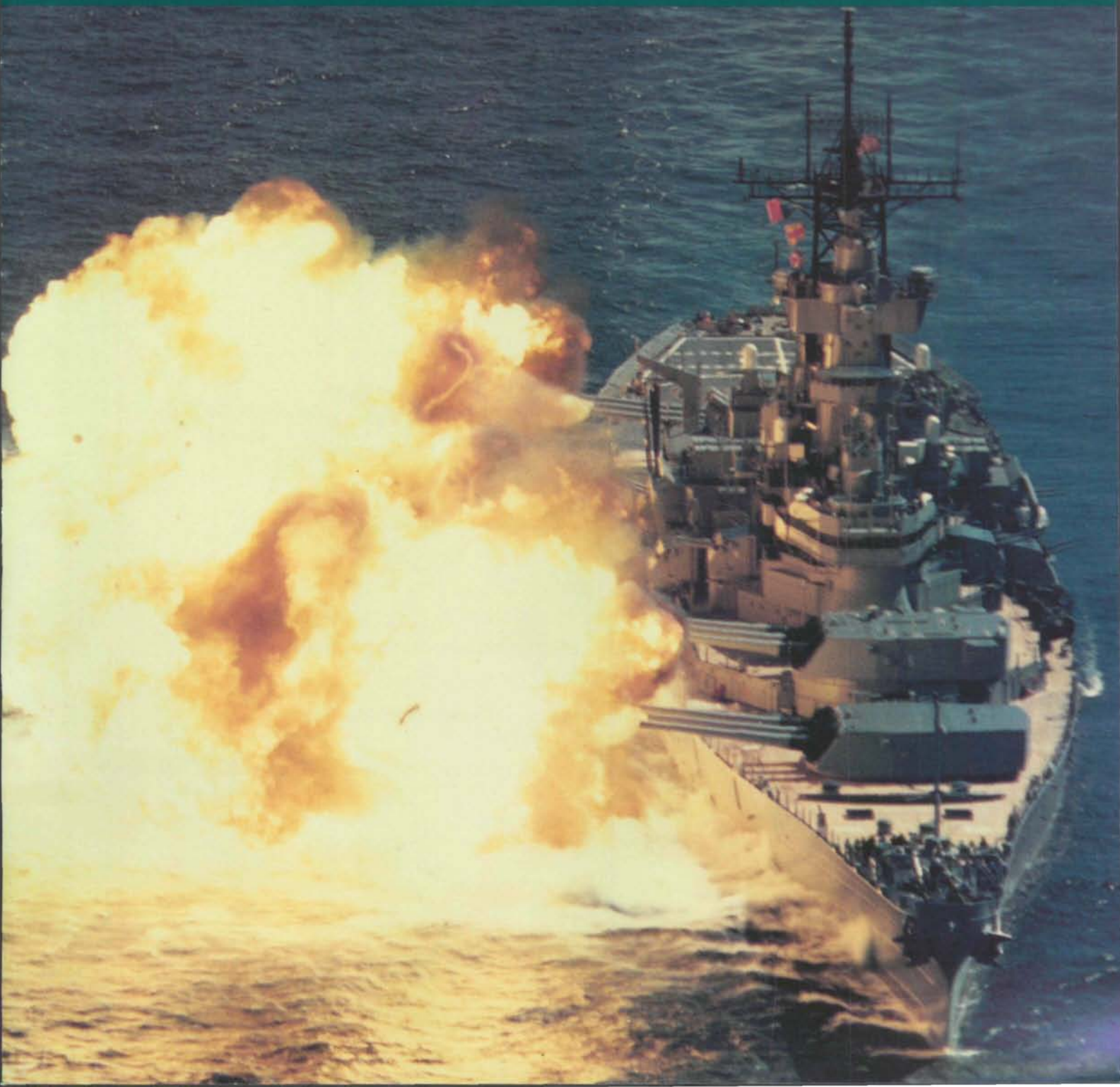
Journal of the Australian Naval Institute

Volume 25 Number Two
April/June 1999

The Future of Surface Combatants...



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The Australian Naval Institute was formed and incorporated in the ACT in 1975. The main objectives of the Institute are:

- to encourage and promote the advancement of knowledge related to the Navy and maritime profession; and
- to provide a forum for the exchange of ideas concerning subjects related to the Navy and the maritime profession.

The Institute is self-supporting and non-profit-making. Views and opinions expressed in the Institute's publications are those of the authors and not necessarily those of the Institute or the Royal Australian Navy. The aim is to encourage discussion, dissemination of information, comment and opinion and the advancement of professional knowledge concerning naval and maritime matters.

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The editorial guidelines for articles are that they are:

1. in electronic format (e-mail or disk); letters to the editor will be accepted in any format
2. in MS Word; and
3. either 250-400 words (letters and illumination rounds), 1500-2000 words (smaller articles) or 3000-5000 words (feature articles).

We can support black and white photography and diagrams but please supply originals or electronic copies. Colour plates are limited within the journal and will normally be reserved for feature articles.

Journal of the Australian Naval Institute

ISSN 0312 — 5807

Volume 25 Number 2 April/June 1999

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PO Box 80
Campbell ACT 2600

Designed, typeset and printed by
NCP
22 Pirie Street, Fyshwick ACT 2609. Phone (02) 6280 7477

Editorial

The two main aims of the Australian Naval Institute are:

- To promote knowledge within the membership of issues relating to the Navy and the maritime environment, and
- To provide a forum for discussion on Naval and maritime issues.

...what have we been doing...

The first aim has achieved in the past four Journals. In the second half of 1998 the "Knowledge Edge" edition was published. This was the first of the theme editions. The first Journal of 1999 focussed on personnel and the second was titled "Amphibious Warfare". This edition tackles the issue of the future of the surface fleet as a viable option for a modern Defence Force.

The quality of the articles in these editions has been exceptional. In a number of cases the experts within Defence and the maritime community were the authors, providing the most up-to-date information on their fields. This is the end result of a passionate past-president and the generous nature of our Defence community (and I include in that our industry partners).

...and it might be working...

This edition has seen the realisation of both the ANI's aims. Not only do we have fine authors contributing their views but also we have managed to generate discussion. The Journal's theme is "The Future of Surface Combatants". An article by Hugh White, Deputy Secretary Strategy and Intelligence, a thought provoking and, apparently, an article-provoking piece, is responsible for prompting two further articles included in this edition.

...but what about this edition...

Commander Peter Jones, RAN, kicks off this edition with an Illumination Round on ship design. Commander Jones proposes that a common philosophy should be applied to major acquisition projects in order to facilitate equipment and training commonality, and, reduce risk. Illumination Rounds (short topical pieces - approximately 500 words) can be submitted at any time for publication. Commander Jones is currently improving his suntan to our north.

The second article is by Commodore Morton and is titled "A View from the USA". The US is obviously the technical leader of modern navies and lessons they are learning are of great benefit to smaller countries with somewhat smaller R&D budgets.

"Why Buy Warships?" by Hugh White is well titled. The article discusses exactly what the title suggests and plainly questions some fundamental RAN concepts. Two articles posing different viewpoints to the same question follow this article. This is a very interesting exchange and well worth the time taken to read it closely.

The Defence Science and Technology Organisation helps expand our horizons with a look into what technology will allow in the future. It is a fine stand-alone article but when read in conjunction with the article by Commodore Morton, it gives a very clear picture of the possible shape of a future surface fleet. Ken Harris, Managing Director ADI Limited, comments on the challenges facing the management of this emerging technology. The need to closely partner with industry to effectively utilise both areas of expertise will clearly be a continuing focus for the RAN.

The RAN Staff College presents the ANI Medallion to the finest essay written by course participants. Last year Lieutenant Commander Dean Schopen, RAN received this award and his winning essay is reprinted in this edition. Although pure coincidence, the article is very topical discussing the balance required in the RAN Fleet.

To complete the Journal for this quarter Captain Meldrum, RNZN, comments on the RNZN surface fleet. New Zealand has made some hard decisions in the past twelve months that directly impact on their surface fleet. This article discusses the way ahead.

...and for our next trick...

The next edition will be very different from any printed to date. The theme is "Midshipmen... What Would They Know?" In the next edition we will find out as a collation of articles written by Midshipmen on Naval and maritime themes are included. If this edition doesn't spark a bit of debate I will be convinced the Journal is only used to keep hot dinner plates off knees during State of Origin games.

ANDREW BEWICK

ILLUMINATION ROUNDS

The Need for a Ship Design Philosophy for the RAN

by Commander Peter Jones

In recent years the RAN has had to wrestle with a broad array of problems related to our ships. Examples are the LPAs, COLLINS Class and WESTRALIA. Overarching these problems has been a shortage of trained personnel as well as fiscal constraints which impact on ship repair and stores support. The absence of and adherence to a ship design philosophy has had either a direct or indirect impact on all these issues.

With the outlook for even more budget tightening, not to mention growing public and government impatience with perceived Defence and/or Navy mishandling of projects, there is a compelling argument to adopt such a philosophy.

So what is a design philosophy? It is a set of standards and criteria that form the framework for design specifications. In our case the criteria should encompass elements such as desired seakeeping, endurance, habitability standards, redundancy, levels of technology and associated risk for different systems, local content requirements, high power standards, MILSPEC criteria (which systems should be MILSPEC and which COTS), signature features and equipment commonality.

The design philosophy criteria would apply, where relevant, through the entire Fleet. Such a philosophy must be dynamic, reflecting technological advances. But it also builds-on the successes and failures of previous designs.

A design philosophy by its very nature encourages two things – equipment and training commonality, and reduction in project risk. These are two areas of course that have been difficult for the RAN to tackle. Unfortunately the unsophistication of our acquisition process has meant the real dollar value of commonality through the Fleet has not been captured or appreciated. Despite this it can be appreciated that when money is tight, it is a luxury for the RAN to support logistically and in training over 20 diesel generator types and around a dozen different navigation radars in the Fleet.

In contrast to the RAN the benefit of an evolutionary design philosophy is consciously or not demonstrated by most advanced navies in the world. A glance at any of the first league navies in *Janes* or *Combat Fleets* will reveal a lineage in design that focuses on qualitative improvements in ships.

A good example of the benefits of a design philosophy is the German Navy's frigate force. The F122 Class frigate is the baseline for two subsequent designs. The F123 Class ASW frigate while having a slightly different hull form and introducing the MEKO concept retains the same machinery plant and many other systems. The latest F124 Class AAW frigate has the F123's hull with once again many common systems. It does not take much imagination to work out the savings both in stores and training. The other advantage of this approach is that it reduces the number of untried systems in each new ship.

In contrast to navies with a tradition of local design and construction, the RAN has shifted from a RN derived fleet, then to a short lived attempt at an indigenous design fleet (the DDL, STALWART, COOK and AOR PROTECTOR) to now a mix of Australian, US, Italian, German, French and Swedish designs. Each of these designs comes with their own distinct design philosophy. The RAN approach often has been driven for the desire for an "existing proven design" to reduce risk. In practice however this has often translated into a foreign design modified to a point where there is little corporate knowledge to be gained from other ships in service around the world. The end result is a Fleet that is a heterogenous mix of old and new that is hard to build, expensive to modify to our purpose and difficult to support.

Yet even with our existing assortment it is still possible to insist on some uniformity. Look at our frigate force for example. The FFGs have proved excellent ships. They are economical, seaworthy, well armed and possess good damage control for their time of build. They also have reasonably good habitability and are well laid out for replenishment. Even if we did not want to build on the same hull, the RAN should have taken the good points of the FFGs and improved upon them in the ANZAC. Alas this was not the case and the lack of commonality in damage control markings is a basic example.

If there is doubt about the value of a design philosophy it is worth taking a historical perspective. For the RAN there is a long term legacy resulting from an absence of a design philosophy as well as a lack of commitment to local design. Since World War II the RAN's force structure has been truncated due to rising costs in local ship construction. A central factor here has been the stop-start nature of ship building.

Shipyards were never going to become efficient when there was no prospect of further work beyond that on the slips at the time. The "slow hammer" syndrome. A steady programme based on lower risk evolutionary designs would have in large part overcome this problem. For the RAN the result was that a 5th Q Class frigate modernisation, a 4th Daring, PROTECTOR and a 2nd SUCCESS (hence WESTRALIA) never materialised. It was also a factor in the delay and reduction in scope of the Daring, DE and DDG modernisations. As can be seen the RAN has paid dearly for a short term approach to acquisition.

As can be seen the advantages of a design philosophy are many. What needs to be done to realise the operational and fiscal benefits of a coherent design philosophy. First we need to look at our Fleet. Identify the characteristics we like and dislikeand what we want future designs to possess.Then settle on some standard ship systems. Such an initiative has to be seen as a long term project. It may not lead to the most technologically advanced ships in every area but it will lead to more reliable ships with lower risk acquisition and a more manageable logistic and training requirement.

Many would say the adoption of a design philosophy is just the application of commonsense. It is. But it requires a change in thinking in acquisition and a will to see the reform through. For those who say it is too difficult one has only to see other navies managing to achieve it. Finally if properly implemented, the benefits of a design philosophy would eclipse anything that NQM, ABM or DRP could hope to achieve.

Commander Jones is Commanding Officer of HMAS Melbourne.

HMAS Melbourne, *Currently on deployment in the Arabian Gulf*

Power Presence and Flexibility – The Future of the Naval Surface Combatant

A View from the USA

By Commodore G.A. Morton RAN

"In the dealings of nations, the supreme reality – no matter how earnestly we wish it were otherwise – is still the possession of physical power"[1]

"Australia must have the military capability to prevent an enemy from attacking us successfully in our maritime approaches, gaining a foothold on our territory or extracting political concessions from us through the use of military force"[2]

Setting the Scene

Our president has asked me to provide some comments on the future of the naval surface combatant, from the perspective of one who has spent the last few years in the USA. Clearly the focus of this article, which I hope will contribute to the debate on this important subject, will be on the future of the Naval Surface Combatant, as it relates to the RAN. There is, of course, much to learn from recent developments in the USA; the question for us is can we draw out the relevant lessons and then relate them correctly to our circumstances?

As the year 2000 rolls around we will be bringing into service, and indeed, still building, a class of ship that lacks the full range of capabilities that might be required in operations today. For some years it has been acknowledged that a very significant upgrade to some of the ANZAC Class' weapons and sensors, is required to bring the class to the level of capability needed for it to credibly go in harms way in support of our national interests. Our progress towards achieving this important goal has been disappointingly slow. Moreover, we have only just decided to extend the life of our hard worked patrol boats, to buy us time to recover from the OPC debacle. What does the future hold for our smaller surface combatants?

The Need

Before going any further, I should address the obvious question of whether there is a future for the Naval Surface Combatant, and in particular, the Destroyer. Will future technology offer us the luxury of not "going down to the sea in ships, and doing our business upon great waters", at least in major surface combatants? There are those who seriously advance the opinion that all the RAN needs are submarines supported by aircraft to provide the necessary elements of maritime power to support our national interests and ensure our security in peace and during conflict. In response, I would start by saying that I have always been struck by the simple Army maxim, that "only a soldier can take and hold ground". The surface combatant, in the arena of maritime operations, is as important as the soldier on the ground. What is needed perhaps, is a slogan like "Power, Presence and Flexibility" which will succinctly convey to the minds of the Australian people the essence of our business, and also encapsulate for them the capability the nation derives from the money invested in maintaining a force of surface combatants.

We can learn something from our US counterparts in this regard. The debate here is not about whether or not there is a future for the surface combatant, rather it is focused on the capability that such a vessel can deliver in support of the likely operations which might be required of the USN. There is a very clear recognition that surface, subsurface and aviation forces are all required to provide the balance and flexibility that has been the hallmark of maritime forces over the centuries. So I would argue that it is not helpful to be diverted by suggestions that the days of the surface combatant are over. Indeed, such suggestions lead us to waste time, money and intellectual effort in proving the obvious and prevent us from concentrating on the real question, which is: how do we acquire the capability that we need as quickly and as effectively as possible?

Our Strategic Circumstances

In arguing for the type of surface combatant we need, it is not my intention to devote significant discussion to the subject of our strategic circumstances and to come up with my own version of a new Strategic Assessment and Defence White Paper. What I do want to do is to very briefly put recent developments into a

context that will point towards the kinds of capabilities that might be required of our future surface combatants in achieving "Power, Presence and Flexibility".

One of the very first things ADML Barrie indicated when he took over the reigns, as CDF was that Australia's strategic circumstances had deteriorated significantly over the preceding 12 months. Nuclear testing by India and Pakistan, impending instability in Indonesia flowing from the transition from the Soeharto regime, uncertainties in North East Asia, and the Asian economic crisis all combined to influence his view. Since he made that observation, things have not improved and the sense of regional uncertainty we face is increasing. Close to home, the situations in East Timor and other parts of Indonesia are far from ideal, and of course PNG will present its own special set of challenges. Further afield, regional competition in the Spratly Islands area of the South China Sea is unlikely to diminish. Coupled with all this are the challenges posed by the potential for powerful non-state organisations and transnational activities to threaten stability in our region. Illegal exploitation of resources, illegal immigration, drug trafficking and piracy are all current strategic concerns which show no signs of diminishing, thus adding to the uncertainty and general sense of instability and insecurity in our region.

The reality is, that despite the determination of the US to remain engaged in our region, there are no guarantees that the next century will be one of peace and prosperity for the Asia Pacific region. The first two decades of the new millenium will be full of uncertainties, complexities and challenges for us. Our maritime forces must structured to provide the capability and flexibility that the government will rightly expect of us in supporting Australia's National objectives. As we have recently seen in this era of uncertainty, we must be able to engage credibly at little or no notice.

Our surface combatant force therefore must have a wide range of capabilities. It must be structured to have the flexibility and adaptability to be able to respond quickly to the unexpected. We are entering an era where we are likely to have to contribute as part of a coalition at the high end of capability, as well as at the lower end protecting our resources and those of our friends. Like the US, we require a mix of major and minor units, but unlike the US, we do not have a Coast Guard to pick up many of the tasks that fall to our patrol forces. We need to address, holistically, the maritime capability we require and recognize that it would be incomplete without the "Power, Presence, and Flexibility" afforded by surface combatants, both large and small.

Roles and Capabilities

Whilst I acknowledge that a new Defence White Paper is likely to be produced soon, it is unlikely that the key roles of the ADF, to which our Naval surface combatants may be required to make a major contribution, will change significantly. In essence these are:

- Intelligence collection, evaluation and distribution;
- Command Control and Communication;
- Surveillance of Maritime areas and Northern Australia;
- Maritime patrol and response;
- Protection of shipping, and offshore territories and resources;
- Air Defence in maritime areas and northern approaches;
- Defeat of incursions on Australian territory;
- Protection of important civil and Defence assets including infrastructure and population centres; and
- Strategic strike. [3]

Our new policy documents are, if anything, likely to give more emphasis to the need to be able to conduct these roles in a regional context.

We also need to consider some oft unstated or understated capabilities required of our surface combatants such as:

- Flexibility, adaptability, availability and reliability;
- The requirement to be able to do more than fight and win if needed;
- The ability of both major and minor units to be able to support our regional engagement policies; and
- The requirement for our destroyers to have adequate command and control facilities to support joint and combined operations throughout our region.

In our region, perception is as equally important as reality. If we are to pay more than just lip service to our Chief of Navy's vision that we achieve "the most capable regional maritime force south of China and east of India", we need to do things very differently from the way we have in the past. Of critical concern should be the possibility (some may assert certainty) that what we may be asked to do with our forces will be quite different from what we envisage and plan for. No amount of "alternative futures gazing" will get it right and we must have the flexibility to respond to the unexpected in short order. The alarming fact is that the

coming five years could be extraordinarily challenging for our region and are at best, likely to be extremely uncertain.

It is at this point that the first lesson from the US experience suggests it self. There is no value in the hollow force. **Ships that cannot be sent in harms way within the deployment cycle have no place in a fighting force.** A surface combatant derives its power and presence from the capability of its weapon fit and the very ship itself. There has never been a "build hulls now, fit with capability later" policy in the USN, hence the USN surface force has remained credible and responsive. Moreover, the need for capable and credible surface forces has never been seriously questioned. Rather, the debate has focussed on how much capability can be fitted. That is not to say that certain things could not have been done better, particularly in relation to the utilisation of manpower, and I will touch on this aspect later. The USN's DD-21 Program takes some bold steps in a number of areas and these are worth examining in the context of our own capability needs.

Major Fleet Units (MFU)

The DD-21

With the DD-21 Program, the USN is attempting to introduce a new approach in meeting its operational requirements. The overall DD-21 Program objective is to "... affordably develop, build, deliver and support the DD-21 'system' as defined in the DD-21 Operational Requirement Document (ORD)"[4]. In the ORD the "system" is defined as the DD-21 ship and her crew, as well as the facilities, processes, products and personnel that will be required to maintain the ship through it's entire life-cycle. The DD-21 System objectives, derived from the ORD, include limitations on operating costs as well as on production costs. They also address quality of life issues for the crew, and define limits for training, support and infrastructure costs.

