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An Expeditionary Australian Defence Force

The Air Warfare Destroyer and Australia's Strategic Reality

The Surface Warship as Force Multiplier: *The Lessons of History*

Land-based Aircraft for Naval Protection?

NCSM: The Collins Class Submarine: *National Benefits and Costs*

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President's Message

I feel very privileged to take up my watch as President of the Australian Naval Institute. It is an enduring institution, part of the fabric of our Navy and has a lot to offer our members, and the broader Navy and Maritime Community. My aim during my tenure will be to foster maritime debate on issues of interest to us all. It is very important that we foster an open dialogue such that views can be fully expressed, and indeed, sit comfortably amongst the more traditional articles. We have shaped our essay competitions accordingly and look forward to some interesting articles in upcoming editions.

On taking on the role it has been very pleasing to see the vigour and commitment of your Council at work. Ray Griggs in particular has done an outstanding job over the past number of years and let me say his dedication to the ANI is an inspiration to us all. You should feel comfortable that our governance processes have been improved significantly over the last year or so and Council meetings generate a great interest in our activities. Some of these include the ANI Warfare Seminar at *Watson* in September, a focus on recruiting our successors into ANI through an ADFA engagement program and essay competitions with prizes to the US and UK for the winners, to name just a few.

I trust you will enjoy this edition of Headmark and encourage you to contribute to future editions and upcoming ANI Community activities.

Yours Aye,
Davyd Thomas

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Front page & left: RIMPAC 08 - 4th of July Celebrations at Pearl Harbour. HMAS Tobruk and HMAS Anzac were right in the middle of the fireworks display. The fireworks were set off from the same wharf where the two Australian ships were berthed.

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An Expeditionary Australian Defence Force

By Dr Gregory P. Gilbert

A landing craft air cushion (LCAC) arrives in the well deck of amphibious assault ship USS Essex.

Expeditionary Operations: Military Operations which can be initiated at short notice, consisting of forward deployed, or rapidly deployable, self-sustaining forces tailored to achieve a clearly stated objective at a distance from their home base.

The recent change of Government in Australia has understandably led to the demand for a new Defence White Paper. While much of the underlying strategy culture and approach to war is enduring, it seems inevitable that the new White Paper will reflect recent changes to Australia's strategic setting and the operational demands placed on the Australian Defence Force (ADF). One of the most important changes in emphasis since the previous *Defence 2000* White Paper is the re-emergence of an expeditionary ADF.

Over the last 10 years or so, ADF activities have not necessarily followed the forecast in *Defence 2000*. Operations including SLIPPER in Afghanistan and the Gulf (as part of the international coalition against terrorism), FALCONER in Iraq, ASTUTE in East Timor and QUICKSTEP in the South Pacific, have demonstrated the requirement for expeditionary constabulary and warfighting capabilities. In addition, the expeditionary requirement in benign environments is demonstrated by recent humanitarian operations, such as SUMATRA ASSIST 2005 and PNG ASSIST 2007. Indeed, Australia's strategic environment has changed significantly since the mid 1990s and it is now recognised that 'in a globalised world, ignoring problems further a field only invites these threats to come closer to Australia.'

The ADF has a long experience in expeditionary operations. The Royal Australian Navy (RAN) has maintained a small amphibious force, on and off, since the beginning of World War I. The heavy lift ship, *HMAS Tobruk*, has been most useful since it entered RAN service in 1982. The modification of the two amphibious vessels HMA Ships *Manoora* and *Kanimbla* during the late 1990s, has significantly added to the ADF's expeditionary capability. The recent decision to purchase two Landing Helicopter Dock (LHD) amphibious vessels, to be named HMA Ships *Canberra* and *Adelaide*, will increase this amphibious capability from 2012. But amphibious ships will form only part of the ADF's expeditionary capability. An expeditionary ADF needs to operate as a joint maritime force (including naval, air and ground elements) working in cooperation with other government and non-government organisations, to deal with the difficult political dimension that is always part of expeditionary operations.

The ADF has made significant progress in developing joint approaches to military operations. In particular, we now have a Joint Operations Command, and many of Australia's current operations have joint command and/or often integrated units. For example, Australian Army transport corps personnel are permanent members of the crews in *Tobruk, Manoora* and *Kanimbla*. Yet it is clear that the 'jointness' of the ADF in the maritime environment remains somewhat superficial, while the advances that have been made are mostly limited to the operational and tactical levels. The ADF, espouses a multidimensional manoeuvre strategy at the highest level, but has not yet developed a comprehensive joint maritime force approach to war. Perhaps more importantly, the ADF has yet to develop a military culture that fully embraces a comprehensive maritime strategy which appreciates the value of expeditionary operations.

