to monitor cable and body towing characteristics. The RLG can be expected to drift a bit thus it will be necessary to develop a system for transmitting corrective data from the ship to the body via fibre optics. This will require a LED or LASER transmitter unit in the ship and an optical receiver unit in the body.

In order to couple signals to and from the cable and the body and from the cable and the ship it will be necessary to develop connectors that carry both electrical and optical signals. The improvements that have occurred in fibre optics connectors and the reduction in copper conductors made possible by the use of fibre optics for reception makes it possible to use the present well proven connector shells. This problem is to be addressed in the cable study.

The present cable is 975 feet* in length. A little more than 800 feet of this can be wetted, thus maximum towing depth at normal speeds will seldom be more than 700 feet. A contract is being let to design a drum containing 300 feet of unfaired cable and 1,500 feet of faired cable. This drum, capable of being fitted in an IRE or DDH 280, will allow towing down to 1,200 feet, the maximum operating depth for the present transducer. This modification should allow VDS to be operated in favourable velocity profile waters over at least two million more square miles of ocean of Canadian interest.

* Editorial Note: Due to the history of this subject all distances and weights are in British Standard Units.

These improvements, coupled with the handling gear, body, fairing and instrumentation improvements now under way will do much to increase the active sonar capabilities of the AN/SQS-505 fitted ships.

NEW VARIABLE SONAR DEPTH SYSTEM

Looking at all the aforementioned AN/SQS-505 improvements it is easy to see that one is well on the way to the design of a new system. The goal is a lower frequency system, say 4.8 to 5 kHz with vertical beam steering and capable of being towed at 3,000 feet in sea state seven. To achieve this goal some development work will be required such as a new body 7.3 feet in diameter, 22 feet long and weighing as close to 20,000 lbs as possible. This weight is required to keep the system from being cable dominated. The large size is required to house the 4.8 to 5 kHz transducer and provide enough space in the cavity for the required electronics.

In addition an efficient single element transducer, will be required, capable of operating to a depth of 5,000 feet. It is desirable to house the SET magnetics and the power amplifier transmitting electronics in the SET frame. However, if this is not possible there should be room in the body cavity. The associated drive circuitry including charge coupled devices, necessary to drive the SET power amplifiers must also be developed.

Next in line for development is the computer which will receive data from the RLG and instructions from the ship, and will be used to set up the SET transmitting sequence so that the transmitted beam will be at the required angle regardless of body attitude.

Development should also be undertaken to produce a power supply to energize the transmitting system. This supply would be required to transform 440 volts 400 Hz 3 phase power delivered to the body to the appropriate DC potentials and supply up to 100 KW of peak power for up to 500 milliseconds with acceptable droop characteristics. The same supply would generate the computer, pre-amplifier, RLG, multiplexer and body sensor power requirements.

Last, but certainly not least on the development list is the handling gear. This should be capable of storing 3,500 feet of faired cable and removing 22 to 24 feet of ship's stern vertical motion from the ship's tow point. Ideally this system should be at least 30% power assisted. The basics of such a system have been worked out by the Design Authority and Industry and it is considered that the system would fit into a DDH 280 without too much requirement for ship alterations.

A system as described above would require special instrumentation to allow cable tensions at the ship end as well as the body to be measured. This is necessary because during shallow towing in heavy seas high cable tension can be generated at the body tow point, whereas during deep towing the sum of the cable weight, body weight, body drag and the cumulative cable drag may cause the cable to part at the tow point at high speeds. For example, the steady state speeds may be 12 knots for 3,400 feet of cable out, 15 knots for 2,500 feet of cable out and so on.

SUMMARY

The Design Authority is well on the way to giving the operator a much improved AN/SQS-505 VDS system. As we proceed with the new body and handling gear developments we should be able to install an active sonar system into a ship that will allow reliable acoustic path detection, 30,000 to 60,000 yards, of a 10 dB target in most of the waters of Canadian interest ten to twelve months of the year. We think that you have put up with the old equipment long enough. Finally it should be noted that this dissertation has not touched on planned allied equipment improvements such as 2,000 metre velocimeters and digital bathy/velocimeter recorders, displays etc., which are all necessary ancillary equipments for successful ASW operations.