The general mission of the DD-21 System is to provide independent forward presence to operate as an integral part of joint and allied maritime expeditionary warfare operations. More specifically, the mission is to carry the war to the enemy through offensive operations by the use of precision strike weapons and to provide firepower support for amphibious and other ground forces. Additionally, the DD-21 System will be capable of protecting friendly forces from enemy attack by theater missile, air, surface, and sub-surface threats. These are not dissimilar to the capabilities needed by the future major RAN surface combatant. I would note here the emphasis the USN places on the DD-21's multi-dimensional war fighting capability. Given the nature of our operating environment, the RAN's major fleet units must have flexibility to meet the multi-mission requirements while, at the same time, employing sensors and weapons that provide a nearly "puncture proof" self defense capability against a range of threats. In other words, the primary capability requirement for our ships must be to go in harms way and if necessary, to fight and win.

USS Valley Forge, *Sydney Harbour – 1977*

Other DD-21 System objectives include achieving survivability and signature goals, introducing new software development and maintenance processes, as well as using open architecture and commercial off-the-shelf (COTS) equipment wherever possible. Metrics to assess the maturity of software development are also being sought. The USN is allowing, with few constraints, US industry to select the best fit of ship and equipment to meet its needs. The key point for us to note is that Industry is being tasked to determine how best to meet the performance requirements and in this process there is a very high degree of teaming and cooperation between US Industry and their customer. This is one aspect that we need to improve on in Australia. While we have experimented with "partnering" and "teaming" we are not yet truly in sync with Australian Industry and its capabilities. The Australian preoccupation with keeping Industry at arms length, and full and open competition for military systems, may not be achieving the degree of capability or the self-reliance we are seeking.

It is of interest that the DD-21 Systems will make extensive use of COTS. Large strides have been made in the US in understanding and designing for the use of COTS equipment. For example, it is proposed that entire submarine combat systems will be changed out every five years with new systems employing the latest COTS computers. Shock damage protection will be achieved by designing the rack mounting system, not the components themselves, to resist shock. Reliability issues have reduced significantly with COTS reliability now approaching the level required by the military, and associated spares are generally more available, thus reducing logistic costs. Aligned with the use of COTS is the extensive use being made of the powerful simulation tools now available. Such use, in the DD-21 context, will facilitate the revolution in acquisition process the USN is seeking by lowering overall costs and compressing the acquisition cycle.

The use of simulation tools has been coupled with a move away from an overly prescriptive ***requirement*** based specification, to one based on ***performance.*** As an example, a design displacement range is not being specified for the DD-21 as this is expected to flow from performance and capability considerations. From all accounts, the ship will be in the 10,000 to 12,500 ton range. Studies undertaken here indicate that size is not a major cost determinant and consequently should not be given undue weight in developing the final configuration of the ship. In the days when destroyer size is loosely defined in the US as being between 5,000 and 10,000 tons, why is it that our thinking seems to be bound by the 3,000 to 5,000 ton range? The distances and environmental conditions in our region, together with the likely capability requirements for our future MFU, suggest the RAN may require a hull size in 5,000 to 10,000 ton range, and we should not be nervous about accepting this possibility. The real lesson here is that in developing our capability specifications, just like the DD21 project, we should focus on performance, and be ready to accept where this leads us.

A final word on size. The DD-21 will have the apparent luxury of up to 96 Vertical Launch Cells capable of accommodating a range of weapons. There is a developing reluctance in the USN to allocate some of these cells to accommodate weapons that might be needed to support forces ashore, in the execution of Operational Manoeuver from the Sea (OMFTS)[8], particularly noting that the ship may be operating in the littorals without air cover. We will face a similar dilemma as we factor into our capability requirements the ability to support our land forces in regional shore based operations, without the luxury of underway replenishment, or change out of munitions load. We also need to be able to accommodate changes in technology and capability requirements that will inevitability occur during the life of the hull. There are a myriad of issues to consider, from constant demands for more personnel to operate new systems, (What impact will Unmanned Aerial Vehicles and new missile systems have?), to meeting future training needs. Many of these potential problems can easily be discounted if, from the outset, the ship has sufficient volume to accommodate future capability enhancements. The USN has learnt that building large ships provides the flexibility in these areas that will inevitability be required. To borrow from the Soviets, "quantity has a quality all its own", size has a capability all its own, and size significantly influences the ability to provide "Power, Presence and Flexibility".

All, however, is not "sweetness and light" in the DD-21 development process. While the engineering solutions needed to meet the performance specifications for the ship are being left to the competing contractors, there is a glaring deficiency in the process. In the view of many mariners, the single greatest risk to the program's success is the mandated maximum manning level of 95 personnel – officers and sailors. Endless articles have appeared in US magazines and papers decrying the manning level of the DD-21 from many view points – damage control, fire-fighting, redundancy, even plain old-fashioned cleaning requirements. In specifying the performance requirements of a future surface combatant, the number of sailors needed to man the ship should reflect the demands placed on the ship.

In the USN and the RAN, the traditional "Naval Presence Mission" aligned with increasing regional engagement tasking, places heavy demands on our ships' crews. With an absolute minimum of crew, who will undertake the simple tasks such as hosting "open to visitor" requirements, let alone carry out the many manpower intensive assistance tasks we are often

required to perform ashore? One answer may be to provide additional accommodation so that there is flexibility to embark additional personnel when ships are undertaking "engagement" tasks. A reserve capacity in the personnel accommodation area may also be useful in other unexpected regional tasking such as Service assisted or protected evacuations. While additional accommodation requires additional space, we should not be afraid to articulate and accept this, and other similar capability needs.

If the ADF is to come to grips with the demands of an uncertain regional future we need to use some of the lessons available from the DD-21 System experience. In following the US DD-21 Program debate, it has become obvious that there is a need for a fundamental change in some of our traditional thinking and processes. One particular difficulty we face is our very process driven acquisition system. Australia needs to keep up with the world's best practices and opt for capability-based not specification-based requirements. The final lesson I will draw from the DD-21 process is particularly important in this regard. We must avoid the pitfalls of "paralysis by analysis". The DD-21 design process will last 3 years and, (if current schedules are maintained), the first ship will be in the water before our first WIP fitted ANZAC is at sea.

Filling the Gap

Earlier, I noted the considerable uncertainty facing us in our region. Even if a new class of MFU could begin construction in 3 years time in Australia, I doubt that it would enter service in time to meet the capability needs that are already upon us. These needs will become even more acute as the DDGs pay off, the FFGs age and the ANZACS are slowly WIP'd into shape.

One possible solution could be the procurement or lease of a number of ships from the USN. This approach has some attractive aspects. It would meet the pressing need for greater operational capability at a level that will not be achieved until the upgraded ANZAC Class becomes operational. In addition, we would almost certainly acquire a larger hull in these circumstances and consequently gain a measure of engagement flexibility that we simply do not have now. Of particular importance, in my view, is the fact that such a move would enhance our interoperability with the USN. If the right deal were to be struck, then logistic support costs could be minimized by judicious use of the USN support system.

Another advantage of this "second hand ships" option would be that it would allow us to delay a decision to acquire new construction ships thus reducing pressure on the Defence budget. It would also allow us the opportunity to gain experience in the operation of larger ships and this experience would allow us to better define the performance specifications of a new class of destroyer. In any case, we would be moving more quickly towards CN's capability vision and be more able to meet the requirements that will inevitably flow from the new Defence White Paper.

Patrol Forces

In our discussions about the surface combatant force, it is very tempting to focus on the glamorous high capability destroyer and ignore the extremely important lower end of the surface combatant capability spectrum. In the US, it is even easier to fall into this trap, as the USN does not operate Minor War Vessels (MWVs) the way we do. Many of the tasks undertaken by our Patrol Boats are undertaken by the US Coast Guard who, interestingly, are also in the process of developing acquisition plans for new classes. Notwithstanding the generally low priority afforded to patrol forces by the USN, there have been a number of technological developments that may be applicable to us. With the recent decision to extend the life of the FREMANTLEs, we have a window of opportunity to re-examine our MWV capability requirements.

Many would argue that Patrol Forces need to have significant speed and responsiveness as well as war fighting, enforcement, engagement and surveillance capabilities. While the FREMANTLE Class has served us well in the circumstances that prevailed in the 80's and 90's, the uncertainties that face us in the new millenium will demand additional capabilities. Just as "Power, Presence and Flexibility" needs should determine the size of our future MFU, these same factors should be key considerations as plans for the next generation MWV are developed. Hull size and design of our future MWV may hold the key to achieving our desired capability. Again, we should not be bound by conventional thinking and we need to look at some of the opportunities presented by recent technological developments.

Of particular interest might be the potential afforded by advanced hull form developments that are typified by the US "SLICE" ship. This advanced wave piercing multi-hull vessel has been developed as a technology demonstrator by US industry in conjunction with the USN. The particular capability strengths of patrol craft based on such a design are likely to be; enhanced sea keeping ability, high speed, and sufficient space for weapons, sensors and personnel. To go to sea on the technology demonstrator "SLICE" vessel is an impressive experience. Perhaps the most serious disadvantage of most of the advanced hull forms is increased draught over similar sized conventional hulls, and this aspect merits further examination from both technological and capability standpoints.

Another very recent USN development that may be relevant in time, is the concept of the "Street Fighter". At this stage I would stress that this is nothing but a concept for a smaller "brown water" vessel which might be optimised for inshore offensive and support operations. It is far too soon to say just where the concept development process will lead the USN, but it may hold implications for us.

Our current patrol boat force – What will be next?

As in the case of major units, I would suggest that the use of the performance/capability based specification process would be of significant benefit. Most of the directions being pursued by the DD-21 project have some relevance to the development of a future class of MWVs for the RAN. Once again there is a pressing need to get on with the job and we should not be risk adverse in the process, despite the conclusions some may draw from the COLLINS experience. After all, we do have considerable experience in building surface combatants in Australia.

Manpower Issues

I have already discussed one manpower issue as it relates to DD-21. Up till now the USN has adopted a very conservative approach to designing ships for minimum manning or even adapting manpower conservation measures for existing units. The SEAWOLF submarine requires 3 men to do what we achieve with 1 man in the ship control area. The "SMART SHIP" project and now the DD-21 have changed all that. Discussion of this important topic requires more treatment than I am able to devote to it in this article however, some recent developments are worth noting.

The USN Horizon Concept

Strategic Studies Group (SSG) XVI proposed the Horizon Concept to the Chief of Naval Operations (CNO) in the summer of 1997. The recommendations included a potentially new manning concept for USN forward-deployed ships in the year 2010. Horizon is based on:

- Extensive use of technology, to reduce maintenance requirements and improve material readiness, to network forces, to improve training, and to improve individual and unit readiness;
- Reducing the size and shape of the shore infrastructure to eliminate non-core functions, privatize or out-source functions not required to be performed by Sailors, and reorganizing as many of the remaining functions into a new "operational duty" cycle;
- Creation of new regional command organizations to better manage and exploit limited resources through standardization and common doctrine;
- Extended forward deployments of rotationally manned warships to reduce time lost in transits and better meet forward presence requirements; and
- A more robust crisis response and surge capability resulting from maintaining warships and people in a continuous ready status and eliminating cyclic readiness.

The particular element of the HORIZON concept that might be of immediate interest to us is the notion of rotating crews not ships, and essentially doing with surface ships what has been done with aircraft and the strategic submarine force for years. The way such a concept might be adopted by the RAN would probably be quite different from the way the USN might proceed, particularly as some of our manpower management processes are more advanced than those of the USN. In this regard, we seem to be further ahead and have fewer difficulties in implementing, commercialisation and outsourcing initiatives.

The reality of our funding environment means that we will never have enough hulls to meet all the requirements placed on our surface forces. There is potential for modern technology to add value to each hull in terms of increased availability. Indeed, we already see this benefit to some extent in both the ANZAC's and FFGs. If we are to realise the full potential of the rotational manning concept, it needs to be factored in as part of the initial capability/performance specification. This would ensure that any special arrangements that might be

required to implement revised usage cycles are designed in from the ground up. The "rotating crews" concept has the potential to add value to the "Power, Presence and Flexibility" of our surface combatant force.

Acquisition Reform

Earlier in this article I made reference to the need to improve and streamline our acquisition processes. This is not a trivial issue and indeed the whole future of our surface combatant force may hinge on our ability to change the way we currently do business in the acquisition arena. Again, developments in the USA may hold some lessons for us.

I have already noted that we need to be able to bring capability into service quicker and suggested that there may be a need to develop a culture which encourages greater cooperation and team work between the Defence Organisation and Industry. In addition, we need to rid ourselves of the nexus between a "competition at all costs" mentality and cost effective capability. It is particularly interesting to see the rationalisation that is occurring in the US Defence industry. While this has reduced options for competition, it also has the potential to reduce costs.

By way of example, the prospect of there being only one specialist submarine builder in the USA is not at all alarming to the USN. Nor is the prospect of reduced competition in the surface combatant construction sector. These developments are seen as facilitating streamlined processes, and reducing overheads and costs. There are risks associated with these developments but they are assessed to be manageable and are outweighed by the potential benefits. In Australia we have a small indigenous market, and an even smaller export market, for naval vessels. We need to seriously consider the proposition that we can afford only one naval construction facility. Apart from the potential benefits for our own acquisition process, such a development may increase our penetration of export markets. We would be seen as presenting a national and coordinated marketing front, rather than a fragmented and divided one. Again, this whole issue merits much greater discussion than I am able to devote to it now and I raise it merely to include it in the debate.

One final USN acquisition lesson we might wish to ponder is that since 1988, the number of people working in their acquisition system has reduced by 50%. Where has DRP taken us in this regard?

Conclusion

In this article I have argued that our current uncertain strategic circumstances demand that our Maritime Forces include capable surface combatants, both major and minor. There are a number of lessons in the way the USN is approaching the design and development of the DD-21 System that may help us in determining the way ahead, and I have outlined some of these. In concert with this is a need to move our acquisition process towards a performance/capability based specification process that does not place unnecessary limits on designers.

There is a pressing need to improve the capability of our surface combatant force quickly if we are to achieve the vision set for the RAN by the Chief of Navy and meet future requirements. Our current modernisation processes will not achieve all the "Power, Presence and Flexibility" we require and the capability improvement we do achieve will arguably be "too little too late". One way of short cutting this process and overcoming some of our capability gap might be to acquire a number of modern, capable destroyers from the USN. We also need to be innovative in developing our future MWV force to fill the lower end of our capability requirements.

In the coming years we will have the opportunity to revise the manning concepts for all our surface forces and serious consideration needs to be given to multiple crewing so as to make better use of the availability of modern ships. If we are to achieve all we need to do to properly develop our surface combatant force, we will need to be supported by a vastly different acquisition process, and one that embraces modern business techniques and philosophies. In saying this I recognise that there may be a need for legislative changes to support such an initiative.

Finally, I would acknowledge that I do not pretend to have all the answers. My intention in developing this contribution has been to contribute to this important debate and hopefully to add some fuel to it. I would also like to acknowledge the contribution that my staff in Washington has made to this article and in particular, the work done by Commander Mark Remmers in developing some themes for me was extremely helpful.

NOTES

1 Sydney Morning Herald October 3 1950. Article on the first British test at the Monte Bello Islands
2 Australia's Strategic Policy P29
3 Defending Australia – Defence White Paper 1994 p30
4 DD 21 Program Description, Objectives and Solicitation Response Instructions.
5 Operational Maneuver From the Sea (OMFTS) is a US Marine Corps (USMC) Doctrine that the USN has signed up to support. It involves the use of over the horizon expeditionary concepts and relies on the USN to support the USMC with fire support.

Why Buy Warships?

Thoughts on SEA 1400

By Hugh White

This paper expresses the personal views of the author. These views are not to be attributed to the Department of Defence or the Australian Government.

C. Northcote Parkinson is most famous for his eponymous law, according to which work expands to fill the resources available. Parkinson's Law is of course deeply applicable to Defence organisations. But it is not his only, nor his most important, contribution to the study of Defence decision-making. Buried half-way back in my little volume of his writings is an essay called "High Finance, or the Point of Vanishing Interest". The heart of the essay is captured in what Parkinson calls the Law of Triviality, according to which the time spent on making a decision will be inversely proportional to the sum of money involved.

I hope no one will suspect me of triviality because I start a discussion of what is, I will argue, a very important issue with citations from Parkinson. I take his writings very seriously, and the point he makes about the Law of Triviality is very important to organisations like ours, and to issues such as the future of our fleet of major surface combatants. I say that because I want to draw attention to the sorts of decisions we need to make about the future of our fleet.

The existence of a project number – SEA 1400 – and a place in the Pink Book make it natural to assume that the big decisions we face about the future of the fleet are about when exactly we want new ships to enter service, how many we want, what size they need to be, and what capability they should have. Indeed it is generally expected within the Defence Organisation and the wider defence community that SEA 1400 will deliver new ships into the fleet as the FFG's start to pay off sometime around 2010–2015, that there will be at least four of these new ships, and that they will be significantly bigger and more capable than the ships they replace. There is also general recognition that they will cost, just to acquire, well over $1 Billion each, and probably much more. Current estimates for investment required for the surface combatant fleet range between $12–$16bn over the next 20 years. SEA 1400 accounts for about half to two thirds of this.

In other words there is a consensus within Defence that we are going to buy a new class of ships over the next fifteen years, that they are going to be high-capability ships, and that all we need to do to progress SEA 1400 is to decide in detail what that capability is going to be.

Where does that consensus come from? I would guess that it emerges naturally from our collective recognition that if we don't replace the FFG's with something, the fleet will start to shrink as they are paid off. But it does not derive from any decision taken by the Defence organisation, or by the Government. As an Organisation, we have taken no decisions about the relative priority of surface ships to other types of capability, the costs and benefits of different sizes of fleet and of different levels of capability for its ships. In short, we have not yet decided whether we need SEA 1400, or whether we can afford it.

This situation may seem shocking, but it is hardly surprising. We are seeing Parkinson's Law of Triviality at work. The bigger a decision is, and the more important it is, the harder it is for an organisation to make it, and the easier it is for the issue to be resolved by default. In Parkinson's essay, he illustrates how the Finance Committee of some mythical organisation decides to buy a nuclear reactor costing 10 million pounds (this was written in the mid-50's) after two and a half minutes' discussion, while agreement on a new bicycle shed costing 350 pounds takes 45 minutes.

In our own case we know that the Source Selection Board will meet for days and consider mountains of detailed and expert analysis before deciding which to two nearly identical tenders we will accept on a contract worth $100 million, while we will slide into an expectation that we will spend $10 Billion without ever making a real decision on the issue at all.

In Defence these peculiarities are not confined to Navy. Nor are they unknown outside Defence. In fact the financial pages are full of the stories of companies who were so busy taking little decisions that they failed to notice the big ones that really mattered to their commercial viability.

Why does this happen? That's too big a subject for this little essay, but it's worth a paragraph just to scratch the surface. I think two related factors are at work. First, big decisions are harder to take than little ones, because they are less susceptible to precise quantification and analysis, and rely more on judgement. They demand more of decision-makers, and most of us most of the time try to avoid them.

Second, the big decisions go to the heart of things we, as individuals and as organisations, hold dear. A company that has spent a century as a leading steelmaker will find it easy to buy a new furnace, but hard to decide to get out of steel. Equally a defence force, and especially its naval component, will find it hard to question whether there are better ways to spend our money than buying more ships. And an airforce will find it hard to face up to a decision to take pilots out of aircraft.

But these are decisions that, as an organisation and as a country, we badly need to start to face up to in relation to our defence forces – and not just our surface fleet. I think that today getting these big decisions right is more important than ever, for two reasons.

First, because Governments will increasingly demand it. In countries like Australia, defence organisations cannot stand aside from the main stream of governments' agendas to reform the way public business is done. While we have had our fair share of efficiency reviews and staffing cuts, we have not yet felt the full force of the revolution in scrutiny of our business that has become the norm in other areas of government. This will come; Governments will not keep taking the word of the permanent public service experts (in or out of uniform) for the ways we spend $11 billion a year, especially once accrual budgeting and management lays so much more of our business open to view. We need to be able to explain and argue, in detail, why our plans provide the most cost-effective ways to meet the governments' strategic objectives.

Second, we need to take the big decisions better because our strategic circumstances demand it. Our ability to provide security for Australia in the Asia-Pacific of the twenty-first century is far from assured. Twenty years from now, as the ships from SEA 1400 might be entering service, the economic turmoil of the last two years may be a distant memory. We must expect that in the longer term, Asia's economies will grow, and grow steadily. We cannot assume that our economy will give us the relative strength to sustain self-reliance into the twenty-first century unless we improve the cost-effectiveness of our defence capabilities. Australia's security in the next century will rest, above all, on our ability to use the resources that Australia can afford as efficiently as possible to meet our strategic needs. By any measure, looking ahead we will have to be able to do our defence planning and management of the resource base better than anyone else. The need to find the most cost-effective mix of capabilities is not imposed on us by the transient fiscal pressures of a parsimonious government, but by relentless strategic logic; the need to defend our continent in a complex and demanding region in which many other countries, over time, will build economies bigger than our own.

This long-term strategic pressure imposes new demands on Defence as an organisation, to make better decisions about the kinds of capabilities we develop, and about the relative priority we give to different types of capability in the light of their different contributions to meeting our strategic needs.

It also imposes great demands on those who contribute to such decisions as individuals. Those demands fall heavier on those who serve, and have served, in uniform. They carry an inescapable and entirely admirable sense of loyalty to their service, and often to their particular arm of that service. But such loyalties cannot be allowed to come before our higher obligations to our country, which requires us dispassionately to evaluate and select those outcomes which are in the nation's overall best interest. We must never forget that the decisions we take in peacetime – decisions such as the ones we face over the next few years – will do much to shape the forces Australia will rely on for its defence for decades to come.