This is not to suggest that the ADF has been ignorant of these issues over recent years. In fact, a strong debate has been evolving with many issues being raised, considered and refined internally. A few areas within the ADF, having identified a need for a comprehensive maritime strategy, are specifically addressing its implications, in areas including capability development, personnel and training as well as doctrine. To address this, the Joint Amphibious Capability Implementation Team (JACIT) has recently been established. This responds to policy direction from the Amphibious Council, which consists of the Deputy Chiefs of Navy and Army, and the Deputy Chief, Joint Operations Command. Much of their preliminary work is directed at defining more precisely the Amphibious Concept of Operations for the ADF, and other implications in areas including capability development, personnel and training, facilities requirements and doctrine. It is clear that the ADF has much to learn from those who have long established capabilities in this arena. However, this need is by no means universally accepted or understood within the Australian Defence community. For example, some air power advocates continue to espouse a 'concentric circle' approach to Australian defence, and have not accepted the need for fully expeditionary fixed-wing air support during ADF joint manoeuvre operations.

The United States Marine Corp (USMC) and United States Navy (USN) Expeditionary Groups are often seen as a good starting point for comparison with the ADF, and the US experience is a particularly important benchmark when joint maritime forces are involved. The USMC is expeditionary - not just on the surface but deep within its culture. The following extract helps to explain what being 'expeditionary' means to members of the USMC.

'Many military organizations use the term 'expeditionary' to describe themselves or to label distinct units. Marines believe 'expeditionary' encompasses far more than a mission involving actions beyond US borders, the official definition. To a Marine Leatherneck the term connotes much more than the ability to deploy overseas quickly. The expeditionary ethos is an institutional belief system that ensures a unit can deploy rapidly, arrive quickly, and begin operating upon arrival. Supplies, equipment, and infrastructure are limited to operational necessities; 'nice to haves' are ruthlessly carved out. Such 'come as you are' attitudes are embedded in the force design of the Marine-Air-Ground Task Force construct, which integrates ground units with aviation and logistics support forces.'

The USMC forward deployed 31st Marine Expeditionary Unit (MEU), based in Okinawa, Japan, which stands ready to operate in and around the Western Pacific is a good example. The 31st MEU is an amphibious, combined arms, air-ground task force, with approximately 2200 troops, capable of conventional and select maritime special operations of limited duration in support of a combatant commander. Capable of sustaining itself for 15 days, the MEU accomplishes these missions by functioning as a type of Marine-Air-Ground Task Force (MAGTF) - a combination of air, ground and support assets. The following are some of the missions that the MEU may be tasked with: amphibious raids, non-combatant evacuations, security operations, tactical

USS Essex conducts a beach landing rehearsal during Exercise Talisman Saber recovery of aircraft personnel, direct action, and humanitarian assistance/disaster relief.

The 31st MEU makes up the Marine force embarked with the USNs *Essex* Expeditionary Strike Group (ESX ESG), also known as Task Force 76. The Commander, Task Force 76 (CTF 76) is responsible for conducting expeditionary warfare operations to support a full range of theatre contingencies, ranging from humanitarian and disaster relief operations, to full combat operations.

During a recent exercise the ESX ESG included the amphibious assault ship *USS Essex* (LHD 2), the transport dock ship *USS Tortuga* (LSD 46), the dock landing ship *USS Juneau* (LPD 10), Helicopter Sea Combat Squadron 25, Tactical Air Control Squadron 12, Beach Master Unit 1 and Assault Craft Units 1 and 5. The CTF 76 mission is immense, complex, challenging, and occasionally dangerous. The ultimate objective is to help maintain peace and stability and protect vital interests in the Pacific. The forward deployed naval assets encompassing CTF 76 are credible, shaped to meet any task at hand, and can quickly surge to meet emergent situations.

How is this relevant to the ADF? The ADF is not, and has no plans to be, able to form an Expeditionary Strike Group or a Marine Expeditionary Unit in the same sense as the US Navy and USMC example. Even if we have the political will as a nation, Australia does not currently have the financial resources, industrial capacity or personnel to do so. The ADF not only needs to be well trained and doctrinally prepared to conduct expeditionary missions but needs to have an expeditionary ethos. Key elements of the Australian Army and Air Force need to get their feet wet, to use the manoeuvre advantage in the maritime environment and not to fear it.

We can also learn much from the United Kingdom (UK) experience. The UK Royal Marines are a 'go anywhere' amphibious force.

'3 Commando Brigade is the Royal Navy's amphibious infantry on permanent readiness to deploy across the globe, and is a core component of the UK's Joint Rapid Reaction Force. Together the Royal Navy's amphibious ships and the Brigade represent a highly mobile, self-sustained and versatile organisation, with a strategic power projection capability that is unique among the British armed services.'