THE MARE CONFERENCE 1982

REVISITED

COMMANDER RHODENIZER

THE AUTHOR

Commander R.J. Rhodenizer received his B Eng degree in Mechanical Engineering from the Royal Military College in 1971. He served in various east coast destroyers and worked in the Halifax Dockyard before assuming the duties of Engineer Officer of HMCS FRASER between 1975 and 1976. He received his MSC degree while on the Dagger course at the Royal Naval Engineering College Maradon and has worked on such marine equipment projects as the PROVIDER RAS System Update, Marine Spey Gas Turbine Development and SHINMACS. He is currently a Section Head responsible for Auxiliary Systems and Deck Machinery and reports to the Director of Marine and Electrical Engineering in National Defence Headquarters.

ABSTRACT

The third Maritime Engineering Conference was held in Halifax, N.S. in June 1982. Approximately 215 members of the MARE profession attended this conference from each coast, NDHQ and field units. The conference was opened by Vice Admiral J.A. Fulton, the Maritime Commander and Commodore E.C. Ball, Director General Maritime Engineering and Maintenance. Technical sessions were held in each Maritime Engineering sub-classification and a general session addressed items of common interest to all MAREs. The social program provided ample time for meeting and discussing various topics. The program was a resounding success due mainly to the efforts of the organizing committee. After three days of presentations, discussions and socializing Commondore Ball brought the conference to a close. He gave special thanks to all who had prepared papers by saying that he was impressed with the overall quality of the presentations and he encouraged those who did not write papers to try and do so in the future.

INTRODUCTION

This paper was written with the aim of documenting some of the ideas presented at the 1982 MARE Conference. Section head lines are the thoughts this author took away from the conference. The paper's central theme is the state of the Navy and the Profession as seen by senior management. Supporting details are provided including a sumamry of the general papers and each technical session.

.......exchange of ideas......

Throughout the conference everyone got involved, discussing technical, personnel and career matters. The conference was an excellent forum for information exchange amongst all MARE's. At night "Over-the-Bar" discussions continued on the ideas put forward in that day's sessions, and the future of the branch in general. The social program effectively supported this informal discussion. Delegates generally seemed to feel free to express their personal concerns for the branch to Senior Management and many got a chance to comment on MARE activities and to seek advice. Senior Managers were very tolerant and listened to everyone.

. . . . . NARCs better in 84 . . . .

The Naval Architectural Session was chaired by Captain Gruber in his capacity as Naval Architect-in-Chief. After speaking briefly on the state of the profession and the way ahead he launched the NARCs into a series of papers that were well-presented, well-received and lead to some lively discussion. The amount of effort so obviously put forward by the participants was appreciated and they were appropriately commended. The civilian/military mix was particularly encouraging as it clearly demonstrates the professional depth of the branch and the cross pollination necessary to maintain it. The Captain closed the session with a short summation and encouraged all present to take away the lessons, problems and ideas discussed; to develop their solutions and thoughts on the various subjects and return to the next MARE conference prepared to make a presentation. He outlined the difficulties in exceeding the high standards set by example in MARE 82 but tasked all to strive towards that goal.

. . . . . CSEs program too full . . . . .

The day-and-a-half Combat Systems Session was intellectual and stylistic to say the least. The large number of papers submitted demonstrated the breadth of the Combat Systems world and the skill of the practitioners of the art. The session was opened by the Director of Maritime Combat Systems, Captain Dean, who fills the senior purely Combat Systems job in the Navy. He emphasized the need for imaginative contributions from all CSEs to solve not only future problems but also present ones. The session consisted of a strong mix of subject matter. Representation was also well mixed including military/civilian, experience levels, and coasts/headquarters background. The program was, if anything, too full; many discussions had to be terminated before all the questions and side-issues had been satisfactorily explored. One obvious and serious lack was input from CSEs on problems with the current fleet; this was surely due to a lack of time and not a lack of material! Looking forward to the next conference in two years' time, there could be a very serious problem in selecting papers for presentation from the dozens which will be offered. A good paper usually takes six or more months from idea to completion, because the contemplation process essential to clarify an idea. Therefore, the challenge was issued "Start this contemplation now so that your paper can be one of those presented at the next MARE conference".

. . . . . MSEs, the full spectrum of technology . . . .