* * *

The good news is that we are slowly developing better ways to approach these difficult major decisions. On the one hand, clearer annunciation of our strategic interests, and the circumstances under which they would be threatened, allow us to build a clearer picture of the sorts of military operations the ADF needs to be able to undertake in the future, and to give some sense of relative priorities between them. On the other hand, the outputs-based approach to resource management allows us to understand much better what different types of capability actually cost us to develop and maintain. In future, we will be better able to balance the uses to which different capabilities can be put against the costs of those capabilities. We will not get precise answers; these will always remain issues for military and strategic judgement. But we now have better foundations on which to build those judgements.

We will soon have an opportunity to put these new techniques to the test. Over the next few years we face a set of capability-development decisions as complex and difficult as any we have faced in the last two or three decades – indeed since the carrier decision. We always seem to be about to face an unmanageable train-smash a few years beyond the present pink book, and certainly today is no exception. But today our problem is not simply the perennial worry about "block-obsolescence". We can manage those problems, as we always have, by deferral, refits, upgrades and the rest of the familiar tool-kit of capability management. But those techniques will not suffice to manage two new, related, kinds of pressure we face.

First, our capability development processes are being squeezed by the need to focus much more than in the past on delivering more combat ready capability, ready to fight as it is. The judgements about warning time which allowed us to fit for but not with, and to take other steps to keep costs down in the 1980's, were valid in their time, but our time is different. The government now expects the ADF's most important capabilities to be developed and equipped so that they are ready at a few days or week's notice. So keeping a wide range of capabilities at lower levels of preparedness is no longer on option.

Second, we need to reach higher levels of capability in high-priority areas if we are to be confident that we can fight and win. The rate of growth of capabilities in the Asia-Pacific region, especially qualitative growth in air and maritime capabilities, is high and likely to stay high. If we are to continue to offer the Government a range of military options to protect our strategic interests, the ADF is going to need to seek higher relative levels of capability in key areas than we needed to reach in the past. In short, if we are going to remain the best in our region in key capabilities, we are going to need to grow those capabilities faster than we have in the past.

These two trends mean that, even with significant growth in defence budgets (which I for one do not expect) we will need to make some tough choices about the range of capabilities we try to maintain. In essence, we need to develop and maintain a smaller range of capabilities at higher levels of effectiveness and readiness. That will give the government more options than a wider range of capabilities few of which are ready or able to meet the demands that might be made on us.

There is one other major factor which will bear on the decisions we have to make about SEA 1400 over the next few years. Between 2012 and 2015, on current planning, the F/A 18's will reach their airframe life. There is little we can do to extend them except reduce their annual flying rate. We do not yet know how we will develop our future air combat capability after the F/A-18's are gone, but we can expect it to be expensive. On current thinking, AIR 6000, the future combat aircraft, and SEA 1400 could between them absorb the entire major equipment portion of the defence budget for seven to eight years. That is hardly possible. Something will have to give.

* * *

This then is the background against which the government will need to decide, sometime within the next few years, whether, and if so on what scale, to buy new ships for the ADF under SEA 1400. What factors will we in the Defence Organisation need to take account of in advising them? How should we apply the new tools I have described to this very important decision?

Let us start with the dollars. Today operating the surface combatant fleet and its supporting capabilities including helicopters, afloat support, training and other requirements costs us $1.2bn per year. That is 11.5% of the Defence budget. This compares with 2.0% for submarines, 7.3% for air combat and 25.2% for land force combat elements. Apart from our land force combat elements, the surface ship fleet is by a long way our most expensive capability output.

The surface combatant fleet has an even bigger share of the capital investment budget. Over the past ten years, we have committed about $7bn dollars on ships, helicopters and weapons for our surface combatant fleet. That is about 30% of our total major equipment investment over that period. If we were to invest $10 billion in SEA 1400 over the ten years from 2003 to 2013, that would be 40% of our total major investment over that period at present levels.

Of course these are huge sums of money. The question is what do we get for it, and more specifically, could we get more capability for our money if we spent it in other ways? That is a big subject, and I'm not going to even attempt to provide an answer here. The most I can do is to sketch the kinds of issues which I think will need to be brought to the table as we start to address the question.

The first point must be of course that the surface fleet does not have a lien on its historic share of the defence budget, any more than any other capability has. The fact that a particular type of capability has been a good investment in the past does not necessarily mean it will prove an equally good investment in the future. That will depend on strategic, financial and technological factors; whether the tasks that a capability can perform are still sufficiently important to justify its cost, whether those costs have gone up or not, and whether technological developments have improved or eroded its performance relative to the threats they may face. One of the marks of a truly effective organisation is its ability to correctly identify the point at which the benefits of an investment or activity no longer justify the costs, or more specifically that the tasks which it has traditionally done in one way can now be more cost-effectively be performed in another way.

The second issue then is to determine what those tasks are. Clearly they must be directly related to combat operations in direct support of Australia's strategic interests. At times in the past, and in some countries today, major force structure decisions have been made implicitly or explicitly on the basis of prestige. Warships in particular have been seen as significant symbols of national power, and as instruments of a vaguely-defined concept of maritime influence. But for us today, judgements about capability priorities must be made on a quite clear understanding of what those capabilities are able to do for us in conflict.

At a broad level, the tasks the ADF needs to be able to perform in conflict are simple enough to enumerate. In defeating attacks on Australia, we need to be able to deny our air and maritime approaches to hostile ships and aircraft. We set no particular geographic limit to "approaches"; indeed it might be better to say that our task is to prevent hostile ships and aircraft approaching our territory. Either way, that requires us to be able to locate and if necessary attack hostile forces at their bases, to deny them bases close to Australia, to detect them in transit, and to destroy or disable them. In broad terms the tasks we might want to perform in defending regional interests are similar.

Analysing these tasks a bit further, we find we need to undertake surveillance of land, sea and air; mount strike operations to destroy forces over land, sea and air, and where necessary protect our own forces from the attacks of our adversary.

Two things become apparent as we look at this list. The first is that major surface combatants can contribute to a very wide range of these tasks – probably a wider range than any other single type of capability. The second is that there are a few tasks – but only a few – that surface combatants can do better than any other.

Surface combatants can undertake maritime surveillance and air surveillance over sea, and can strike maritime, land and air targets. But maritime and air surveillance can increasingly be done, and probably more cheaply in most circumstances, from aircraft, UAV's and satellites than from surface ships. Anti-shipping strike can be done in many circumstances more quickly and cheaply from aircraft, and in some circumstances from submarines. Anti-aircraft action can be done in most circumstances more effectively with aircraft.

Ships have generic advantages and disadvantages in relation to other types of platform and system. Their key advantages are range and endurance. A key disadvantage is slowness to deploy and redeploy. These need to be carefully weighed.

But in considering the relative effectiveness of ships and other means for performing these tasks, the key factor we will need to take into account is the relative vulnerability, and the relative value, of different platforms. Obviously the surface ship has become increasingly vulnerable to detection and destruction, not just over the past few years, but over more than a century, starting with the appearance of asymmetric threats in the form of mines and torpedoes. The measures to improve their survivability are themselves very expensive, increasing the cost of ships, to the point that a very high proportion of the cost of a capable ship today is its self-defence systems. There seems to be no reason to expect this trend to abate. Indeed on the contrary, improvements in anti-ship strike to penetrate ships' defences seem to be much cheaper than the improvements in defences needed to defeat them. This means that cost and vulnerability will increasingly limit the cost-effectiveness of ships in a wide range of roles.

The size of ship's crews is a particularly important element of this vulnerability. I am not sure that we have entered the era of post-heroic warfare; in fact I am pretty sure that we have not. But I am sure that Australian commanders and Australian governments will always seek to minimise Australian casualties. They will be very reluctant to risk a ship carrying 100 or 200 crew to perform a task that could be done by a few aircraft carrying perhaps two crew each.

In many of these shared roles, therefore, I think we need to look very hard at the competitiveness of surface ships against other ways of doing tasks. I would add two cautionary notes, however. First, while we need to strive to find the most cost-effective ways to do particular tasks, we need to avoid becoming so narrowly specialised that we have only one way to do them. We should complicate an adversary's defensive task by maintaining a range of ways to do different things. So our measure of cost-effectiveness needs to incorporate a measure of prudent diversity.

Second, in the infinite complexity and unpredictability of war there will always be circumstances in which a flexible and sustainable platform like a ship or group of ships will be able to do things that other platforms or systems cannot. We should preserve a capacity to cope with surprises, and to inflict them on an adversary.

Having looked at the relative value of ships in roles they share with other platforms, we also need to pay careful attention to the circumstances in which ships have unique advantages. The most obvious example is the protection of our own shipping, where a warship's ability to travel with other shipping is critical. I do not think we should give much weight to the convoying of trade, because the task is beyond economic achievability; no fleet we could afford could protect even a tiny share of our sea-borne trade. But the protection of amphibious forces could be a major priority, especially in operations within the inner arc. Where we had not already neutralised air and sea threats by other means, an ability to protect forces in transit would be important.

More broadly, ships have unique advantages in the complex and ambiguous situations which often develop in the transition from peace to war. The ability of a ship to appear and to linger in international waters, but close to a scene of dispute, can be very valuable, and may be important in preventing a war at all.

The foregoing is no more than a very superficial brush over a very complex set of issues. I think it is very unlikely that anyone would conclude that we do not need a fleet of major surface combatants. I certainly do not conclude that. But equally I think it is clear that we must question very closely whether we can justify further investment in the fleet on the scale that many would envisage under SEA 1400.

Thinking About Surface Ships

By James Goldrick

This paper expresses the personal views of the author. These views are not to be attributed to the Royal Australian Navy, the Australian Defence Force, the Department of Defence or the Australian Government.

In considering the requirement for a future surface combatant, we have to recognise the level at which we need to begin. With a total force as small as the ADF is and probably will ever be, new surface combatants represent such a large relative commitment that they have to be considered in relation to the entirety of our defence strength.

This is where we first get into difficulties. How do we judge our capacity as a defence force? What are the measures of military strength and combat potential? The first point to make is that we must move away from the tendency to focus on individual roles, or even individual environments. Such a "stovepipe" approach has never been a satisfactory one and it is even less acceptable when we consider that the present and future realities are that all operations of any scale will be inherently joint.

Even talking of possessing or creating a "range of capabilities" can be downright misleading. Where we need to talk of a "range", the context should be in the presentation of a range of options for military action to government. Individual force element capabilities contribute to the creation of these options but should not be considered in isolation. If we accept the manoeuvrist focus of Australian strategy within an environment that is not merely maritime, but archipelagic maritime, this creates requirements for combat forces which are capable of operating effectively within and contributing to all three environments.

We thus need to treat the synergy of assets as a pre-condition of joint operations and not a side effect and we must look at all times at what units within one environment can do for others. That we have not done so often enough before has been at least partially a fault of our "project defined" acquisition process. This has to change. We can learn something from the move away from "platform based" thinking which is one of the most encouraging aspects of the American drive to "network centric warfare". Whatever other very considerable conceptual problems the latter may have, it puts the focus very much on the contributions which individual elements can make to a total scheme of warfare.

This necessary emphasis on contributions should also allow us to look more closely at costs, both absolute and relative, and learn to treat glib statistics with caution, particularly in relation to platform cost. The sort of difficulty which we can encounter in working out the relationships between contributions and costs has some interesting historical examples. During the long drawn out debates over the relative efficacy of aircraft and heavy surface ships in the 1930s, the British Royal Air Force finally agreed in consultation with the Royal Navy that the relative cost of medium bombers to battleships when all supporting elements and infrastructure were factored in was 43 to one.[1] The issue here is not whether one type was necessarily more useful than the other – that we can leave to the historians – but the psychology of national resources. The idea that the destruction of aircraft (and their highly trained crews) could represent a significant drain on resources was one that few appreciated at the time and probably never have. The loss of 983 bombers during the 1944–45 campaign in support of land operations in northern Europe – this figure does not include the casualties in the campaign against German cities – was and should be viewed as a necessary price for a great strategic victory.[2] But it has rarely been assessed in terms which have indicated that the expenditure of national treasure was equivalent to the destruction of twenty or more major capital ships.

Even the increasing sophistication of contemporary Defence accounting (and accountability) has some real problems when we are trying to face force development issues squarely. The most recent publicly available measures of Defence costs are contained within the *Portfolio Budget Statements* for 1999–2000 and the Defence Outcomes and the figures therein contain much food for thought. In bald terms, the total resourcing for the Defence Outcome (which includes the capital use charges that are a fundamental element of accrual accounting methods) is 16.5 billion dollars. Within this figure are contained 22 Outputs and an "Administered Expenses" figure. Some idea of the relativities can be gained by looking at what could loosely be described as "major environmental groups" which can created by combining clearly mutually dependent Force Element Groups. In the case of Navy, let us combine Major Surface Combatant Operations at 2.4 billion and Afloat Support at 228 million as one. This equates to 15.8% of the Outcome resourcing – a lot, and something that is the subject of increasing comment outside the Navy.

Now look at the some of the air side. Excluding Maritime Patrol Aircraft and Airlift, Tactical Fighter Operations come in at 1.2 billion and Air/Strike Reconnaissance at 660 million, or the two at 11.2% of resourcing. But should the 149 million for Combat Support of Air Operations be included in this percentage?

The situation is even more complex for land warfare. Land Task Force Operations are the major output in cost of the entire Defence activity at 3.8 billion or 22.8% of the total. To this should certainly be added Logistic Support for Land Operations at 400 million. But what about Special Forces Operations at 206 million, Amphibious Lift (which exists solely for land forces) at 257 million and Airlift (which is primarily for land forces) at 904 million? Join these in a simplistic manner and the Land output cost climbs to no less than 33.5%, or just over a third of outputs.[3]

But statistics are never as simple as that because no "output" is readily distinguishable in the sense of being a clear military option. Special forces, for example, require access to sophisticated intelligence and communications systems, not to mention the assets to insert and extract them from their missions. Options come, as already described, from a fusion of individual capabilities, the whole of which is greater than the sum of the individual parts. We therefore have to focus on what is required to meet the sequence of strategies under current guidance, ranging from Defence Against Attacks through Defence of Regional Interests to Support of Global Interests. What can particular platforms contribute and what will be the costs?

So we need to think a little more about the costs of platforms and develop a better framework for analysis. One possible approach which is more useful, if still relatively simplistic, is to divide the capabilities (and the costs) into two: inherent and added. An inherent capability can be described as something inherent to the platform. For a submarine this is stealth, for a surface ship presence, and for an aircraft it is speed. An added capability is something that can be placed upon and deployed from the platform – all three types, for example, could be fitted with cruise or anti-surface missiles.

The advantage of this distinction is that it should give a much clearer idea of how much a particular platform costs in relation to what that platform can do better than any others, rather than the offensive systems it carries which might be delivered in other ways. The modern accepted wisdom, for example, is that "what the US Navy refers to as hull, machinery and electrical" (in other words the cost of the ship itself, rather than the sensors and weapons it carries) has fallen to some 20% of the total cost.[4] Now, this raises some very interesting prospects for breaking what has been a historical nexus between weapon/sensor fit and size in warship design. The truth is that larger warships have tended to be much more expensive than smaller ones because much more has been put into them rather than their increased tonnage per se. Despite this, the truth has also been that bigger ships are still relatively cheaper than smaller ones.[5]

We have, of course, to remember the issue of protection and self defence. In modern warfare, particularly maritime warfare, self defence bears a direct relationship to target signature. If you have a small signature, no matter what part of the electro-magnetic spectrum the weapon sensor operates, then defensive measures are much easier and cheaper to take and soft kill likely to be much more effective. Furthermore, if you can keep your signature small enough, then expensive and complicated hard kill systems are not required. So small ships do not have some of the inherent costs that big ships do if they are to survive to complete their tasking.

But it is not as simple as that. Bigger size, the evidence increasingly indicates, confers vastly improved capacity to resist damage and remain operational if that increased size has been used to aid in the dispersal of systems and the installation of redundancies, rather than cramming the structure with additional weapons and sensors. Bigger size also gives the potential to utilise a ship in the future for systems and capabilities which were not considered at the time of its construction. Given the service lives of major ships (in recent years at least twenty and closer to thirty years in most major navies), the lead time of construction projects and of building runs, this must confer considerable flexibility on any force structure, particularly one that is inherently resource limited in the first place.

With all these issues in mind, most especially those of the requirements of manoeuvre warfare within a maritime region, perhaps the most exciting aspect of current technological and warfighting developments is the extent to which the ability of seaborne units to contribute to military options is increasing, particularly for smaller defence forces.

This is because the capabilities of surface combatants in particular to do something more than fight the maritime war are progressing through a number of developments. Thus, surface combatants will not only continue to make their contribution to the protection of shipping and the creation of a maritime environment which permits the deployment and sustainment of land forces, but add something to the fighting powers of the land forces themselves. Several areas are of interest here.

The first is in fire support, something which naval bombardment has accomplished for operations close to the coast for many years. But close to the coast was, even for the biggest guns, never more than twenty miles and often, because of terrain or the depth of inshore waters, much less than that. Improvements in

remote sensors – notably through innovations such as reconnaissance Unmanned Aerial Vehicles (UAVs) and much improved communications links – and in extended range "smart" munitions give the promise (already achieved in US Fleet Battle Experiments) of two or three fold range improvements in range and thus four to nine fold improvements in area coverage.

It is notable that some of these developments, such as the Extended Range Guided Munitions (ERGM) being developed for the 5 inch gun by the United States Navy, should be capable of adoption even by existing units of the RAN such as the ANZAC class. The efforts being extended on UAVs are more uncertain in their applications for smaller navies, but the improvements which are being achieved suggest that two hangar ships such as the FFG 7 class may well one day supplement their helicopter in one hangar with a range of UAVs in the other.

The value of these sorts of capabilities should not be underestimated. While never a complete replacement for the organic fire power which land forces require for effective operations against any substantial threat, surface combatants will have the potential to support land forces, substituting, particularly in the early stages of an operation when lift capacity is most constrained, for the weapons and munitions which cannot easily or quickly be brought forward into the area of operations.

Much more subtle, but no less important, will be the contribution which surface combatants will make in two areas, what can be termed "Battlespace Awareness" and in air defence. These two areas are by no means the same, but when facing a high technology threat – which will most often manifest itself by aircraft or missile attack – they deserve to be treated together.

Maintenance of "Battlespace Awareness" and sustaining the ability to react quickly must be counted as the principal difficulties which a small and asset poor combatant force faces in modern warfare. There can be no doubt that, if sufficient resources are available, the combination of high capability command and control, remote sensors – particularly space based sensors - and a range of highly capable airborne units encompassing AEW&C, ELINT and other high resolution sensors for detecting air, surface and sub-surface movement must be ideal. The Americans have worked long and hard to achieve their version of such an ideal and it came to a remarkable even if not flawless culmination in the results of the Gulf War in 1991.

But continuity of awareness means just that. The problem with limited numbers of airborne assets is that the effect of any one of a range of problems – aircraft unserviceability and weather, to name only two – can be to reduce battlespace awareness to effectively zero if a single sortie is missed and no aircraft comes on station. One example of this effect in a wholly maritime context is the way in which the good work of several days of unbroken search effort to prevent a diesel-electric submarine "snorting" and thus replenishing its batteries can be wasted if even an hour of active airborne surveillance effort is missed. The same problems apply to many other threats in other environments. Sustaining this continuity is in reality the major challenge faced by smaller air forces in achieving their goals of air supremacy within a situation in which forces are required to deploy at long distances from their normal bases.

The surface combatant represents a more practical capability to maintain continuity of battlespace awareness at a level which, even if lower than that of the most sophisticated airborne platforms, is nevertheless credible and one which is sustainable over long periods with only a few assets. Two or three surface combatants can remain on station for weeks or even months, developing, monitoring and contributing to the battlespace picture. A frigate or destroyer has a battle picture development capability in terms of computer power, command displays and expert people which is comparable with that of the largest AEW&C aircraft. They, too, can access remote sensors and remote information sources, assessing threat levels and queueing when necessary the airborne platforms to be available to enter the area of operations and raise battlespace awareness to the highest level at the time of the highest threat. The anti-aircraft weapons of ships can also contribute significantly to the defence of a precious on-station AEW & C aircraft and release fighters from protective stations and defensive tactics to more offensive activities.

Even now, surface ships can exchange processed data via near-real time links with each other and with other platforms. Developments in train are allowing the direct exchange of sensor data between different sensors, markedly increasing both detection probabilities and fire control capacity. Add a similar exchange capability between sea and airborne units and there are further enormous improvements possible in detection and engagement performance.

The technology bears some explanation because of what it offers. Hitherto, individual sensors have often made isolated detections on adversary units, but the number of detections has been insufficient to allow tracking systems to generate and maintain the track on such targets, make a threat assessment and allocate a weapon. If sensors operating in different locations and in different parts of the electromagnetic spectrum can fuse their data in effectively real time conditions, one or two "hits" from an individual sensor can be matched to another and a track generated. The quality of tracking will be such that weapons can be fired from platforms which are not themselves in contact and are acting only on remote information. Known as Cooperative Engagement Capability (CEC), this concept is still in its childhood – although it has already gone to sea in USN AEGIS cruisers – but there are indications that it

promises just as much for smaller forces as it does for the American battle groups for which it was first intended. An Australian AEW & C aircraft, for example, may one day be able not only to co-ordinate the air picture and direct the operations of the limited number of fighters which will be available, but also direct the firing of anti-aircraft missiles at long range from surface combatants at targets which are well below the organic sensor detection horizon of those ships. This must be one of the most perfect examples of a situation in which the fusion of platforms and platform capabilities must be very much more than any possible sum of the individual parts. In the long term, of course, it must also be remembered that CEC will not simply be confined to major units but may be extended to any platform with sensor capabilities.

Fulfiling the promise of CEC will not be simple and it will require, in particular, a closely co-ordinated approach in the development of both air and seaborne elements to work. Nevertheless, for a defence force which cannot afford more than limited numbers of AEW & C aircraft – or indeed of any unit – but desires to create and sustain a credible capability for maritime manoeuvre, such a combination of surface combatants, early warning aircraft and fighters is probably the only practicable method of achieving the domination of the battlespace which is required and which is so difficult for a small force to do.

Hitherto, much of this focus has been on the maritime environment and directed towards attack on or the protection of ships on the sea and aircraft over it. But those same developments suggest that some of the inhibitions of ships in relation to operations over land can be overcome. UAVs, army sensors ashore and the sensors available in aircraft operating over land could all provide data which would allow for firing anti-aircraft missiles over land – even when the target is obscured from the sea by terrain. They also suggest that some at least of the command and control capacity of seaborne units should be able to support or even substitute at certain stages for such activities on land. Again, not only during the vulnerable stages of insertion and extraction, but when a light footprint is required by ground forces, the value of such a capability will be considerable.

This discussion has so far concentrated on the direct support of land operations by maritime forces. What must not be forgotten, however, is that maritime forces – particularly surface combatants – will continue to have fundamental responsibilities for what has long been termed "sea control", that condition which exists when one has freedom of action to use an area of sea for one's own purposes for a period and, if necessary, deny its use to an opponent. It is not often realised that Australia has existed for all but a few years in this century – 1941 to 1942 – in a condition in which the extent of maritime supremacy was such that the requirements for its maintenance have been effectively transparent. Australian land forces, in particular, have been transported to and sustained within a variety of far distant locations within a wholly benevolent maritime environment. Since the Second World War, this situation consistently applied in contingencies such as Korea, Vietnam and Confrontation.

Such conditions cannot be guaranteed for the future. Maritime forces will be required to create and maintain a favourable environment for the operation of sea communications and for the use of the sea for the projection of power in the face of a wide range of threats. The proliferation of high technology weapons within all environments has for some time disconnected the "high" in combat technology from that of combat intensity and, no matter what the situation, forces must be prepared to respond to the unexpected and the technologically sophisticated.

The challenge for maritime forces will thus be in achieving sea control and, in its broadest sense, contributing to the projection of power while doing so under uncertain but rapidly changing and highly demanding threats.

Will surface combatants continue to play a role in these activities? Or have technological developments other than those so far discussed combined to render them ineffective? My answer would be that the surface combatant will have a role to play and that technology is providing as many solutions as it is challenges. That 20% of the total cost of a surface combatant provides for the deployment of capabilities of presence and continuity, of readiness and of reach, of command and control and multi-dimensional battlespace awareness, of weapon deployment and target selectivity which in combination are not so efficiently delivered by any other platforms. Above all, this combination of capabilities results in a degree of flexibility which must mean much for any government seeking the widest range of options in meeting its strategic needs.

Biography

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NOTES

1. The Naval Staff originally calculated a ratio of 45:1. The Air Staff, on being consulted, actually suggested 37:1 before joint reassessment of the figures came up with an agreed ratio of 43:1. *It Might Happen Again* Volume II *The Navy and Defence: the Autobiography of Admiral of the Fleet Lord Chatfield* Heinemann, London, 1947. P.100.
2. John Terraine The Right of the Line: The Royal Air Force in the European War 1939-1945 Sceptre, London, 1988. P. 663.
3. All these figures are taken from the *Portfolio Budget Statements 1999-2000: Defence Portfolio* Budget Related Paper No. 1.4A Department of Defence, Canberra, May 1999. Page 21.
4. John Eldridge "Damage Limitation Exercises the Minds of Naval Planners" *Jane's Navy International* Vol. 104, No.4, May 1999. P.24.
5. See Philip Pugh *The Cost of Seapower: The Influence of Money on Naval Affairs from 1815 to the Present Day* Conway Maritime Press, London, 1986, especially Chapter 14.

The Surface Combatant and the Future: Time for Re-assessment

Commander Ray Griggs[1]

....the conventional surface ship is now a marginalised instrument of military force.[2]

Introduction

There is no shortage of quotations that can be used to open an essay on the future of the surface combatant. Most will lay waste to many of the notions that those of us in the navies of the world have held dear for decades. Within the Australian Defence Organisation (ADO) the doomsayers of the surface ship and in particular, the surface combatant, are alive and well and heartily endorse Keegan's quote. In general they see surface combatants as slow, vulnerable, expensive and, paradoxically, either not well enough equipped, or too expensive, to be put in harms way, or too sophisticated for many of the peacetime tasks they are called upon to perform. Of course Navy is not alone in having some of its conventional wisdoms and central tenets challenged. There are many challenging the need for a Hornet replacement and whether should or should not have a human occupant. There are even more who consider the debate on the future of field artillery to have concluded. They are now of the view that artillery as we know it is to join the Thylacine in the near future.

There is nothing wrong with challenging "sacred cows"; we have for many years questioned capability proposals, but that has largely been done from within the "replacement syndrome". We are content to slowly add capability, despite the risk of hollowness, but, are reluctant to shed it when strategic, technological or economic realities rear their head. That said, the current debate on the surface ship in particular reflects a trend towards simplifying what needs to be a rigorous examination of our future force requirements. This simplification manifests as a series of generalisations using what appear to be a number of immutable "universal" lessons extrapolated from limited actions such as the Gulf War and more recent actions in the Balkans.

For too long RAN planning has rested on the "givens" of Australia's strategic geography and the historical utility of sea power. In some ways this has restrained our capability development horizons which have simply not been pitched far enough out into the future. Compared with the wider ADO, Navy is well behind the pace when it comes to articulating its contribution to the future joint force.[3]

We articulate the past very well, and so we should, but we do need to strike a better balance between the historians and the futurists.

This article posits the need to re-assess both our thinking on, and articulation of, the role of the surface combatant in tomorrow's ADF. It does this through an examination of the future warfare landscape, the commonly perceived threats to the surface combatant and the opportunities that technology and new operational concepts may provide.

Approaches to Future Conflict and Security

The shape and scope of future conflict remains as difficult to define as it has ever been. Prediction, remains a mug's game, one that we should not engage in if at all possible. In recent years our reluctance to "predict" has led to a number of alternative approaches to long range planning, the most recent and topical of which has been the alternative futures approach[4]. Of course there are many variations to this approach, some are more evangelical than others and some too rooted in the realist construct to allow thinking to really work its way out of the box. Regardless of the hype or the methodology employed, considering a range of plausible futures and developing the notion of a "planning space" rather than a single strategic future is an inherently sound way to approach long range strategic planning.

While the geo-strategic future may remain uncertain there are a number of useful discernible trends in future conflict as well as some less useful myths. Perhaps the greatest myths revolve around the progression to a clean, surgical and bloodless conflict. This myth is rooted in the somewhat bizarre notion that total situational awareness is achievable and will lead to the lifting of the fog of war and propels us into an era of perfect decision making.

Discernible trends such as increased resource scarcity, greater environmental implications of military operations, increasing activity in the information environment and the rise in power of multi-national corporations and sub-national groups are all shaping the characteristics of future conflict. Despite an increasing focus on high technology, long-range, low casualty, precision conflict, warfare will remain a

violent and uncertain human activity. It will still involve a degree of death, suffering and collateral damage for those nations and their populations affected by it.

Martin van Creveld has argued that conventional, state-based military conflict and the equipment and forces structured to wage it will gradually disappear. Citing the fact that the vast majority of conflicts post-1945 have been waged by or against organisations that were not states. Van Creveld sees future forces comprised of some combination of Special Forces, transport, intelligence and logistics together with a home guard.[5] A contrary perspective to van Creveld's is provided by those that argue that we stand on the threshold of a Revolution in Military Affairs (RMA). They envisage a vastly different future battlefield where rapid tempo, precision, dispersal and massed effects without massed forces or a large, discernible operational or logistic footprint, will be enabled by the possession or denial of information technology and knowledge.[6] Similarly, "Network-Centric" warfare; the ability to harness a range of information to achieve rapid command decision making and synchronisation of force element activities on the battlefield is one of a number of concepts forming in response to the opportunities provided by emerging RMA related technologies.[7] The RMA view is having a dominant influence over Australia's strategic policy and capability priorities, in exploiting information technologies to gain maximum effectiveness for small forces.[8]

While these two very different views are both highly plausible, the prudent analyst would suggest a hybrid outcome is more likely. There is no doubt that an aggressive, technologically focussed, RMA approach is beyond Defence's resource capacity. What Australia must ensure is that the technological, organisational (including cultural) and doctrinal aspects of the RMA are examined within an Australian strategic context. By adopting such an approach the RMA remains very relevant to Australia and avoids the seductive lure of the unaffordable "techno solution"[9]. Notwithstanding, van Creveld's thesis too has some validity based on recent history and certainly questions many of the central tenets of standing military forces.

Features of the Future Warfare Landscape

One of the key features of future warfare will be the replacement of the environmental battlefield with that of an integrated battlespace in which environmental boundaries will be close to seamless. Space and the cyber domain will join the sea, air and land environments as critical elements of this battlespace. This type of concept is starting to be articulated within the ADO; the Army's new edition of its capstone doctrine publication "The Fundamentals of Land Warfare" is the first formal attempt to do so. The use of what is becoming known as "soft power" is another likely feature of the future that will challenge conventional military responses. According to Joseph Nye, soft power involves getting other countries "to want what you want" principally through the allure of your country's culture and ideology.[10] Countering soft power threats may be most effectively done by diplomacy and a range of "counter-cultural" soft power responses. Military diplomacy will continue to be an important element in these responses. The development of coalitions, be they either regional or extra regional, to counter soft power approaches is another available option. Subtle and patient approaches (such as seen by China with its maritime claims in the South China Sea) which rely on the implied threat of economic reprisal or denial and are inherently difficult for militaries to respond to. They may require protracted responses consisting of finely graduated, incremental applications of both the threat, and use of force.

Uncertainty in our region demands that our forces be adaptable. While this has always been a truism, with a continuing uncertainty in our strategic future, the spectre of failed or rogue states and the notion of short warning and short duration conflicts in increasingly complex terrain, adaptability has become critical. Specialised forces are likely only to exist where their unique skills deliver a critical capability. If their overhead is high or their function can be replicated by another means, their continued survivability is limited. Multi-roled and function platforms will dominate.

When all these factors are combined one cannot escape the limited ways in which a small to medium size military organisation can respond. Set against the context of continued budgetary restraint, increased "jointery" is simply not enough, the ADF can only be effective in facing these challenges if it operates as a force that is **fundamentally integrated**. To this end duplication of functions must be removed and the operational and cost effectiveness of various means of delivering effects carefully analysed. This will mean winners and losers as priorities are struck and the new force structure shaped.

Future Roles for the ADF

The current roles of the ADF are well articulated in Strategic Guidance.[11] Extrapolating these roles out to 2025 is risk laden. To combat this, the alternative futures programme of ADHQ is starting to show plausible future roles. Analysis of these futures programmes not surprisingly suggest that the ADF will continue to be called upon to conduct a wide range of roles across the spectrum of conflict. These roles will include constabulary, humanitarian, peacekeeping, peace enforcement and warfighting tasks in differing mixes.

For the foreseeable future, Defeating Attacks on Australia (DAA) will remain the core force structure

determinant.[12] In force structure terms, there are fundamental differences in approach between DAA and its predecessor, Defence of Australia (DOA). DAA is a much looser geographic construct and has got us over the problems associated with the "moat" mentality of DOA. The impact of continuing globalisation and even a renewed momentum towards trade liberalisation will further shift our focus toward increasingly widely dispersed national interests rather than conventional notions of territory and geometric geographical constructs. All this, combined with Australia's enduring posture as a good international citizen and reliable alliance partner, means that the ADF must be prepared to "deliver" in new ways and in unforeseen places. As a result the validity of the level of geographical determinism evident in our current strategic guidance will be increasingly tested and with it the basis for capability decisions.

In an uncertain regional strategic climate the ADF needs the ability to deliver "effects" into the region in defence of our national interests and in support of regional allies and partners. As events in the Balkans are re-affirming, no single mode of warfare is likely to achieve the desired end state in the majority of conflict situations. Land forces, like it or not, remain the most effective conflict termination option in many instances and the obvious force option for humanitarian, peace-keeping and peace-enforcement roles. One of the key competencies that the ADF must continue to seek is the ability to **effectively** lift, transport, protect and sustain land forces whether it be to insert them into the north of Australia or its territories, or into the region itself.

Roles for the Surface Combatant in the Future

There are a number of enduring roles for the surface combatant. Interdiction, protection of shipping and SLOC, resource protection and a number of military diplomatic and constabulary roles feature prominently. Other capability options can perform some of these roles, but none except the surface combatant can perform the full range of these roles. Flexibility and adaptability, combined with range and endurance and therefore the ability to provide sustained presence wherever needed, remains one of the major strengths of the surface combatant.

New opportunities exist too. The advent of Remotely Piloted Vehicles (RPV) holds enormous promise for the ADF. Vertical Take Off and Landing (VTOL) Uninhabited Aerial Vehicles (UAV) will be well established at sea before 2025 (the outlook for the combat variant (UCAV) is less optimistic) as will Uninhabited Underwater Vehicles (UUV) deployed from either the surface combatant, the air or from a submarine. These advances provide enormous potential for a naval force (whatever its size), a more complete tactical picture, greater input into the broader common operating picture and weapon delivery capacity at ranges not even achieved with a small aircraft carrier is a substantial advance. The DDG air wing proposal of the USN's Strategic Studies Institute envisages 20-25 UAV in an Arliegh Burke DDG sized combatant. When converted to an Australian context 6-8 VTOL UAV could be embarked in an ANZAC FFH and more in a larger ship. With continuing miniaturisation of sensors, a range of either "plug and play" or multi-sensor configurations are possible. This capability may well lead to a reduction on the costs spent on platform self defence capabilities as a percentage of total ship costs. Importantly though for the ADF, this type of capability is highly adaptable and becomes very useful as part of a wider integrated force. This further reduces the tail required to conduct an operation and, in conjunction with other advances, may minimises the need in many circumstances for the establishment of a resource hungry Forward Operating Bases (FOB).

Adopting an Integrated force outlook offers opportunities for a more enhanced role in supporting other elements of the ADF in the battlespace. The land force has traditionally relied upon organic fire support with its inherent high overheads for force protection. The surface combatant of 2025 will be able to provide much of that support, at a considerable distance inshore without stretching either one's imagination or R&D realities very far. In the near term, weapons such as the Extended Range Guided Munition (ERGM) and the Forward Air Support Munition (FASM) will provide the surface combatant with an ability to provide rapid, long range, responsive and tailored effects. Even evolutionary development of these capabilities will increase the range and responsiveness of their effects out into the future. Land attack missiles take the concept a step further. The land force too will contribute to overall force protection through later generation Ground Based Air Defence (GBAD) systems and even land based anti-ship missiles. A combination of sensors and weapons optimised for both the ground and sea environments networked together is particularly useful in the archipelagic or littoral environment for the integrity of the whole force.

Shifting to an integrated force concept will require a number of cultural and attitudinal shifts across the ADO. Duplication of effects, unless required for specific purposes, will need to be eliminated to resource this approach. The RAN in time will need to break away from the "sea transport and force drop off" mentality of today's amphibious warfare and move to a more holistic approach of operating in the littoral or archipelagic environment. The Army will no doubt question the "reliability" of the sea based fire and logistics support given the other tasks that will inevitably be assigned to the surface combatant. Longer weapons ranges and force-wide common operating pictures will allow future surface combatants to provide this support concurrently with other maritime surveillance strike and force protection tasking. Can this concept succeed in the

Australian context? Issues of scale are critical and the ADO's ability to effectively pursue this concept depends upon serious prioritisation and the shattering of the odd "rice bowl" in the resource outlook process.

Perceived threats to the Surface Combatant

The single major threat to the surface combatant remains the perception that the defensive/offensive pendulum is now stuck in favour of offensive weapons. If one subscribes to this theory then it is easy to develop some convincing arguments as to why the surface combatant has limited utility. Combine this with the zero risk view of conflict and you have a dangerous mix. There is no risk free option in conflict; NATO losses in Serbia illustrates this. Nor can risk be reduced to some form of statistical measure of survivability. It remains as it always has, a judgement on whether the risk in commitment of forces in particular circumstances is justified by the criticality of the national interest being protected or the degree to which national survival is being threatened.

Philosophical positions aside, there are a number of more tangible threats to the surface combatant such as its perceived vulnerability. Advanced weapon technologies such as the development of both supersonic and hypersonic cruise missiles fitted with multi-sensor terminal guidance present significant threats. However, the basic requirements of the attacking force to detect, locate, track, identify, and engage the target still apply. Longer weapon ranges and increased detection ranges through networked surveillance systems will cut both ways assisting both attacker and defender. Radar Cross Section (RCS) and other signature reduction techniques continue to develop and also cut both ways. Stealth remains elusive as a panacea as there is inevitably a cost and capability trade-off to be made.[13]

Layered Anti Ship Missile Defence (ASMD) utilising a combination of hard and soft kill options remains a valid approach particularly in the littoral with the development of an integrated force protection system. ASMD will be enhanced by more capable point and area defence missile systems, sophisticated decoys and capabilities similar to Cooperative Engagement Capability (CEC). Directed Energy Close in Weapons Systems too will be a reality at sea before the 2025 timeframe and will further reduce the surface combatant's vulnerability. Mines and torpedo threats will remain potent but developments in Anti Submarine Warfare and Mine detection, classification, sweeping and avoidance techniques have prevented the total ascendancy of these threats. Arguably, life for the ships company of a surface combatant in 2025 will be no more dangerous, in relative terms, than it was for any of Nelson's ships companies of 200 years ago.[14]

Survivability is a related factor to vulnerability. There is a view at present that surface combatants have such limited survivability that their future role in warfighting is limited. One could use the same argument against submarines, but it is seldom heard. System redundancy is a key factor in the survivability equation. Poorly placed critical systems limit survivability and mission effectiveness. Dispersion of critical systems would appear such an obvious approach that it defies being mentioned. Sadly, the cost and capability trade-off decisions often result in both being lowered. Greater destructive effects are likely as warhead technologies continue to develop; this will increase the kill and incapacitation zones around impact. The only effective counter to this is to concurrently increase the overall hull size and the amount of redundancy and distribution of mission critical systems. An increase in hull size to the 6000–8000 tonne range would appear to be the sort of scale that is needed.

Personnel are often ignored in this discussion but personnel dispersion is as important as it is for critical systems. Has the Operations Room had its day for example? We have been busy concentrating as many of the elements of the Action Information Organisation (AIO) in one compartment for the best part of 40 years but is it a smart policy for the early 21st century? Warhead effect is one reason that such a shift in direction may be required. The radius of incapacity from a missile hit is considerably more for personnel than it is for equipment. It would make sense in this era of distributed combat systems to distribute the operator as well. A series of smaller, highly connected, but importantly, multi-functional operations cells throughout the ship would provide a greater chance of combat system survivability than with a centralised AIO approach. Increased levels of connectivity will allow this to occur well before the 2025 timeframe.

Ship speed and speed of deployment are another important set of relevant issues. The era of long range precision stand off weapons and stealthy platforms works against the slow and detectable surface ship. Although there are a number of experimental hull forms in development, the size of vessel required for combat operations in 2025 is unlikely to support some of the alternative hull form designs. Without major hull form development the surface combatant will continue to operate in the 25-35 knot maximum speed range and speed will remain an issue. From the strategic perspective the speed of deployment of surface combatants may increasingly remove them from a **rapid** response option list that may be provided to government. Notwithstanding, pre-positioning of surface assets in or close to an expected Area of Operations (AO) still provides considerable flexibility.

The combination of cost and perceived vulnerability of surface ships is often cited as one of the prime reasons for its impending demise. There is no escaping that cost remains an important, if the not the critical issue. Increasing miniaturisation, the greater use of Commercial off the Shelf (COTS) equipment and increasingly sophisticated modular design and construction techniques may stem the real cost increase to a certain extent. The maintenance of a domestic ship repair and building industry for example is a strategic overhead that successive government's have felt obliged to retain. It is an overhead that carries a significant cost penalty and, in the context of the "come-as-you-are" future conflict, its utility can be argued against. The idea of a rapid indigenous shipbuilding or even a major ship repair programme does not seem a viable option for the future. Our efforts would perhaps be better directed by reducing both the construction and "parent navy" cost overhead and further develop our software, weapons and systems integration expertise.