The Marine Systems Session was conducted under the chairmanship of Captain Reilley, the Director of Marine and Electrical Engineering. The Captain charged the assembled delegates to move forward in the profession and remain as far ahead as possible in the full spectrum of technology. The presenters from MARCOM, MARPAC and NDHQ were joined by Lieutenant Commander Scholey who was on exchange at RNEC MANADON. The pace of the papers provided ample time for questions and comments. While agreement was not always reached, mutual understanding of points of view and problems was achieved. The presence of the other disciplines, Combat Systems Engineers and Naval Architects, although small in number added to the effect of the session. It is hoped that at future conferences some of the junior members will take part and more of the "coal face" problems will be addressed by presentations from serving engineering officers. It is appreciated that those at sea have little time, but that "bee-in-your-bonnet" that was so eloquently expressed during the informal discussions would have made an excellent paper and provide an increased scope for discussion. The Marine System Session closed with further discussion of Captain Bowkett's presentation on the results and implications of the MARE study.

. . . . . USSR has a "Blue Water" Navy . . . .

Admiral Fulton, in his opening speech addressed the threat of the USSR. He indicated that the USSR ship developments including cruisers, carriers, submarines and supply ships, have given her a truly "Blue Water" Navy. He pointed out that the USSR economy though weak will go on and should not be expected to collapse. Changes in leadership in the USSR can be expected which may bring new difficulties but these cannot be predicted the Admiral added.

. . . . . Falkland Crisis will have a positive effect . . . .

In the West the Admiral suggested the Falkland Island engagement will open everyone's eyes to general Naval Requirements. However, he cautioned everyone to be careful not to believe all that the press has written on the subject. He went on to say that much detail remains to be sorted out and the full story will only be available in the future. The Admiral said he believed that the Falkland Island Crisis will positively affect the Senate Sub-Committee on defence in the Navy's favour. Two specific items he did mention were the relative performance of the various surface ship missiles and the effect of a lack of British tactical air and good AEW (Airborne Early Warning) cover. Commodore Ball also addressed the Falkland Crisis noting that when the RN provides details of the results of boards of inquiry much more can be said. He pointed out, in the mean time, that the public discussion on alumnimum is over simplified. The vulnerability/survivability problem is much more complex than that, he said, and the sooner it is understood and integrated into our thinking, the sooner make real progress will be made.

. . . . . inflation makes the problem worse . . . .

Returning to the Canadian scene Admiral Fulton said we must reduce our expectations. The state of the economy and the low dollar value will put procurement of some off shore equipment out of reach. Inflation at the same time, he said, will make the problems even worse. He felt that senior management will do all it can to protect the CPF project. However, he indicated that the spiralling cost of the CF 18 will have a negative effect on other projects. On the brighter side the Admiral referred to many visits he had made across the country in the last year. In conversation with people from all walks of life he got the impression there is a true concern that Canada should have an efficient and credible defence force. He commended the efforts of those involved in the destroyer boiler problems and noted that this has made the public more aware of our problems.

. . . . . navy course carefully set . . . . .

Admiral Fulton said that the future course of the Navy in Canada must be set very carefully. In this respect he said the Naval Board consisting of CMDO, MARCOM, MARPAC, DGMEM and COS MAT convenes quarterly to discuss new programs and projects.

. . . . . food for thought . . . . .

Commander Taylor, with significant support of his staff and others in the Command, presented "The Marine Weapons Platform". This paper proposed an alternate approach to warship design which disregarded all the traditional concepts of manning and operating a warship. The result was a fresh look that provided much food for thought. It has been suggested as preliminary reading for those joining the Naval Requirements Staff. Commander Preston's "USN Ship Design and Construction Programs" enlightened the audience of the USN activities to build up a 600 ship navy in support of the 15 Carrier Battle Groups which will be the focus of future US Seapower. The paper also described planned action groups, amphibious forces, convoy escort groups, underway replenishment groups and future submarine forces. The paper described the process proposed to build up these capabilities. The author stated the USN has the capability and the will to build up such a force and predicted that the next five years will be busy and challenging both for the US Navy and American Shipyards.

. . . . . praise in public, criticize in private . . . . .