Conclusion

Within the ADO, a debate is underway which challenges our close held beliefs relating to the surface combatant. The future warfare landscape will demand of the ADF a force structure that is highly adaptable, multi-roled, integrated and cost effective. While precision, long range weapons will form an important part of the ADF's future weapon inventory; they remain rather blunt instruments of force. Softer, more finely graduated responses will be required to deal with an increasingly diverse range of challenges.

Likely technological developments fuel both sides of the surface combatant debate, but to date, have failed to make a real impression on any particular view. We have not yet seen what new offensive and defensive measures technology may yet spawn and it is premature and strategically risky to assert, as many do, that offensive weapons will remain in the ascendancy. On balance, the risks involved in committing surface combatants are no greater than they were a century ago.

The inevitable shift from the "joint" to the "integrated force" offers a number of opportunities for the surface combatant to make a greater contribution to the overall utility to the ADF. These include an enhanced role for the provision of surveillance, fire and logistic support to a deployed force which will provide the ADF with the ability to deploy forces with a reduced operational and logistics footprint in a wider number of scenarios. On this basis the surface combatant would appear to have an important and enduring role. It remains an inherently flexible and adaptable option for a variety of military diplomatic, tension reduction and force projection and sustainment tasks.

To be credible in the debate on the future shape of the ADF, we in the RAN need to understand, and be prepared to discuss, both the limitations and utility of the surface combatant in the future warfare environment. This will involve asking ourselves some hard questions about what it is the RAN of the future will be required to do and how it will fit into the ADF. We must articulate the utility of the surface combatant (along with our other force elements) as part of a coherent "Navy" view. The planned development of a "doctrinal" publication similar to the Air Power Manual is an excellent initiative and one that is sorely needed. However, it will be important to keep the document forward looking, informed, but not dominated by, historical example. A single document of course will not be the panacea. It will be in imbuing the intellectual and philosophical underpinning of that document into our daily thinking that will be important. In articulating the case for the surface combatant we need to be honest, objective and prepared to change some of our long held beliefs, as we will expect of others, if that better serves our primary aim of defending Australia and its interests.

NOTES

1. Commander Griggs is a PWO N by trade who has served in a variety of ship types. Until recently he was the Director Future Warfare in the Australian Defence Headquarters. The views and opinions expressed in this paper are personal.
2. J. Keegan, *The Price of Admiralty: The Evolution of Naval Warfare*, Penguin, Harmondsworth, 1990, p 326.
3. Army's creation of a Future Land Warfare Branch within AHQ and initiatives such as ADHQ's Project Sphinx, RAAF's project Oracle 2030 and futures programmes in National Support Division and Headquarters Special Operations are relevant examples.
4. Similar in approach to that successfully pioneered by Peter Schwarz when working for Royal Dutch Shell in the 1970s.
5. M. van Creveld, "Present and Future War", in H. Smith (Ed) *Preparing Future Leaders: Officer Education and Training for the Twenty-First Century*, ADSC, Canberra 1998, p. 29.
6. Chairman of the Joint Chiefs of Staff, *Joint Vision 2010*, CJFS, Washington D.C., 1996, p. 13.
7. A. Cebrowski & J. Garstka, *Network-Centric Warfare: Its Origin and Future*, Naval Institute Proceedings, 1997, (http://www.usni.org/Proceedings Articles98/PROcebrowski.htm).
8. As evidenced by the concept of the Knowledge Edge and the recent establishment of the Office of the RMA within Australian Defence HQ
9. A useful start would be to shed the term RMA itself and along with it some of its intellectual and institutional baggage.
10. S.P. Huntingdon, *The Clash of Civilisations and the Remaking of World Order*, Simon and Schuster, New York, 1996, p 92.
11. Department of Defence, *Australia's Strategic Policy*, DPUBS, Canberra, 1997, pp. 29-36
12. ibid., p29.
13. N. Friedman, "Stealth and Survivability", *Jane's Navy International*, July/August 1996, p 10.
14. See the discussion on casualties in Keegan, op cit., pp. 101-2.

Future Technologies for the Next Naval Surface Combatant

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Defence, Science and Technology Organisation

Introduction

Over the past two decades there have been rapid improvements and growth in many technologies that are now having a significant impact on naval vessels and their modes of operation. For example, there have been extensive developments and a proliferation of "smart weapons" requiring that modern surface ships need to employ greater stealth and, in the event of weapons strike need to have enhanced survivability.

Defence budgets will remain constrained but the pressure to meet preparedness objectives will not be reduced. A range of military engagement scenarios, from low-level short warning conflicts to prepared intensive engagements must be considered for the next naval surface combatant. According to senior Australian Defence Organisation (ADO) clients, the factors that are likely to influence future technologies are:

- Reduction of acquisition times and acquisition costs of platforms;
- Reduction of life cycle costs of platforms and increased life of assets;
- Improved operational capability;
- Improved preparedness (readiness and sustainability) through improved logistics management and support, as well as more cost-effective training;
- Improved long term planning;
- Increased capability and concept development;
- Increased capacity for industry support.

The aim of this paper is to outline technologies which are currently being investigated by the Defence Science and Technology Organisation (DSTO) and are likely to have a significant impact on a new naval surface combatant. Issues that need to be considered in the ship design process related to operational activities, materials, signatures and survivability are discussed in terms of how the above factors influence future technology development.

Hull Forms

Traditionally the design process for surface ships starts with a basic hull form. A decision on the type of hull form will have significant effects both on the operating costs and operational capability. One of the most significant operating costs of the platform is the fuel required for propulsion. To reduce the fuel costs, the naval architect directs the designs towards hydrodynamically efficient hull forms. However, there is also the requirement for the platform to have a useful and functional layout, for example sufficient space for a hangar to house a helicopter. These two often conflicting areas of interest can pull the platform design in opposing directions. For low resistance, the platform needs to be a long, thin tapering hull which restricts the useful space and causes several layout constrictions. Additionally, one of the determining characteristics of naval platform capability is the motions of the ship (seakeeping ability) and the effect that this has on personnel and equipment, particularly weapons systems, and helicopter operations. For the long, thin vessel, the controlling motion will be roll. A solution to this is to design the vessel with opposite dimensions to the optimal hull form for resistance ie a short fat ship. A potential solution to this conflict is to investigate the use of a multi-hulled vessel, either a catamaran or a trimaran. Such a vessel will require less effective power at high speeds but will incur several other penalties such as an increased cost of production and longer inspection and maintenance times.

Various navies have operated advanced multi-hull forms in the post WWII era. The US Navy currently operates Landing Craft Air Cushion (LCAC) designs for amphibious warfare and specialised Small Water-plane Area Twin Hull (SWATH) vessels. The former Soviet Navy employed Surface Effect Ships (SES) and a number of vessels with hydrofoils. These types of vessels have inherent limitations which often conflicts with the military need to have vessels with high endurance and be capable of deploying over great distances.

This means that the monohull has remained the favoured hull form for surface combatants. However the US Navy has been investigating the SLICE hull form (variant of the SWATH) which offers a reconfigurable ship for the future and the MoD UK is currently building a trimaran demonstrator.

Whether the next surface combatant is a monohull, catamaran or trimaran, there are many issues relating to structural integrity that need to be investigated to

support the vessel through its life. Modern ship design and analysis methods are moving towards assessments of both fatigue life and ultimate strength. Each of these assessment criteria requires a sound understanding of the loads likely to be experienced over the life of the ship and must be relevant to its areas of operation. Of particular concern in the Australian context will be the wave induced loads caused by the sea conditions in the Southern Ocean. Tools currently being developed at DSTO will assist in the assessment of designs and will offer advice for through-life management in terms of structural performance. These tools will need to be valid for all hull forms.

The ability to determine the status of a particular vessel in terms of its operational capability will need to be significantly improved. To assist with this task and to provide validation for the shore based predictive methods, a series of structural sensors are likely to be placed on-board future platforms. This may include fatigue-monitoring equipment similar to that currently installed on HMAS *Arunta* or a complete system that provides feedback to the ship's crew for operator guidance. This will, for example, offer advice on strategies to reduce the fatigue damage, based on measured sea-states and the effects of changes in heading or speed. The US Navy is currently investigating an example of this technology utilising fibre optic sensors.

Steel and Welding

In recent times, Australian surface combatants have been constructed from conventional grade 350 structural steel hulls and aluminium superstructures, except the ANZAC frigates in which both hull and superstructure are fabricated from conventional grade 350 structural steel. In the early and mid 1980's, the tragic lessons learned from the catastrophic fires which ravaged HMS *Sheffield* and USS *Stark* resulting from missile impact during combat, forced designers to abandon aluminium alloys for use in superstructures and revert to steel which, although considerably heavier, is far more structurally tolerant to ship-board fire.

Conventional naval structural steels typically have design strengths of 350 MPa. In designing the next generation of surface combatants, there is now considerable interest worldwide in taking advantage of a new generation of high strength structural steels which are readily weldable, for fabricating both hulls and superstructures. In fact, the US Navy has already made extensive use of one of these high strength structural (HSLA) steels, denoted HSLA 80, in their CG 47, Ticonderoga Class Cruisers and their DDG 51 Arleigh Burke Class Destroyers. Use of these new high strength steels, with design strengths of 550 MPa (ie 60% higher than conventional steels), permits thinner sections to be used provided rigidity is not compromised. This can provide great advantages for naval designers by way of stronger and lighter structures with greatly improved structural integrity and shock resistance for both hulls and superstructures. This confers the further advantages of improved sea keeping (resulting from a lower centre of gravity) and the potential to accommodate increased topside weight from more extensive weapons and surveillance systems.

Although the US-designed HSLA 80 steel (see above) has already been successfully used in naval construction, it is relatively expensive to produce because of its relatively high alloy content and complex thermomechanical treatment. DSTO has recently identified an inexpensive alternative, a high pressure gas pipeline steel, newly developed by BHP and denoted as X80. This steel, has a very lean chemistry compared to HSLA 80 steel yet possesses the same strength, good toughness and excellent weldability. It can be produced as plate, strip and stiffeners in all thicknesses likely to be required in ship construction.

The cost per tonne of X80 steel (at AUD 1,100.00) is some 40% higher than Grade 350 structural steel. None-the-less, the actual material cost for the whole structure may be less than for Grade 350 if full benefit can be taken from the use of thinner sections. A comparison of X80, Grade 350 and HSLA 80 in terms of yield strength/AUD per tonne is shown in the table below.

Steel	Yield Stress (MPa)	Cost ($/tonne)	YS/$
Grade 350	350	800	0.45
X 80	***550***	***1100***	***0.5***
HSLA 80	550	1800	0.3

While the costs of the materials used in constructing surface combatants is important, the costs in fabricating these materials into the finished naval platform is even more so. The two welding processes most likely to deliver substantial productivity savings for the construction of the new surface combatant, while still maintaining excellent weldment integrity and properties, are flux cored arc welding (FCAW) and laser welding (LW). For FCAW welding of X80 steel, further investigations are required to ensure the steel can be welded without preheat under all conditions. Some further consumable development may be required to deliver this capability. Laser welding for ship construction is already used in Europe where it has produced substantial productivity savings.

This type of welding is best suited to the high speed welding of sub-assemblies. The main obstacle to its introduction in Australia is the general lack of

technological experience with the process within the country.

In recognising the inherent advantages that X80 can confer in terms of improved structural integrity and naval platform performance, DSTO is presently assembling a detailed technology package for this steel including mechanical properties, corrosion performance, weldability and a full assessment of the performance of welded joints. This work is being conducted under international collaboration arrangements.

Propulsion systems for future warships

The propulsion system is one of the most important systems on any naval combatant, and has a significant influence on the operational capability of the vessel. A propulsion system consists of prime movers (engines), a transmission system, and propulsors.

For the current generation of warships, the choice of prime movers is limited to diesel engines and/or gas turbines. No other prime mover offers a reasonable alternative for the foreseeable future. While fuel cells are certainly close to the bounds of technical feasibility, it appears that an installation of sufficient size to power a surface warship still presents a technological challenge. The steam turbine now has a niche only in nuclear powered vessels, and Australia is not pursuing this option as a matter of policy.

HMAS Anzac
Combining the power of Gas Turbines with the economy of Diesel

Diesel engines have high efficiency but are relatively noisy and maintenance-intensive. They have acceptable efficiency under a wide range of conditions, but can have difficulty with extended periods at light load. Gas turbines provide more power for a given weight or volume, but at a cost in fuel efficiency, and their fuel efficiency is degraded much more at light load. CODAG and CODOG (Combined Diesel and/or Gas Turbine) are options for larger warships. Diesel engines and gas turbines can be taken rapidly from idle to full load, and can be on load from a cold start in a matter of minutes. DSTO has research programs involving both gas turbine and diesel engines, and provides advice and consultancy services to the RAN.

Diesel technology is mature, with innovation being confined mainly to detail matters and auxiliary equipment. However, competition from the gas turbine has led most manufacturers to seek to increase the power-to-weight ratio of their engines, sometimes to the detriment of reliability and longevity. Where a gas turbine plant is combined with diesel propulsion, the turbine provides the ability to sprint or chase and the diesel engines provide cruise power. The large difference in speed between the two prime movers requires gearboxes and clutches which allow either plant, or both, to drive the same shaft(s). In this way, the fuel consumption penalty of the gas turbine is paid only when the need for high speed outweighs fuel cost considerations. The need for two complete power plant systems and complex gearing renders this option relatively expensive at the acquisition phase and it is chosen mainly for larger vessels where the cost of the propulsion plant is not dominant.

Development work in the marine gas turbine field features regenerative systems for increasing thermal efficiency, in an attempt to reach the fuel efficiency of the heavier turbo-charged diesel engine. It seems probable that these engines will approach the fuel efficiency of present-generation diesel engines, reducing the overall cost penalty of this technology.

There is increasing interest in electric transmission systems, where the engines drive generators, and electric motors are used to provide power to the propulsors. Connection between the generator and motor is by electric cable only, providing mechanical and acoustic isolation. Such systems have found favour for low-speed propulsion systems for some smaller vessels, especially minehunters. On the debit side, the present power density of motors is prohibitive for larger installations. This is an area where technical advances may change the situation within the next few years.

An extension of the electric transmission system is the Integrated Full Electric Propulsion (IFEP) ship. This

uses a common power system for both propulsion and ship's services. If batteries or fuel cells are also used, this would enable the ship to have an ultra quiet state as well as normal and sprint modes. However, obstacles need to be overcome before the naval "Electric Ship" becomes commonplace. Technologies such as permanent-magnet motors and high-temperature superconductivity may overcome these problems, and if achieved, the potential payoffs are high.

Warships are generally propelled by screw propellers, usually with controllable pitch. Although they are efficient and reliable they are prone to damage. They have a tendency to "sing" when trailing vortices excite the natural frequencies of the blade, which leads to a distinctive noise signature for the vessel.

Vertical axis propellers and steerable thrusters have a niche application in minehunting where exceptional manoeuvrability is essential; their lower efficiency at speed and higher cost makes them less attractive for primary propulsion in larger vessels.

Waterjets are the propulsors of choice for commercial fast ferries. They provide thrust by taking in water below the hull and accelerating it through a rearward-facing nozzle. They offer good vibration characteristics, good acceleration and outstanding ability in an emergency stop. Superior efficiency is claimed at higher speeds and available sizes are increasing. The largest are able to transmit more than 20 MW, and steerable waterjets with reversing gear are available with capacities exceeding 15 MW.

The magnetohydrodynamic system has been trialed in Japan in recent years. Accelerating seawater through a large magnetic field produces thrust. The system is currently of such low efficiency that it seems unlikely to emerge as a useful technology for the foreseeable future.

For the near future, waterjets have become the propulsors of choice for fast vessels in the commercial sector, and are becoming more common in the military domain for fast patrol craft. Coupled with diesel engines, their cruising efficiency can be very good. For very fast vessels, gas turbines coupled with waterjet propulsion can provide high efficiency. Both combinations have potential military application. For larger ships, screw propellers are still attractive where continuous high speed is not the main requirement. If extensive low speed operation is envisaged, an auxiliary system would be indicated, and if stealth is a requirement at these times, retractable steerable thrusters are a promising option. Electric or hydraulic transmission for the thrusters allows retractability and low noise, this latter quality is especially achievable with electric motors. For prime movers, diesel engines offer less complexity of gearing and better fuel efficiency, while for high speed vessels gas turbines offer smaller, lighter and quieter prime movers, with penalties in fuel efficiency, gearing complexity and capital cost. In the more distant future, the long-heralded fuel cell is likely to find electric warships among its applications.

Smart Ships and Reduced Crewing

There are a number of factors, both technology driven and socially driven, that will influence the way future warships are designed and operated. These drivers include the push for reduced crew levels, increasing use of commercial-off-the-shelf (COTS) equipment, the requirement for adaptability in function for warships and the need to reduce the whole-of-life-costs of the platform. Personnel costs are a significant component of the total cost of ownership of a naval platform and even small reductions in crew size can lead to significant savings. In addition, fewer people on a platform puts fewer people in harm's way during periods of conflict. Many terms have been used to describe this push for reduced crew levels. What started out as "minimum manning" has changed to "austere manning" and is now being called "optimum manning". Optimum manning means the minimum manning level consistent with the ship's mission, human performance and safety requirements, and affordability and risk constraints, and can be achieved by any one or combination of the following:

- Automation
- Function elimination
- Task simplification
- Function consolidation
- Workload levelling and reduction.

Human Systems Integration (HSI) is the engineering approach that allows us to evaluate the effect of these processes on ship operation and ship reliability.

Examination of the way overseas navies are planning for their future warships, and how they are currently modifying existing systems can give us insight into how optimum manning can be achieved.

The United States Navy has initiated the Smart Ship Project on the USS YORKTOWN (CG48). This project has demonstrated that it is possible, in an operational ship, to reduce workload and manpower requirements whilst maintaining mission readiness and safety. This has been achieved through changes in three areas:

1. Policy and Procedure – Changes in policy and procedure were instituted through changes in the traditional watch keeping arrangements by implementing a flexible matrix organisation consisting of core teams and flex teams.
2. Maintenance Methods – Rather than time-phased maintenance procedures, the Project implemented

reliability and preventative maintenance concepts. Improved corrosion control procedures have also reduced workload.

3. Technology – a number of functions have been automated through the use of COTS equipment. These include an integrated bridge system, integrated condition assessment, damage control systems, machinery control, fuel control and internal communications. The COTS system is integrated by a fault tolerant fibre optic local area network.

Crew reductions of up to 15% have been achieved in the Smart Ship Project and many of these innovations are planned to be implemented in other Aegis cruisers and Arleigh Burke destroyers.

Rather than implementing reduced crewing levels in existing ship designs, the Surface Combatant 21 (SC-21 or DD-21) project aims to drastically reduce the crew size from a baseline of 440 to 95 personnel. Such large reductions in crew size, if achievable, will require the application of HSI technologies to ensure that the ship can be operated effectively and safely under all operating conditions. These technologies include modelling and simulation, task analysis, human engineering design principles, job task simplification and HSI decision aiding. The success of the DD-21 program with respect to the crew size reductions will largely depend on the effective application of these technologies.

However, the ADO is not lagging in applying some of these engineering processes in the design naval of platforms. The manning levels planned for the Offshore Patrol Combatant (OPC) were analysed using an Australian developed task analysis modelling system. The OPC Operational Profile Database and Mission Profile Generator, developed by Mercadior Pty Ltd in Canberra, analyses personnel requirements, consumable resources and system requirements and was used to determine whether sufficient resources were available to meet a variety of mission profiles. In addition, the Maritime Platforms Division of DSTO has developed new research projects in the areas of ship automation, fault tolerance, decision support systems, smart ship sensor systems and human-machine integration to provide appropriate advice to the ADO on how best to implement an Australian version of the smart ship.

Signatures

Ship design involves a broad compromise between a spectrum of competing requirements. In this spectrum, signature management has historically taken a low priority. Hence, if subsequently applied to an existing vessel, signature management is seen to cost money to apply and upkeep, consume displacement that could be used for munitions or weapons, interfere with traditional practices and have limited efficacy and hence only be useful in a supportive role to enhance the operations of other countermeasures.

Such impressions stem from the low priority provided for signature management in initial design and are not intrinsic to all styles of ship. Indeed these impressions can all be proven false by suitable design changes. Noting current trends in naval design, pressures to reduce operational and build costs and reduce crew sizes will, most likely, assist the achievement of lower signatures. However, technologies supporting trends to improve sea-keeping could be either counter productive or of assistance.

It is well recognised that signature management is important and will become more so in evolving world political scenarios with the adjustments to the end of the Cold War and regional instabilities. COTS detector technology is currently available to sense and analyse a gamut of potential signals across the radio frequency spectrum, the infrared, visual and ultraviolet, the acoustic spectrum and further can show spatial magnetic anomalies and respond to different aspects of sea or air wakes. Individual stealth concepts have been developed to reduce a ship's detectability for the most immediate of these threat sensors. However, the delivery of reduced or controlled signatures will become more difficult in the future due to multi-band signal integration and the introduction of several new sensing technologies specifically designed to reveal conventional stealthy vessels. Traditional stealth, therefore has to be rethought and become true broadband stealth and be given high priority at the ship design stage. Many ships have pioneered the way for stealth (e.g. Duke and Arleigh Burke classes). However, ships designed for "high" stealth will look very different from today's vessels (including the somewhat unconventional La Fayette class and the Sea Shadow). Both the shape and all the materials of the outer hull will need to be fully optimised for broadband signature suppression. In principle, signature levels could then be significantly reduced, enhancing existing operations and potentially allowing a range of new tactical operations not undertaken by present warships. Most of the basic design concepts for low signatures are well known. Particular attention will have to be given to all fittings and onboard sensing and communication equipment. Australia is amongst the very few countries possessing a broadband stealth material capability. This capability is needed in addition to an adherence to stealth design concepts to achieve remarkably low levels of stealth. Whilst there is further scientific and development work required, a range of construction materials are potentially available to passively reduce the signature of ships.