Commodore Ball took time in the conference to suggest where initiative should be taken and would likely pay off. However, he warned that we must be careful of our attitudes. He suggested that the following tips should be helpful:

a. The other guy is just as smart and just as keen as I am! (A broad mix of educational backgrounds and levels of experience are an asset to the Classification. We need both highly educated and experienced engineers and at the same time keen young people to replace them as they leave the service).

b. Why don't we . . . .? (Keep an open mind - look at policies, technology and their application to see how we can improve our way of doing business).

c. What needs to be done here, now? (Take charge when necessary).

d. Leave the space in better shape than you found it!

e. What would I do if I were Cmdre ----, Capt(N) ----? (then tell him politely!)

f. Praise in public, criticize in private.

g. Build the credibility of your superiors. It is the source of their effectiveness to act on your behalf.

h. Look to your brother engineers and naval officers as a reminder, it is one Navy. Look to your professionalism as naval officers and do not hesitate to remind those who question your fitness to command men that you are a naval officer too. Do them one better at their own business.

. . . . . need for all the talent available . . . . .

The Commodore also had other words of wisdom as he noted that the Branch is short some 45 officers to fill hard engineering billets. He went on to state what he understands the general dissatisfaction to be and what we can do to improve the situation. In particular he suggested the following:

a. Get at the truth - "It is not the things that are true that cause problems, it is the things that people think are true that are not."

Ship Design Policy - We did the CPF Concept Design and are in on the evaluation team and we may yet be fully involved. From the DD 963 experience we know there will be a need for all the talent available and thus a need for our involvement. In addition we are designing TRUMP and the NATO Frigate Replacement.

Second Class Citizens - What makes us think we are the only ones needing/lacking recognition? This is the state of almost 100% of the populace! We are second class citizens only if we accept it.

Promotion Opportunities - Up to the rank of Col, MARE is as good as, or better than any other classification, other than specialist officers.

Promotion System is stacked - We promote off the top of the merit list. The francophone "dip" is protected. Just like all others, CFR's compete on merit 80% and potential 20%.

Best jobs go to others - We are prepared by education, training and experience to tackle the most forward looking tasks. We must cultivate an attitude that we will accept the challenging tasks and find a way to look after the less challenging tasks. We must resist and correct any tendency in ourselves to accept that we are too busy, too preoccupied, or too understaffed to tackle the best jobs.

b. Attack Causes which can yield

Unwieldly Decision making system - In the majority of cases our ignorance of the system, and our unwillingness to find out how it works so we can make it work for us, is the culprit. Do not be afraid of intelligent shortcuts. Use your full authority and rank. You do not have to bulldoze or bully. Do not be afraid to make a wrong decision. Give your staff room to make a mistake.

Interference in your job - Politely but firmly identify when others are interfering in your area of responsibility. Do not use your authority outside your sphere of responsibility. If this interferance persists, escalate it.

Reluctance of superiors to act - We should acquire our superiors perspective. If the problem still exists use an alternate channel like MARE seminar, a word to a MARE council member, a trusted confidant. Put it all together and put it in his hands Often we unrealistically expect our bosses to do our staff work.

c. Face Reality - "Really, there are some things that cannot be changed easily. They must be accepted or worked around since they are not readily surmounted."

Pay - There is no money for massive pay increases. A pay increment for engineers, much as it would help, is highly unlikely in the foreseeable future.

Language Policy Priority - This is dictated by government policy reinforced by the Minister and is not negotiable. That makes it a political question subject only to political approaches and solutions. My input in that sphere is exactly the same as your own.

. . . . . MARE training is changing . . . .

Admiral Fulton in his remarks noted that feedback from STANAVFORLANT indicated Canadian MAREs and Technicians were doing well compared to those of other nations in the squadron. He indicated he was happy with the way MORPS is proceeding and pleased with METTP. He would however, like to see greater numbers in the METTP pipeline. With respect to recruiting the Admiral felt it is going well but we must now find better ways to bring people into the service. Commodore Ball pointed out that the MARE Study was to be reported at the conference for the first time. He said it was not a catalogue of ideas with instantly acceptable "flashes-of-brillance" solutions. It is a bottom up, broad perspective on what we do, career progression and possibilities, and classification structure as a baseline for our future. He added that CSEs have overhauled their classification training and reduced it by at least 40%. NARCs too have streamlined their training. Now the challenge is on for the MSEs. The MARE study will show the way. Accreditation, he pointed out, is progressing but needs more attention by the CS trades.

. . . . . professional standards? . . . . .