Many of today's current ships use both shaping and materials (eg US Arleigh Burke) for Radar Cross-

Section (RCS) control, however, they remain vulnerable in other bands. Some nations are building low observable technology demonstrators (eg DERA trimaran) that will pave the way for stealth in the 21st century. The demise of the DARPA Arsenal ship has not diminished the US enthusiasm for a rethink in ship design concepts and one may confidently predict that radical changes to ship designs and hull materials will take place over the next 30 years.

It is not always recognised that stealth is not only the prerogative of the big powers, some smaller nations have prototype and stealthy warships (eg the Visby class of Sweden).

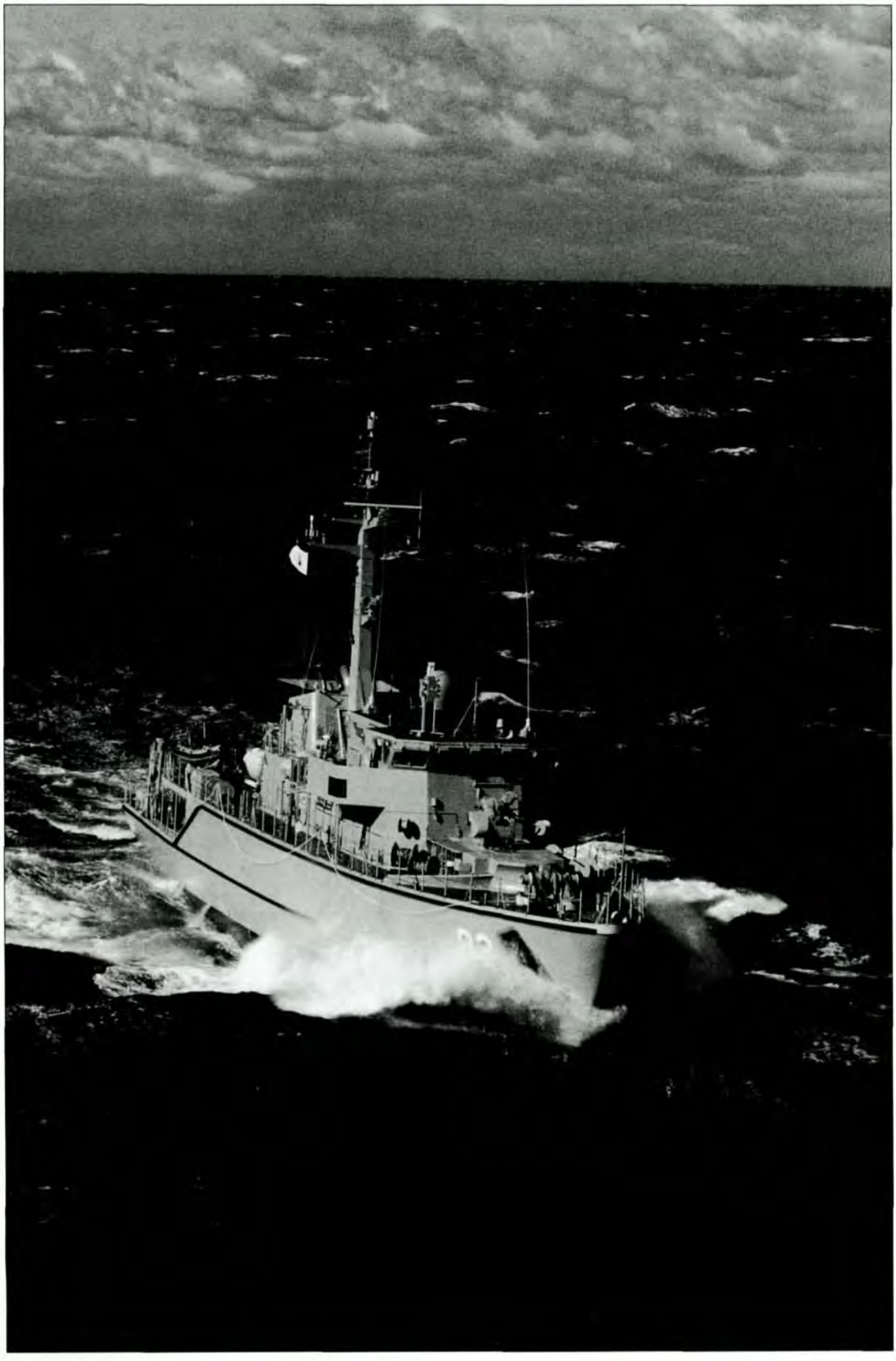
Survivability

Damage to warships in battle scenarios is potentially extremely varied and complex. The primary threats to surface warships include aircraft bombs, anti-ship missiles (ASM's), tethered and active mines and torpedoes. The type of damage produced by these weapons involves both instantaneous and time-dependent effects. For example, the detonation of an ASM within the structure of a warship will produce essentially instantaneous damage due to explosive blast and high-velocity metal fragments. The explosive event will often be followed by a fire that may then progress through the ship depending on the success of the Damage Control (DC) effort. A warship striking an underwater mine is likely to experience localised rupture of the hull leading to flooding and also extensive damage to installed equipment due to underwater shock. In this case, the DC effort will involve the containment of flooding and the recovery of systems damaged or displaced by underwater shock.

The science of quantifying the interaction between a weapon and a naval platform after impact is known as ship vulnerability assessment. In general, the instantaneous damage effects are more readily quantified using ship vulnerability computer codes than the time-dependent effects such as fire and flooding. This is primarily due to the fact that the DC personnel intervene in the physical processes of fire and flooding and their success is influenced by many factors which are not readily predicted. Typically, the instantaneous effects produce severe localised damage to the structure and systems of the warship, but in many cases, it is the slowly evolving time-dependent effects such as fire and flooding which have the potential to produce total loss of the vessel. For conventional wars during this century, about 60% of warships involved in the conflicts received battle damage of some kind.

In recognising this threat, DSTO has developed a wide ranging assessment capability to evaluate the threat to RAN warships and to identify key areas where significant improvements can be made to new-build warships. For example, the DSTO Ship Vulnerability Assessment Methodology (XVAM) provides a computational basis for quantifying the improvements in ship surivivability resulting from modifications in the following areas.

1. The blast-resistance of the ship's structure can be significantly increased. Research has demonstrated that the blast-resistance of typical welded steel bulkheads can be increased up to 300% simply by changing the edge-attachment details. Traditionally, water-tight doors are designed to withstand a notional water pressure of about 100 Kpa (15 psi) and perform very poorly when subjected to explosive blast. Recent field experiments have demonstrated a prototype water-tight door capable of resisting a blast overpressure about 400% larger than for traditional water-tight door designs. These modifications would be essentially cost-neutral in new-build warships.
2. Changes to the configuration of the warship represent another area in which major improvements in battle-worthiness can be achieved at minimal cost. For example, it can be demonstrated that for many ship systems, the most vulnerable parts are the connections such as electrical cables and pipes rather than the major items of equipment which make up the system. A special case for modern warship is the need to protect the computer Local Area Networks (LAN's) which carry much of the vital information required to operate the combat systems. Changing the configuration of the ship to incorporate these cables (and other linkages) into linear structures such as box girders has the potential to significantly improve the survivability of many vital systems.3. The size and packing density of a warship is a fundamental determinant of its ability to absorb battle damage. Packing density refers to the density of vital components packed into a given volume of the warship. Studies have shown that significant improvements in survivability are possible by increasing the displacement of a surface warship and reducing the density at which vital components and systems are packed into the platform. The results of these studies provide strong support for a larger displacement warship to replace the DDG destroyers of the RAN in the next decade. It is important to note that the structure of a warship is both the largest and cheapest part of the vessel. For many frigate-sized warships, the cost of the complete hull and superstructure is only about 10% of the total cost.
4. Survivability may also be improved by protecting the vessel against underwater shock damage. Equipment mounted low down in the warship is likely to experience much more severe shock loading than equipment mounted high in the



Huon Class MHC has been used to develop the shock resistance of our future surface ships.

superstructure. Accordingly, a variety of shock-mounting techniques are employed to protect the major fighting systems of a warship to specified shock levels. Extensive research is currently being conducted which aims to assess the performance of various shock-mounting systems. In addition, detailed Finite Element modelling has been used to evaluate the shock resistance of vessels such as the new Mine Hunter Coastal (Huon-class). The final part of this process is the shock-testing of a first-of-class warship to ensure that the correct construction and installation procedures have been followed. This is part of the Acceptance into Naval Service (AINS) process. DSTO personnel are currently participating in the shock qualification of the Huon class in the sea off Newcastle. The major outcome of this process will be the identification and correction of any shock-mounting problems. These modifications can then be incorporated into the remaining ships of the class. The shock data will also be of great value in validating the results of DSTO's shock modelling research. It is vital that this shock qualification process is carried out for each first-of-class warship commissioned by the RAN (e.g. ANZAC-class, COLLINS-class) to ensure that the vessels are truly battle-worthy and that the designed shock-resistance has, in fact, been achieved.

Recent battle experiences from the Falklands and Persian Gulf conflicts have demonstrated that fire is a potent cause of ship loss following strikes by ASM's. Despite changes in fire-fighting equipment and DC procedures, fire remains a significant threat to RAN warships even in peacetime as demonstrated by the recent fire on HMAS Westralia. DSTO maintains a vigorous fire research program that addresses many facets of this problem. This research includes assessments of fire loads on RAN vessels, assessments of the effectiveness of various fire-fighting agents, evaluation of the efficiency and cost-effectiveness of thermal barriers for protecting vital spaces such as magazines and engine rooms. In addition, a significant fire modelling effort addresses fire and smoke propagation and improved techniques for fire training. This modelling capability was employed to assist in the investigation of the HMAS Westralia incident.

Concluding Remarks

While this paper is not an extensive review of naval platform technology, the most important topics have been addressed and are key drivers for research currently being undertaken within the Maritime Platforms Division at the DSTO. It is essential that DSTO keep abreast of all recent developments in these fields so that it can advise and assist the RAN in major capital equipment decisions. The next naval surface combatant will form an integral part of Australia's defences into the early part of the next century and therefore it is important that these issues are considered in determining the nature of the new surface combatant.

The Challenge of Managing Emerging Technology and the Future of the Surface Combatant

A View from Industry

Ken Harris, Managing Director, ADI Limited

Introduction

During the coming decade, decisions are expected in several parts of the world on the purchase of a new generation of medium-sized surface combatants. In the United States a procurement announcement might be expected on the DD-21 land attack destroyer, while experimentation has been foreshadowed with the concept of a smaller, more stealthy *Street Fighter* ship. In Europe a number of countries will be deciding whether to proceed with the *Horizon* frigate programme, Britain will be considering the possibility of frigates with a trimaran hull form and, in Denmark, decisions may be forthcoming concerning the construction of the proposed class of large standard vessels, probably in a number of configurations. In Australia as well, the coming decade will see detailed consideration being given to the type, or types, of new-generation surface combatants that may best fit the country's needs in the 2015–2050 period.

Planning for a class of major defence equipments that may not be commissioned for 15 years and can still be expected to be in service in 45–50 years time is a daunting exercise. Questions need to be asked about the nature of the security environment that is anticipated in this period. What can we expect the world to be like? Will the United States still be the dominant economic, political and military power in the Asia-Pacific through this period? Will this region be dominated by a framework of security cooperation or by increased inter-state tensions and conflict? Will Australia's Southeast Asian neighbours regain their economic momentum so that our countries can enjoy a new era of friendly prosperity, or might we face a more troubled Southeast Asia with several crippled states and, possibly, one or more "rogue" governments?

Then it will be important to assess how Australia's strategic priorities might develop in the 2015–2050 timeframe. Where will Australia's most critical interests be? Who are likely to be Australia's closest allies and friends? Will Australia's relative power grow or decline during this period? In particular, should Australia's primary defence focus be on our most vital, and generally geographically closer, interests or will we be able to afford to develop and maintain military capabilities designed to protect much more expansive interests?

A further set of preliminary questions concerns the nature of the military operational environment that can be expected in the 2015–2050 timeframe. How well developed can we expect wide-area surveillance and intelligence systems to become in the Asia Pacific region in this period? Can we expect advanced combat aircraft and supersonic anti-shipping missiles to proliferate through many parts of the region? Will some regional countries be able to develop much more highly integrated sea-denial capabilities in this timeframe?

These, and a range of other related questions, deserve careful consideration if Australia's new surface combatants are to be optimised for the future defence environment, rather than that of the present, or even the past.

Changing Operational Requirements

Although the precise nature of the future operating environment is impractical to define now, it is possible to identify some of the strong tides of change that are likely to have significant consequences for the ways in which the Australian Defence Force (ADF) of the future will operate. Particularly notable developments might be expected to include the following.

First, new generations of wide area satellite, air, sea and land based surveillance systems look likely to be deployed in the Asia-Pacific region by the more wealthy and powerful countries in the 2015–2050 timeframe. When these systems are tied together *via* tailored communications links, large parts of the theatre will probably come under continuous surveillance. This is likely to mean that most types of operations in the air, on the surface of the sea, and large scale operations on the land will be much more readily detected and monitored. Particularly pertinent to this discussion is the prospect that operations on the surface of the sea are likely to be far more transparent in this timeframe. Stealthy technologies to reduce ship signatures and other countermeasures can be expected, in consequence.

Second, if the ADF's access to a combined Australian and United States surveillance network across the Western Pacific comes to fruition in the way that is generally anticipated, opportunities should be opened for Australian surface combatants to operate in new and rather innovative ways. In the 2015–2050 period, the allied surveillance network should be able to advise, in close to real-time, the positions of hostile, potentially hostile and neutral ships, submarines and aircraft in most parts of the Asia-Pacific. This knowledge should provide freedom for Australian surface combatants to manoeuvre in combat environments with much greater confidence and security and, when appropriate, to disperse with much less risk.

Third, in the 2015–2050 timeframe, Australian and allied operations on, above and below the surface of the sea seem likely to be networked in ways that we are only now starting to visualise. Individual surface combatants are likely to rely frequently on surveillance information provided by the broad surveillance network and by other platforms. Indeed, cooperative engagement technology should provide next-generation surface combatants with the capability to launch attacks against air, surface and sub-surface targets using tracking and guidance data provided entirely by off-board sensors. In many situations this should permit next-generation surface combatants to operate safely in much more passive modes. These developments raise important questions about how complex and expensive an optimised sensor mix might need to be for the next generation of surface combatants.

A fourth important change in the 2015–2050 timeframe will be the greatly increased distances over which surface combatants will be able to launch attacks and the much larger volumes of fire that they will be able to deliver in short periods of time and with high precision. Indeed, because of the volume of long range precision fire that they will be able to bring to bear on key targets, the next-generation of surface combatants may become a primary strategic strike asset for advanced defence forces. At the more basic end of the weaponry spectrum, new 127 mm guns are expected shortly to demonstrate extended range guided munition delivery to distances of 116 km. The Land Attack Standard Missile and the Navalised Army Tactical Missile System provide options to reach out several hundred kilometres. The *Tomahawk* cruise missile and the Hypersonic Strike Missile, that is scheduled to be demonstrated during the coming few years, will be able to deliver to ranges of 900–1500 km.

HMAS Perth
DDGs in the twilight of their careers

A fifth area of anticipated change is the development of much more tailored logistics for surface combatants. New surface combatants will not only contribute and receive networked information on the operational environment but will also send and receive detailed information on consumables, equipment states, spare parts requirements, and stores availabilities etc. This should facilitate the tailored delivery of supplies and the development of much more rapid and precise maintenance schedules, both at sea and in port.

A sixth important area of change that is likely to affect surface combatants, and nearly every other element of the ADF in the 2015–2050 timeframe, will be the much more rapid pace of campaign execution. Many types of conventional operations are unlikely to last for weeks and some may not even last for days. The primary phases of many campaigns in this much more transparent environment may only extend for hours. Nevertheless, the periodic need to pre-position some surface units to distant locations and the demands of low intensity conflict and peacetime operations may still require at least some future surface combatants to be capable of extended endurance.

While these and related changes can be expected to have a substantial impact on the operational environment in the medium-to-long term future, exactly how far and fast these trends will develop is difficult to predict. A degree of caution would seem appropriate when considering the rosy promises of some information technology specialists. In particular, it would be prudent to exercise care about the practical limits of the information that many of the new surveillance systems will be able to deliver. For example, the processes of detecting and tracking enemy, friendly and neutral shipping may appear achievable, but positive identification of all apparent neutrals may prove to be much more difficult in practice. In particular, ascertaining the presence of "Q" ships[1] via remote surveillance sensors may be exceedingly difficult in most operational conditions.

Further, in networking the theatre by tying together widely dispersed surveillance systems and combat units with advanced communications and computerised command and control systems, we should not overlook the potential vulnerability of some of these electronic systems. In designing and developing such networks, there will be a need to prepare for defensive and offensive information warfare from the outset. This is the venue for a new arms race and the key systems on Australia's new surface combatants should be designed to put the ADF in the strongest possible position.

Considering the factors likely to change in the naval operating environment in the 2015–2050 period clearly raises a range of fundamental issues pertinent to any new class of Australian surface combatant. Most fundamentally, given the nature of the military operational environment that might be anticipated in the 2015–2050 period, it would seem appropriate to reconsider carefully those military roles it will most likely be expedient and cost-effective to perform on and from the surface of the sea in the future. What precisely is it that surface combatants, as against other defence platforms, will be ideally suited to perform in this timeframe?

How important can we expect the protection of surface shipping to be in this era? Might there not be scope for a combination of long range surveillance systems and combat aircraft to carry more of this load or will the protection of surface shipping remain a key role for surface warships? How might anti-surface ship warfare be performed most effectively in the period ahead? Can we expect combat aircraft and submarines to carry more of this task? How important will anti-submarine warfare be for the ADF in 2015–2050, and how is it likely to be undertaken most efficiently? Might fire support against shore targets possibly become a more important surface combatant task in the period ahead? Will amphibious combat operations in the medium-term future most likely involve slow, conventional over-the-beach assaults, or will they more frequently take the form of long-range heli-borne special force raids? And will tanker and other afloat support ships still be critical, or might there not be scope to trade off some or all of these ships' capabilities by simply designing the new surface combatants with substantially larger fuel carrying capacities?

Alternative Approaches to Australia's Future Surface Combatants

In weighing all these factors and assessing the likely consequences for Australia's new surface combatants, three main schools of thought appear to be developing in the defence community.

One view is that despite the major strategic and operational changes that seem to be underway, the fundamentals of maritime warfare are unlikely to change. In consequence, in the 2015–2050 period, the Royal Australian Navy (RAN) will need to be able to perform its primary roles using highly capable multi-purpose combatants in a manner broadly similar to the accepted practice of the last 50 years. According to this logic, the ADF's new surface combatants would probably be moderately large, relatively conventional, and very expensive, but they would offer the potential to operate with flexibility on their own in many hostile environments.

A second school of thought argues that operations within the coverage of the type of allied theatre information and combat network anticipated for

[1] i.e. an enemy ship that is disguised to appear neutral or friendly

2015–2050 changes markedly the desirable characteristics of next generation surface combatants. According to this view, opportunities are being generated for less expensive vessels, that while still providing great flexibility, would be more tailored to the priority roles and tasks identified in Australia's strategic policy. These vessels would be much more closely integrated into the theatre network, would make extensive use of off-board sensors, and might possibly be faster and more stealthy.

A third school of thought argues that in the 2015+ timeframe, the surveillance, intelligence and maritime strike capabilities of all credible opponents in the Asia-Pacific region will be so strong that there will be little that can be done cost-effectively from the surface of the sea in intensely hostile environments. This school of thought argues that there may be a case for the ADF to possess some modest surface forces to conduct peacetime and low-intensity operations, but that in serious conflicts it would be better to avoid placing high value capabilities at risk on the surface of the sea. A preferred course would be to reinvest the resources saved in sub-surface, air and other capabilities that are able to perform those maritime tasks that strategic guidance identifies as being critical.

As a taxpayer located outside the defence force structure decision-making process, the conduct of this sort of debate in a timely way would seem to be very healthy. Only through a rigorous process of assessment and discussion will the Defence Organisation and the government be able to define the best way ahead, and be able to convince the Australian community that the most cost-effective path has been chosen.

Broader Factors Relevant to New Surface Combatant Design

When viewing the tides of technology and military operational change from an industry perspective, some broader themes seem likely to exert increased influence on the shape of Australia's new surface combatants.

First is the strong trend in both defence expenditure and in operational capabilities from defence platforms *per se* to defence systems. It is the electronic systems that can collect, process and display information, facilitate rapid decision-making and then initiate and control appropriate responses that increasingly dominate modern defence forces. In the case of new airborne, seaborne and land-based platforms, much of the information, and frequently a great deal of the processing that is required for effective task performance, is gathered and/or transferred by other platforms or off-board systems. In effect, ship platforms may eventually become just expedient means of keeping key elements of networked theatre systems afloat and dry in convenient locations.

Second, the rise of information and combat systems that are networked across multiple ship, airborne and possibly other platforms raises new challenges for the planning and management of system modifications and upgrades. Because of the integrated nature of the new multi-platform systems, many modifications and upgrades will probably need to be undertaken by phases not just in individual platforms, or even through platforms of a particular class, but across all force elements that play roles within the networked system.

A third factor for change that would seem to have implications for new surface combatants is the extraordinary pace of civil technological development. When the life-cycle for commercial software is 12–24 months, and the life-cycle for much commercial hardware is 3–5 years, the traditional acquisition cycle for major naval systems of 15–20 years now appears risky. One consequence is the desirability of building-in standard commercial hardware and software if and when this is practical. A second consequence may be to encourage new thinking about the contracting practices for future surface combatants so as to minimise the risk of locking contractors and the ADF into approaches and technologies that have short life-spans in the commercial world. There may, for instance, be scope to consider the innovative use of evolutionary and/or progressive acquisition methodologies to overcome the danger of early system obsolescence.

A fourth element of change that may have implications for future surface combatants is the prospect that, in the years ahead, the Defence Force will come under increased pressure to contract out almost all non-core combat functions. There may be ways of designing and operating new surface combatants to make the most of the contribution that can be made by contractor personnel. For example, as mentioned earlier, the automated monitoring of ship systems and sub-systems and the routine transmission of this data ashore should facilitate much faster, tailored maintenance schedules by contractors in port. Similarly, it may be sensible to plan for the routine use of contractor personnel to provide particular services, or to support some systems, at sea. For this process of staff "merging" to be most successful, additional effort would be required in both industry and Navy to strengthen cooperative relationships and build a stronger shared culture.

A fifth factor that will impact on Australia's approach to new surface combatants will be the extent to which it will be feasible for the RANs existing frigate force to be upgraded economically for operations in the new environment. Particularly pertinent here will be

considerations of the wisdom of spending substantial funds on the proposed ANZAC Warfighting Improvement Programme, when the capabilities that may result could fall far short of those required in the 2015+ period. At a time when the forward capital equipment programme is under an unusual level of pressure, carefully considered judgements on future ship upgrade programmes will be critical to an optimal outcome.

A sixth factor that is likely to impact on planing for new Australian surface combatants is the high costs of ship-borne personnel. These high costs, when combined with the growing experience of automated naval systems, suggests potential for future crew sizes to be substantially lower than those of the past. The Smart Ship programme in the United States is providing valuable insights in this field.

A seventh and related challenge will be that of recruiting and training the naval personnel with the right mix of skills and talents to crew the new ships.

At its core will be criticality of preserving the Navy's warrior spirit, whilst most crew members will spend nearly all of their working hours in front of computer screens. It will be essential for the new ships to be commanded by officers who can handle extreme stress, who can cope with critical failures in information sources and who can lead their crews through the chaos and awfulness of battle. Despite the pervasiveness of high technology on Australia's new surface combatants, human factors will remain critical to combat outcomes.

Key Requirements of Industry Support

This discussion suggests that at least some of the factors likely to drive the shape of Australia's future surface combatants will be different from those that we see today. Most of these influences for change will also have important implications for defence industry. In the 2015–2050 timeframe, what can we expect the key requirements of industry to support new surface combatants to be?

First, companies will need deep expertise as system integrators and system managers. They will need to be strong, not only in designing, building, installing, operating and upgrading systems within the new ships, but because many of the key operating systems will span multiple sea, air, space and land-based platforms, companies will need to be able marshal and apply skills right across theatre networks.

A second characteristic that will be critical for effective defence company performance in this period

HMAS Anzac

will be the capacity to build and manage effective business partnerships in what is increasingly becoming a global, high technology industry.

As we look to the challenges that will be posed by the new surface combatant project, no single company will have all of the resources necessary to completely satisfy the ADF's needs. Even in the current era of defence industry rationalisation, when we are seeing the emergence of a number of very large defence conglomerates, there are still few defence projects that single companies can tackle effectively alone. Assembling and managing teams of companies to supply, integrate and maintain the required technologies, with an overall leader to mould the contributions into a good product for the customer, will be critical to success in this field.

A third key requirement for defence companies involved with the new surface combatants will be sound project management. The requirement will not be just for project management skills in a narrow sense, but project management skills enhanced by deep knowledge of, and experience with, relevant advanced technologies. Companies that wish to succeed in this field will need to actively foster project management skills, to build a strong culture of excellence and, above all, to generate a high level of cooperation between employees, partners and customers.

A fourth key requirement for defence companies will be to attract and retain high quality personnel who routinely demonstrate great creativity and flexibility in proposing and demonstrating innovative and effective approaches. Given the pace of change in this field, we will need people who thrive on new challenges. Hence, the requirement will not just be for people who possess strong professional skills, but for those who also generate that intangible spark of creativity and capacity for lateral thinking.

A fifth key requirement of defence companies in this area is likely to be the development of a culture and a set of practices that facilitate much easier and more effective merged operations with uniformed personnel. New orders of flexibility and one-team approaches will be essential. Modifications to staff training and conditions of service will also be required, particularly if some contractor personnel are required to accompany combat units into harms way.

Creating the Most Productive Environment for the New Surface Combatant Project

This article has painted the picture of an environment for Australia's new surface combatants that may be significantly different in its strategic features, require modified military concepts of operation, be characterised by higher levels of system and technology integration, require new approaches to ship support and upgrade concepts, encourage greater industry involvement and, probably, be characterised overall by a more rapid pace of change.

If these elements of change are likely to be prominent in the future, what broad policies and practices might best generate a healthy and effective environment in which the Defence Organisation and industry can cooperate most effectively?

Let me make a key point here that is often overlooked. Both the Defence Organisation and Australian defence-related industry have a vital interest in seeing the Australian economy continuing its processes of structural reform and maintaining high rates of growth. A strong, highly competitive Australian economy is critical to the country's future security. There are four main reasons why the Defence interest in a healthy, growing economy is so strong.

- First, successful economic reform and sustained high rates of economic growth will generate increased resources for defence investment.
- Second, highly competitive and productive Australian industry will strengthen the technological and skill base that will be available to support national defence. Australia's companies will have much stronger capabilities to contribute to "whole of nation" security efforts.
- Third, a strong, internationally competitive Australian industry will be capable of producing quality defence products and services at lower prices.
- Fourth, because of the rising strength and competitiveness of most of Australian industry, we are now integrating our economy into both the technologically strong economies of the United States, Europe and Japan, but also into many of the high potential economies of the Asia-Pacific region. Closer integration of Australia's economy with those of the region will strengthen joint interests and inter-dependencies and help substantially to foster regional cooperation and a favourable security environment.

The Defence interest in the success of the Australian economy is, hence, very strong. The most secure countries of the world, and those with the most capable defence forces, are generally those countries with the strongest economies.

Moreover, Defence has an important role to play in fostering such economic strength. At the core of Australia's recent economic success has been a robust commitment by successive Australian Governments to open market principles, to free and fair competition, to deregulation and to a striving for best value for money. If defence decision-making implements these policy approaches vigorously and creatively in the period

ahead, Australia's defence industry support capabilities are likely to be strengthened greatly. Australia's capability to support major new defence capabilities, such as the future surface combatants, will be substantially enhanced.

In considering the practicalities of making further progress in this field, several areas seem deserving of particular attention. For instance, the processes of the Defence Reform Programme involve considerable rationalisation in many support areas of the defence portfolio in order to permit a re-allocation of resources to priority combat and combat-support functions. Despite the substantial progress that has been made through the commercial support programme in recent years, my sense is that the Defence Organisation has yet to fully embrace a "whole-of nation" approach to security capabilities. Industry is willing and able to contribute a much broader range and depth of capability to Australia's defence effort if Defence is prepared to think beyond traditional approaches to capability development and maintenance. I believe that there is potential here for further significant efficiencies.

A second area in which Defence can reap much better results from competitive activity is in its statement of specifications for acquiring equipment and services. When companies are given broad functional specifications, they have demonstrated a remarkable capacity to respond with highly innovative and cost-effective proposals. In this area, Defence could benefit greatly by lightening its hand on the tiller, reducing specifications to the basic essentials and giving industry the freedom to show what it can really do.

A third key area requiring reform is the way that in recent years elements of the Defence Organisation have applied the concept of "best value for money", particularly in equipment maintenance. In this field there has been a tendency by some to assume that the lowest bid price is automatically that which offers the best value. Some of these judgements have resulted in the award of important, technically demanding contracts to "tin shed" operators who possess little technical depth and very weak financial resources. The result has often been a poor quality result, that has been over budget and delivered very late. If the concept of "value for money" took into consideration the need to develop and strengthen the industrial capability needed to support military equipment over long periods, there would be fewer "tin shedders" in business.

Assessing bids for projects of technical and managerial complexity requires balanced judgements of the type routinely made by major commercial organisations. While the perception exists that a junior decision-maker rarely gets into trouble by recommending the lowest price bid, Defence will remain vulnerable. Not only are further contracts likely to fail, but Australia's capacity to provide quality "whole-of-nation" defence support will be diminished.

In this field, defence could ensure more cost-effective, predictable and timely outcomes by requiring tenderers for technically and managerial challenging projects to satisfy a demanding set of prior qualification criteria. Then, by specifying the work in broad functional terms, highly competitive, innovative and deliverable responses could be guaranteed. Processes such as these should foster a strengthening of the real capabilities of industry to support the Defence Force. Those companies that are serious about providing sophisticated and deep levels of support to the ADF would be encouraged to invest in the complex skills and the specialised plant and machinery that is required to provide quality support to surface combatants and other key defence assets. Through processes such as these there is potential to harness the full support of the nation far more effectively.

If the processes of the market are allowed to operate effectively, capable defence contractors should earn profits. This is in the interests of both business and Defence. Without profits, companies will withdraw from this industry and will not invest in its future. Without business investment, Defence will find that the essential capabilities needed to develop and maintain our Defence Force will disappear. Profitable defence contractors are as necessary to the future strength of our defence effort as is a well trained Defence Force. Defence needs companies who will be around in the long term to provide competition and technology. They must be encouraged to stay in the business by positive market signals.

In creating a more productive defence environment for the demands of the 2015–2050 period, industry also needs to lift its game. In particular, defence companies need to work harder to understand where the Defence Organisation is going, and especially to gain a much more detailed appreciation of the technical and operational challenges now confronting the ADF. When considering future maritime programmes, defence companies need to move beyond the smell of welded steel and the screech of lathes to focus on the network systems challenges that will be at the heart of the ADF's operational capabilities. Only when industry develops this greater depth of understanding and shifts the focus of its attention to the ADF's real challenges of the future will it be well placed to perform effectively as a close teaming partner.

Conclusion

The Australian Naval Institute is to be congratulated for taking the initiative to foster public debate on the future of the surface combatant. There are important issues to be clarified and some significant opportunities to be explored as thinking in this field progresses.

Many key issues concern the roles and requirements for future surface combatants. Precisely what roles will they need to perform, in what types of operational environments and with what networked connections to other platforms and systems? How far will it be sensible to go in reducing crew sizes and how strong are the prospects for evolving more innovative and cost-effective support capacities?There would seem to be potential for developing some highly capable and very cost-effective design options that would give Australia substantial maritime power in the first half of the new century.

The processes of developing a programme for future surface combatants also provides an unusual opportunity to strengthen Australia's broader defence capabilities. A project of this size and importance has the potential to encourage both the Defence Organisation and industry to work together to produce a "whole-of-nation" outcome that is greater than the sum of its individual parts. By reinforcing open market principles and fostering high quality commercial practices, the industry-defence partnership has the potential to grow much stronger and to acquire more powerful capabilities. The planning and decision making challenge is to ensure that Australia gains the greatest possible economic and security benefits from the opportunities that lie ahead.

Submarines – part of a balanced fleet

Has the Royal Australian Navy Achieved A Balanced Fleet?

By Lieutenant Commander D P Schopen, RAN

"Medium powers will find much they need to safeguard, much they would like to do, at sea in strategic terms – and all too few resources to do it with."

Rear Admiral J R Hill[1]

Introduction

Maritime Strategists have theorised comprehensively over the subject of what determines a balanced fleet. Traditionally, a balanced fleet is essentially, the combination of a Battle Fleet and a Control Fleet.[2] The successful balance must lie with the capacity of the state to sustain the fleet, and the strategic circumstances within which the state finds itself. Consequently, the combination of vital interests, threats, alliances, levels of conflict and reach becomes the core of maritime strategic planning and the basis for designing forces within reasonable limits.[3]

Australia has generally been regarded globally as a medium power.[4] Since priority was given to self reliant defence in the mid-1970s, it has attempted to broadly base strategic concepts around an ability to defend the country across the sea-air gap. More recently, the current government released *Australia's Strategic Policy* 1997 (ASP 97) which identified that the Australian Defence Force (ADF) would be required to undertake combat operations to defeat attacks on Australia, defend our regional interests, and support our global interests.[5]

In response to the changes in regional security arising from the end of the Cold War, and domestic pressures from society to direct more government spending towards community welfare issues such as health, education and employment, the force structure in the Royal Australian Navy (RAN) has changed significantly over the last twenty years. Australia has attempted to maintain capability, in line with military technological advancement, opting for platforms which could be sustained on the minimum manned concept, at the expense of the large manpower intensive warships that existed in the RAN from the end of WWII until the mid 1980s. However, history has shown that the financial burden of maintaining a fleet is significant. The largest challenge for a country, such as Australia, is to sustain a maritime force capable of protecting such a vast coastline and substantial economic zone. The aim of this essay is to examine how the RAN has attempted to maintain a balanced fleet, in line with the national security strategy and budgetary constraints.

Maritime Strategy Considerations

The focus of this section of the essay, will be on the maritime strategy considerations for medium powers, such as Australia. Admiral Hill argues that: "A medium power is a state that prizes autonomy and is able to manipulate power in order to deserve it, a medium maritime power will aim to use the sea in order to enhance this ability."[6] The basic problem faced by a medium power is coping with the vulnerability of its interests, and the diversity of the threats to them, from its available resources.

Sea Control

A consistent understanding from the "Historical School" of maritime strategists has focused around a balanced fleet having the ability to project power, win a decisive battle in order to gain command of the sea, and then maintain and exercise that command and control. Sir Julian Corbett proposed that "by destroying or neutralising the enemy, the battlefleet won command which only these other naval forces could exercise". The control fleet, who operated under the cover of the battle fleet, "exercised command, patrolling focal and terminal trade areas, escorting convoys and military transports, and patrolling to intercept enemy commerce."[7] While contemporary strategists have refined the concept of command of the sea to a need for sea control, this principle still applies.

The strategists and historian, John B. Hattendorf suggests that: "The fundamental focus of the military element in maritime strategy centres on the control of human activity at sea... There are two parts to this: establishing control against opposition and using control, once it has been established."[8] For a state to exercise sea control, it must achieve sea assertion, which is defined as the ability to use the sea for ones own purposes, and sea denial, which attempts to prevent the enemy from using the sea.

Medium powers look at sea control as being "in limited areas and for limited periods of time."[9] They would expect to exert control in coastal waters, or to the extent

of an area that could be covered by the organic air assets. This focus on sea control for a medium power revolves around its ability to use the sea. It confers mobility, initiative, the ability to choose new axes of advance, and to complicate the opponent's problems; it allows those entities (nations, garrisons, expeditionary forces) that are not self sufficient to be sustained; and it is an important vehicle for maintaining the territorial integrity of the more vulnerable participants. The economic uses of the sea consist of trade and commerce on its surface, and exploitation of recourses in its depths and subsoil.[10]

Sea denial for a medium power can provide both positive and negative situations. Under favourable circumstances sea denial may be exercised against an intrinsically stronger power, resulting in a range of outcomes, from successful deterrence to a limited conflict. Alternately, a significantly weaker power may undertake similar action against a medium power to deny use of the sea. However, it must be said that penalties for getting sea denial wrong may be quite severe, as was the case in the Falklands War.[11]

Levels of Conflict

The level of conflict is a very important planning tool for a medium power in determining its maritime strategy. It helps to set the limits on what a medium power needs to be able to do on its own, with the resources it can provide. In order to extract the maximum planning value from a broad scope of realistic situations, Admiral Hill proposed four levels of conflict: normal conditions, low intensity operations, operations at the higher level, and general war.[12]

In considering these levels of conflict, a country (such as Australia) can develop a force structure specifically for its own situation, accounting for a multitude of contingencies that may arise. It will also provide the catalyst for determining policy for a myriad of issues, some of which are: degrees of preparedness, weapon order of battle, presence, care of alliances, scope of operations, rules of engagement, and extent of commitment.

Reach

Reach can broadly be defined as the distance from home bases at which operations can be carried out.[13] If a medium power has no extended vital interest beyond its exclusive economic zone (EEZ), then it may judge that there is no requirement to extend its reach further than that EEZ. However, often medium powers will restrict their reach as a consequence of budgetary constraints rather then perceived needs. This places a medium power like Australia in a difficult situation, whereby it must protect the sovereignty of distant territories such as Heard, the Cocos and Christmas Islands.

Reach must be complemented by sustainability. A medium power will not usually have sufficient support bases beyond the domestic mainland so it is necessary to either cultivate alliances or provide autonomous means if reach is to be sustained. Sustainability is comprised of both human and material factors.[14] With increased reach comes long periods away from home port, and this must be acceptable to the individuals and their families. Warships must be designed to work in all expected sea states and climatic conditions.

A Medium Power's Requirements for a Balanced Fleet

Maritime force requirements for a medium power should activate two trains of thought: the first being what forces are required for national needs of self reliance, considering the levels of conflict and reach requirements; and secondly, the price of alliances.[15] Most medium powers will pay for an alliance with a combination of strategic position, facilities, diplomatic support and contributory forces. Medium powers must take due care to ensure that they focus their force structure on national needs, rather than contributing to an allied force that would be optimised for a level of conflict which is higher than that in which they are willing to get involved. An ally should provide a force when the medium power's vital interests are threatened, and it cannot cope on its own.

The first consideration for a medium power maritime force, is likely to be the protection of domestic territory, including the waters around its shores. To protect a substantial coastline and economic zone, this force should consist of constabulary air and surface forces, linked to a well organised vessel traffic services (VTS) organisation. The VTS organisation undertakes operations such as survey, navigational warning, traffic routing buoyage, and port approach control.[16] If successful, this organisation will reduce the likelihood of any undetected territorial infiltration.

To support this constabulary force, other assets should include powerful air and surface combatants. A quick-response special force should be available to deal with any attack that may be directed at offshore installations. Submarines would provide significant cover against a major invasion force, and mines have proven to be a very effective force multiplier in defence of coastal areas, and as a means of deterrence in periods of tension. Of significant note, is that the majority of these forces should at least be able to reach to the limits of the EEZ.

Most medium maritime powers have interests exceeding their EEZ, and this is where the next set of considerations should focus. The medium power must determine the level of conflict they are prepared to commit to, and against what kind of opposition. This force structure should be designed towards a capability of operating independently at the higher levels of

conflict.[17] It is reasonable to suggest, that most of these operations will occur a significant distance from home shores, and sea use will be the ultimate aim. All warships that operate in these areas need effective above-water defence, in the way of weapons and countermeasures. But the most comprehensive (and expensive) defence for such a force will come from combat aircraft. The requirement for these aircraft to reach several hundred miles from home base, highlights other necessities such as an air-to-air refuelling capability and forward operating bases. Otherwise, the most desirable option to guarantee aircraft reach is to provide ship platforms for sea based combat aircraft – a very expensive option.

Other considerations for this force include: the use of submarines in countering a surface threat; anti-submarine warfare (ASW) capabilities, including maritime patrol aircraft (MPA); and ships capable of conducting replenishment at sea. The requirement for an amphibious force is a matter for considerable debate, and I would suggest that the inclusion of a significant amphibious capability, may have to come at the expense of another capability.

The final consideration of force structure for a medium power, relates to the employment of platforms in general war. Assets within the force must be capable of providing a meaningful contribution to an allied force, and have the ability to sustain a fighting capability amidst enemy fire, which may be of a disproportionate scale. The second consideration within the context of general war, is whether the medium power should provide its own nuclear deterrence.[18] Whether it be a sea-based system or not is another argument, suffice to say that its possession puts a medium power in a completely different category with respect to the defence of its territorial integrity. In the current world climate, it would be fair to say that it could cause considerable unpopularity and tension.

Australia's Strategic Requirements

To consider Australia's use of sea power, it is initially pertinent to consider Australia's current strategic policy. ASP 97 identifies that defeating attacks on Australia carries the highest priority, and that it is the core criterion for decisions about priorities for capability development for the ADF. "Maximising our self-reliant ability to defeat attacks on Australia is important because this capacity is central to our overall strategic posture, and indeed, to our wider national self image... it has been the central figure of our strategic posture since the 1976 Defence White Paper."[19]

Australia's second highest priority of defending our regional interests draws attention to maintaining the capability to make a substantial military contribution in many different possible circumstances, in order to defend our regional strategic interests.[20] Australia's other priority, supporting its global interests, will not determine force structure, as it is envisaged that the capabilities developed to meet the higher priority tasks, will provide a sufficient range of options to meet these tasks.