Many discussions at the conference hinged on professional standards. What should and shouldn't be done in the branch, etc. The paper that most typified this interest was that by Lieutenant Commander Mack. "The Marine Engineering Fraternity: What Maxims Have We Forgotten". It made us all take a step back and look at ourselves, to consider what we should be doing to improve and maintain professional standards and our performance as responsible leaders. This paper is highly recommended to anyone who has not read it.

. . . . . Canadian Forces must be ready to fight . . . . .

Commodore Ball indicated we are in very difficult times rising out of economic, social and political upheaval. He said it is imperative that our armed forces be ready and able to move and fight if necessary. He went on to note that the CPF is on target and in good shape. "There are treacherous shoal water ahead but there is a good pilot, captain and an experienced crew on board". In addition he pointed out that the NATO Frigate Replacement project is coming to a critical stage of feasibility study and national commitment.

. . . . . refits, dockyards and submarines . . . . .

Captain (N) Wilson's paper "Ship Refits in the Canadian Navy - Past, Present and Future" dealt with the development of surface ship and submarine refit policy over the years and included a brief reference to USN and RN policies. In addition the paper examined some of the more general refit matters such as resources, planning and refit management. He concluded that the correct formula for the maintenance cycle of the steam destroyers has now been found but regretably just as they are about to be phased out. Commander Richards' paper "The Halifax Dockyard Development Project" covered CFB Halifax Development is general and the SRU(A) Jetty Two Project specifically. It is planned to spend $318 M (budget year) dollars on Base Development of which $192 M is already approved. This expenditure will result in a much improved capability to meet the challenge of supporting a new and modern Navy. The final paper, by Lieutenant Commander Wiseman, dealt with the acquisition of new submarines in the CF, "The Canadian Submarine Acquisition Project (CASAP)". The plan is to produce new submarines by the 1990's to replace the three Oberons. This project will attempt to maximize Canadian content in the design and construction where possible.

. . . . . all not rosy . . . . .

Commodore Ball warned that all is not rosy even though there are exciting new activities going forward. He warned that the cost of new weapons and maintaining the old will increase at a rate in excess of inflation and the resources provided will not meet the needs. In this environment the Navy faces an immense challenge, of how to allocate scarce personnel and financial resources to the competing demands of the present Fleet and the Fleet of the future. The Commodore said the trick is to find the middle ground; an optimal mix of both elements. He also pointed out that although the boiler problem is now behind us we should never be surprised to meet unpredicted problems in our older ships.

. . . . . MARE 84 . . . .

On the morning of 24 June some sixty of us crawled out of the Halifax Holiday Inn to catch flight 712 west. It had been an exciting three days - lots of presentations, discussion, and socializing. I think we were all the better for it as well. Now I look forward to MARE 84. - Wait for it. Upper Canada Spring 84 is the word. Maybe in conjunction with the National Capital Marathon - Bring your running shoes and a good paper. See you there.

(At Left)

CMDRE E.C. BALL PRESENTS RETIREMENT MEMENTOS TO CMDRE B.L. WILKINS FROM THE BRANCH.

(Below)

CMDRE E.C. BALL DISCUSSES THE DAYS PRECEEDINGS WITH LT's KLING AND BLATCHFORD.

NOTE BOOK

Lt(N) W.I.G. Dziadyk, a new member of the fraternity but not new to the Navy, has recently been awarded the Assistant Deputy Minister (Materiel) Certificate of Merit. Bill joined the Navy in 1967 as a MARS officer but due to eyesight difficulties was reclassified into the CELE classification. After ten years in the wilderness Bill is returning to the fold as a MARE. However, before leaving the CELE organization Bill produced a Top Down approach for the OSAR software development and convinced the contractor to implement it. For his efforts he won the ADM(MAT) Certificate of Merit. Bill is now at RMC doing post graduate work in the Electrical Engineering Dept and should be joining NDHQ/DGMEM in early 1984. It is good to have you back with us Bill.

CDR D.W. Wilson was promoted to the rank of Captain effective 23 Nov 82 with a posting to 2 CFTSA in Montreal 26 Nov 82. Good luck in your new position Don.

On 26 Nov 82 LCdr F.B. Smith took up the duties of NAO in NEU(A) and the acting rank of Commander. Frank was subsequently promoted to the rank of Commander effective 1 Jan 83.