Such strategic guidance would suggest that the focus of a supporting maritime strategy should be sea control, emphasising "operations which concentrate on defeating any aggressor in our maritime approaches, before they reach our territory."[21] However, it clearly has not deliniated to what level of conflict Australia is prepared to go to, and against what kind of opposition.

Is the RAN a Balanced Fleet?

ASP 97 states: "If Australia maintains the capability to deny our air and sea approaches to hostile ships and aircraft, then we can prevent hostile forces reaching our territory or operating on it for long."[22] However, again the questions must be asked: against what type of threat, and to what level of conflict? So as a basis to determine balance within the fleet, I believe the RAN must be able to undertake major independent operations in a major regional conflict. That includes implementing a strategic deterrent, conducting operations within range of high capability hostile shore based aircraft, operating under threat of modern diesel-electric and nuclear powered submarines, and conducting operations against surface combatants of similar capability to our own.

The RAN must be able to ensure the safety from mine, submarine, or surface attack of Australia's coastal sea borne and overseas trade. Also, it must have the capacity to move Australian military forces throughout the EEZ, and support those forces once they are ashore. A requirement for the RAN to undertake combined operations with the United States and other friendly regional powers is also a necessity.[23] It is widely recognised that Australia's maritime force is joint in nature, so while the majority of air assets are owned by the Royal Australian Air Force (RAAF), I will regard them as part of the maritime force.

In normal conditions, the RAN must be able to play it role in patrolling the EEZ. This commitment is currently honoured by the Fremantle Class patrol boats (FCPB), in partnership with the government funded Coastwatch, who provide air surveillance assets and additional patrol boats. In recent times, the RAN has committed HMAS *Anzac* and HMAS *Newcastle* in a constabulary role, to protect the territorial waters surrounding Heard Island. Highlighting the fact that RAN vessels are apprehending fishing intruders is important in demonstrating to the Australian people that the navy they pay for is doing something essential. The RAN has demonstrated a stalwart commitment to hydrographic surveys around the coast of Australia and within the region for many years. I believe these two functions offer a "naval presence" to the national public.

Our maritime force has demonstrated the ability to manage all contingencies with which it has been tasked, during normal and low intensity operations. However, the challenge to the force lies in its ability to conduct credible operations at the higher level, and ultimately during general war. The force must be capable of asserting some, or all, of the facets of sea use, sea denial, and reach. For these operations, lethality, information gathering and processing, and communications are all critical.[24] Much of this has been recognised in ASP 97, with the publication of the force structure development priorities.

The highest capability priority is given to obtaining the "knowledge edge", by exploiting information technology, so as to use our relatively small force to maximum effectiveness. The second priority is to develop a mix of air, surface and sub-surface forces to defeat threats in our maritime approaches. Upgrading our strike capability with the extension of service for the F-111s, acquiring long-range stand-off weapons, improving electronic warfare and air defence suppression capabilities, is the third priority. Developing land capabilities to defeat threats on Australian soil is the final priority.

In recognising these priorities for capability enhancement, and successfully completing all current force development projects, (such as the Anzac war fighting improvement program, the FFG upgrade, and the acceptance into service of the remaining submarines, the LPAs and MHCs), I consider that our maritime force will be a credible, effective and balanced force, with some exceptions. This is said, considering the significant constraints on personnel and budgetary limitations implemented by the government.

The effectiveness of defensive mining as a low cost force multiplier and deterrent was best illustrated during the Gulf War in 1991. The ADS's mining capability is limited to the delivery of modified bombs by aircraft or submarine.[25] This is a very expensive means of weapon deployment in a defensive role. The RAN needs to increase its mine inventory with easily deployable, discriminatory weapons, and effectively use existing fleet assets to undertake the defensive mining role.

Once fully functional, I am sure the Collins Class submarines will be everything initially expected from the original design, and would whole-heartedly support the construction of the seventh and eighth submarines if viable. However, at the risk of disagreeing with the ASP 97, I believe the Collins Class weapons outfit does not exploit the full potential of the platform.[26] The acquisition of a new modern torpedo to replace the Mk 48 should occur in parallel with the capability enhancement project. But the addition of a *Tomahawk* type land-attack cruise missile would add a new dimension to the RAN's strategic strike and covert deterrent capability. This may be an extremely unpopular decision amongst regional neighbours. However, it would go part of the way to providing our own strategic ballistic missile deterrence. ASP 97 does recognise that "Australia is within range of the ballistic missile forces of the five declared nuclear powers. And in our region, India, Pakistan, and North Korea have or are developing ballistic missiles."[27] While none of those countries currently poses any threat to Australia, as Admiral Hill suggests, it must be remembered that: ". . .normal conditions in international relations are more those of compensated tension than of true peace."[28]

There is significant discussion on the enhancement of the ADF's air-to-air refuelling capability. Considering the time it takes for a project to translate military prospects into reality, I believe this should be the ADF's highest capability priority. Earlier, I discussed the desire for a medium power to achieve reach, and in achieving reach they must be able to demonstrate some form of sea control. Combat aircraft can contribute greatly to gaining sea control. An effective air-to-air refuelling capability will add significant reach to our combat aircraft, and consequently to the reach of our maritime force. This will also be a far more cost effective alternative for the support of maritime aircraft, than an aircraft carrier would be.

It must be highly uneconomical for such a small fleet air arm to support so many different types of aircraft. The Anzac Class ships are capable of carrying Seahawk, so why the need to introduce another airframe into the inventory? It is accepted that the role of the Super Sea Sprite will be different to the one currently undertaken by Seahawks in the FFG. However, it is hard to believe that more Seahawks could not be purchased, and adapted to the anti-surface role. In my opinion, time spent training the already low numbers of aircrew on another new airframe is time not well spent.

Conclusion

A maritime strategy should exist to support the national security strategy. Australia's Government has partially articulated its national security strategy through ASP 97. It provides guidance on the tasks which could require the ADF to undertake combat operations, and force structure development priorities, which will contribute to enhancement of military capabilities to defeat attacks against Australia.

Australia's maritime strategy is fundamentally concerned with the defence of Australia. Such a strategy calls for continued focus on the sea control function maritime forces provide, and the protection it affords against use of the sea to threaten sovereignty.

The general requirement for a medium power is a balanced and versatile force. But this does not mean having a lot of the best of everything. The combination of vital interests, threats, alliances, levels of conflict

and reach is the core of maritime strategic planning, and the basis for designing forces within reasonable limits.

Contemporary maritime strategists suggest that a well balanced force for a medium power should have the following: a constabulary force for surveillance and law enforcement in the economic zone, optimised to normal conditions and short-reach, low-intensity operations; long reach surface forces optimise to low intensity operations; and a strictly limited number of surface, air, and submarine units of long reach, optimised to higher level operations.

Seahawk conducts operations with HMAS Darwin

Upon successful completion of current force enhancement projects, the RAN will have a fleet of capable ships to operate throughout our maritime approaches, under land based air cover. The maritime force will satisfy what I consider to be a balanced fleet, with some exceptions. The introduction of an improved defensive mining capability would act as a low cost force multiplier and deterrent. The acquisition of the seventh and eighth Collins Class submarines, and a weapons upgrade across the class to include new torpedoes and *Tomahawk* type land-attack cruise missiles would add a new dimension to the RAN's strategic strike and covert deterrent capability. An effective air-to-air refuelling capability will add significant reach to our combat aircraft, and consequently to the reach of our maritime force. A reduction in the types of airframes within the fleet air arm would alleviate some of the problems associated with aircrew shortages, and reduce aircrew training requirements. In summary, by the year 2010, if some modifications are made to current plans, Australia truly has the potential to develop a balanced, albeit small fleet.

NOTES

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2 Till, G. 1984, *Maritime Strategy in the Nuclear Age*, (2nd edn.), The MacMillan Press Ltd, London, p 129
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Regeneration of the Combat Force of the Royal New Zealand Navy

By Captain J.R. Meldrum, RNZN (Rtd)

"Changes to the force structure within a Navy are challenging and costly at any time. In a small Navy like the RNZN, they can threaten the very viability and sustainability of the organisation. In the light of the decision not to proceed with the purchase of a third ANZAC Ship the RNZN struggles to find a way to evaluate the alternatives."

Introduction

In November 1997 the Defence White Paper announced that the Royal New Zealand Navy's front line frigate force was to be reduced from four to three ships in order to meet the New Zealand Defence Force's other funding requirements. In December 1998 the Government declined the purchase of a third ANZAC Ship to replace the last Leander in 2005. As a result, in a period of a little over a year, the planning assumptions on which the Royal New Zealand Navy had relied for the previous ten years were made irrelevant.

The RNZN is in a period of transition and transformation as it meets the challenges of significant changes in technology, operations and support. The introduction of the ANZAC Class of ship is posing significant questions. To date however, our responses have been derived from a view of the future comprising a naval combat force of four ANZAC ships and a support force comprising a tanker, a three ship hydrographic/oceanographic fleet, and a diving support vessel. This combat force structure looks increasingly unlikely and we must now face the question, "How do we re-invent ourselves to cope with the uncertainty we now face?"

The Implications

The implications of not having an all ANZAC combat fleet are far reaching. A review of the policy and investment decisions made by the RNZN over the last five years reveals the extent to which the planning environment has influenced naval thinking. In the personnel and logistics areas alone, policies have become almost exclusively focused on the ANZAC ship. For example:

- Financial forecasts have been made anticipating significant reductions in personnel due to the reduced manning requirements of an ANZAC
- Training infrastructure has been developed to meet ANZAC needs
- Training objectives have been revised around ANZAC ships
- Branch and promotion structures have been revised to reflect the manning requirements of ANZAC ships
- Inventory Management policies have reflected the considerable amount of support available from local industry for ANZAC Ships and the economies of scale possible from close collaboration with the RAN
- Maintenance facilities have been progressively structured towards the ANZAC class
- Armament Depot capability has been progressively reduced as ANZAC weapons systems are common with the RAN

The planning paradigm has permeated all aspects of policy. This, of course, is right and proper as the Navy has sought to find efficiencies and increased effectiveness in pursuit of providing a better deal for the public of New Zealand.

The recent change in direction means that the policies so carefully crafted, will have to be tested against a new paradigm. But first what is that paradigm to be?

A Long Term View

Management thinking today emphasises the need to be able to respond to rapidly changing circumstances. The perfect organisation has dynamic structures that can shape themselves according to the current needs of the organisation, it is driven by a common vision and is at all times in pursuit of excellence in its particular endeavour. This is the ideal.

This thinking however ignores the realities evident for an organisation which manages and operates major physical assets. In this environment, the rate of change and the scope of change are defined by the nature of the asset, it life expectancy and the amount of capital invested. This does not mean changes cannot occur, or that there should not be a dynamism in organisational behaviour, or that organisations in this environment cannot pursue excellence, it simply means that there are external constraints on the organisation's behaviour which need to be understood. So it is in the Navy's business.

Warships are expensive, somewhere between $0.6–1 billion per copy, they have a life of 25–30 years, and they require special skills to operate and maintain them, each according to their individual design and equipment suite. In fact the design of the vessel and its equipment fit is so fundamental, that it drives all aspects of the Navy's business. The type of ship determines the roles the Navy can take in support of government defence and security policy, the personnel and support requirements and ultimately the financial resources requires.

Purchase of a warship cannot be taken lightly. It can take up to six years to introduce a new vessel into service. Through life costs can be as high as three times the purchase price. It is just not practicable to trade them in as we do with our cars; we cannot pop along to a "warship showroom" and take the natty grey number in the corner.

Different types of ships have different personnel, maintenance and other support needs, these needs can only be worked out over a period of time. It is the pervasive requirements of the ships themselves that drive the need for a long term planning perspective, which in turn allows efficiencies to be gained in operation and support. It is therefore essential that a long term planning environment be in place.

Towards a New Paradigm

A new view of the future for the RNZN will emerge only as three strands of understanding come together. The first is general agreement within the community over the maritime security needs of New Zealand. The second is a good understanding of the constraints of managing a small fleet of combat ships, and the third is the long term commitment to fund it.

New Zealand's maritime security needs have been well explored in Defence White Papers over many years and little change in stance has been evident since the late 1980s. However I do not believe that there is a general consensus amongst New Zealanders that the views espoused in these papers are widely held, no matter how well founded they might be. In my opinion there must be a public examination of New Zealand's requirements of its Navy and how they are to be achieved. Ultimately it is the public of New Zealand who determine what they are prepared to support and this should be reflected across the political spectrum.

The second strand in a sustainable future is to understand the dynamics of managing a small fleet of warships. The immediate planning position for the RNZN is now two ANZAC ships for 25–30 years, complemented by one second hand vessel to replace HMNZS *Canterbury* in 2005. This vessel would have a life of about 15 years and would then be replaced by a new ship. This needs critical examination for viability and sustainability.

Experience to date indicates that for a small navy, not only the ship type, but also the numbers of ships are important management considerations. A fleet of ships has a minimum critical size. This is determined by four main factors.

- The operational role the ship is expected to perform and its availability for the role;
- The ability to train personnel at sea;
- Shore based infrastructure; and
- The branch and promotion structure of personnel.

Modeling of the combat fleet of the RNZN carried out in 1996/97 predicted that a reduction from four to three vessels of frigate size (in particular ANZAC Class ships), would reduce the capability to train at sea to the point where an attrition rate difference of two or three per cent per annum would critically effect the ability to sustain sufficient trained personnel in the Service. Further, as the numbers of personnel in the Navy decreased, the branch and promotion structure would become the major determinant of overall personnel numbers, overriding the effects of sea shore ratios and requirements for shore based infrastructure manning. This work assumed that all of the combat vessels were of the same type.

Operating a fleet of mixed types of vessel introduces a further range of complexity into the management equation. In the case of an orphan ship, unless training at sea is relevant and practicable on the other vessel types in the fleet, then this will be unsustainable. Similarly if there is not more than two of each type of vessel, neither of the types can sustain sufficient trained manpower on its own. i.e. streaming of personnel to type is not practicable. Therefore there must be some cross training. The extent of the value of training on one platform for the other would seem to be a critical parameter. Similar consideration must be given to the relative contribution of each vessel type to the availability of ships to meet the operational roles. A small number of ships with differing maintenance cycles and periodicities will inevitably increase the risk of not having a ship available for deployment at any given time.

To examine these effects in more detail, the RNZN is developing a model of a navy comprising three or four surface combatants in addition to the current fleet of auxiliary vessels. The model assumes up to two types of vessel within the combat fleet. The model will concentrate of the fundamental drivers of the viability of a small navy, namely the operational availability of the vessels and the maintenance of trained manpower. This work will take some time to complete, but early analysis of the manpower effects has confirmed that in a small navy the key factors are attrition rates, the ability to train appropriate numbers of personnel at sea and the ability to provide for career progression given the many trade and skill groups required to

operate a complex combatant ship. These alone are likely to disprove the viability of a navy comprising three combatant vessels and point to four ships as being a viable minimum, but only time will tell.

The third strand of a sustainable future for the RNZN is that of financial commitment. The consensus view of the requirements from the navy must flow into a commitment to sustainable funding. In anyone's language the purchase of four ships is a serious investment decision. In New Zealand the defence asset base is about $3b and the annual defence budget of about $1.4b in total. An investment decision to replace the combat fleet every 30 years at a cost in excess of $2b is very large, irrespective of how it may be financed and over what length of time. The history of ship purchases in New Zealand would indicate that to buy more than one or two at a time is not practical. Even the ANZACs were ordered as a pair, with an option for two more, despite full knowledge that the entire combat fleet of the RNZN would require replacement during the build programme for the ANZAC Ships. Whether the reasons for this were political or financial, this reality should be acknowledged and we should plan only to replace a maximum of two ships at a time. A rolling programme of this nature allows the standards to specifications of the new vessels to set the standards for the progressive updates of the existing vessels. The capital costs can be fairly spread over a long period in the Defence Force budget and the resultant commonality of equipment and standards across the whole fleet would provide ongoing economies of scale and other logistic benefits.

I suggest that the three strands, of community support, management constraints and long term funding, can and must come together. When they do, a new planning paradigm for the combat fleet of the RNZN will emerge. It is my belief that it will be based on the replacement of two combat ships every 12 15 years.

Biography

Captain J. R. Meldrum, OBE BSc F.IPENZ, RNZN

Captain John Robert Meldrum joined the RNZN in 1976 as a Weapons Electrical Engineering Officer, having completed a Bsc at the University of Otago. He subsequently undertook further training in the United Kingdom, completing the Royal Navy's Weapon Engineering Application Course at Manadon in 1978. In 1980 he was awarded his Weapon Engineering Charge Qualification while serving with HMNZS *Canterbury*.

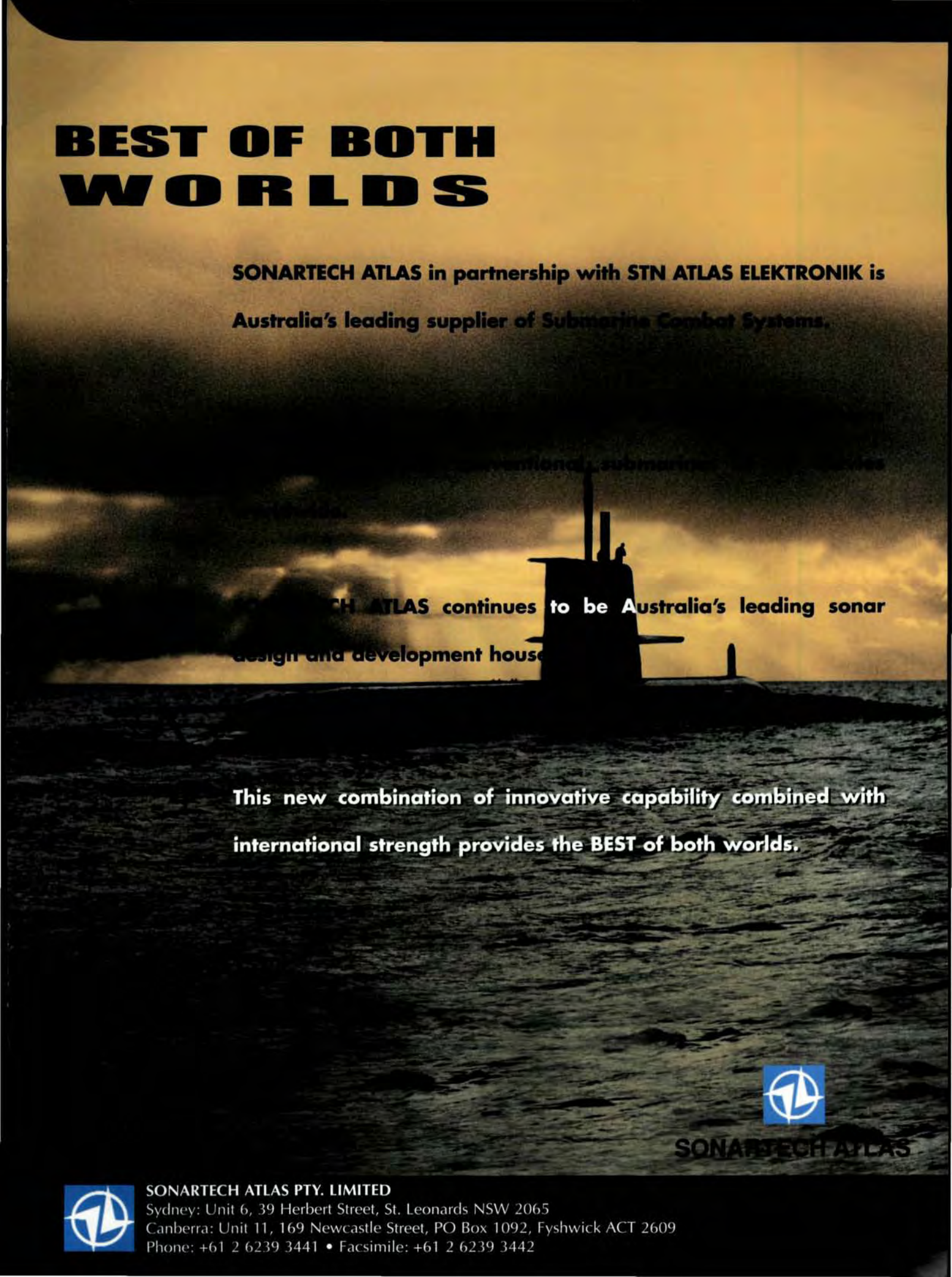
Between 1980 and 1989 he held a number of engineering posts in the Naval Dockyard and Naval Staff and served as the Weapons Electrical Engineer Officer of HMNZ Ships *Otago* and *Southland*.

On completion of the Royal Australian Navy Staff Course in 1989, he attained the rank of Commander and was appointed to the ANZAC Ship Project as the Project Director's Representative on the prime contractor's site in Melbourne. Commander Meldrum was awarded the OBE in the Queens Birthday Honours List in June 1993 in recognition of his work in this post.

During 1993 and 1994 he was appointed as the project manager for the commercialisation of the Naval Dockyard in Auckland. On completion of this assignment he held the post of the Director of Weapon Engineering in Naval Staff.

In 1996 Captain Meldrum was appointed as the Assistant Chief of Naval Staff (Materiel) in which role he is responsible for engineering and logistic policy for the RNZN.

Captain Meldrum is 43 years old, married to Barbara and they have two children. He retired from the RNZN in March 1999.



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