How is this relevant to Australia? The ADF has no plans to form an Expeditionary Strike Group or a Marine Expeditionary Unit on a similar scale to the US. Setting aside issues of political will, Australia does not currently have the financial resources, industrial capacity or personnel numbers to operate and sustain forces on this scale.

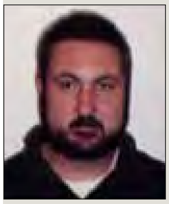
The ADF does, however, need to be well trained and doctrinally prepared to conduct expeditionary missions with a fundamentally joint ethos. Key elements of the Australian Army and Air Force need to get their "feet wet", to use the manoeuvre advantage in the maritime environment. This will be a key task for the JACIT, who have the task of planning the introduction of the new ADF amphibious capabilities.

A balanced Australian amphibious force with integral fleet, aviation and army units, based around the new amphibious ships *Canberra* and *Adelaide* with a reinforced battalion group and support elements, will offer many of the strategic and operational advantages that are inherent in its US counterpart. At the forefront of an expeditionary ADF, these units will need to combine the professionalism and experiences of the three Services to maximise the options to respond in defence of Australian global strategic interests.

An expeditionary ADF consisting of a joint maritime force with a strong expeditionary mindset will not only be a most important tool in Australia's defence toolbox, but also a significant enabler for diplomatic peace initiatives. Upon reflection, the Australian defence community should see that an expeditionary ADF is a fundamental input into the nation's military strategy.

A self contained and sea based force is the best kind of fire extinguisher because of its flexibility, reliability, logistic simplicity and relative economy.

Dr Gregory P. Gilbert worked as a naval designer within the Australian Department of Defence (Navy) between 1985 and



1996. He was a Defence contractor until 2002. He has broad research interests including the archaeology and anthropology of warfare, Egyptology, international relations – the Middle East, maritime strategy and naval history. He is currently the Senior Research Officer in the Sea Power Centre – Australia.

Disclaimer: The views expressed are the authors. They do not necessarily represent the Royal Australian Navy or the Department of Defence.

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The Air Warfare Destroyer and Australia's Strategic Reality

LIEUTENANT SAM FAIRALL-LEE, RAN

"To defend a country you can't defend, because of your small population, you buy aircraft that can't be there when you need them … For six billion dollars you could buy a couple of carriers … So what is it? Aircraft are nice but reality isn't?... It's not coherent."

Dr Norman Friedman on Australian Defence Strategy *Why Naval Power Matters*, Address to the Lowy Institute for International Policy, 25 July 2007.

For most maritime professionals, the Royal Australian Navy's (RAN) need for Air Warfare Destroyers (AWDs) is obvious. For some strategic and defence policy commentators and for the general public, however, this acquisition continues to be the subject of questions, articles and in some cases outright hostility. Why is this? Why is it that there is general agreement on the need to spend $16 billion on replacement fighters, but that spending $6 billion dollars on three ships for the world's largest island nation, which will replace a total of nine ships by 2015[1], raises so much ire that some feel the need to repeatedly question the program in academic circles and in the mainstream media?

The problem lies not in the appropriateness of a guided missile destroyer (actually a guided missile frigate[2]) for the RAN, but in a general lack of understanding of Australia's strategic maritime reality amongst the community at large. As we know, maritime strategy is a more subtle and complex affair than either land or air warfare, and it is far harder to demonstrate and explain. This is a challenge that the Australian maritime community must continue to meet. The Australian Defence Force (ADF) is an element of government, and government in turn reflects the wants and needs of the community. If the community does not understand the role of its Navy, it will become even harder to justify our acquisitions in a tighter and tighter fiscal environment. As such, this article seeks to relate the AWD program to Australia's strategic maritime reality, and to do so in fairly broad terms. It will highlight the fact that Australia's security is not defined only by the need to defend against a conventional seaborne invasion, prove that land-based strike aircraft are not capable of defending Australia's strategic interests on the world stage, and demonstrate that the changing nature of international relations means Australia's interests are just as likely

The Spanish F-100 Frigate Alvaro De Bazan

Spain's Alvaro de Bazan. The Air Warfare destroyer is shown on her visit to Australia-photo by Chris Sattler to be found in the Straits of Hormuz as they are in the Timor Sea. It will describe why AWDs specifically are critical to Australia's strategic reality, and it will provide some options for financial trade-offs within the Defence Capability Plan (DCP), should that become necessary.

Australia's Strategic Reality

Since 1987, three separate Defence white papers have, to different extents, myopically focussed on the so-called 'sea-air gap'[3], attempting to enunciate a strategy whereby Australia would, in essence, wait to be attacked and then bomb our attackers with sophisticated fighter-attack aircraft within four hundred miles of Darwin[4]. Such a strategy was appealing as it seemed to provide a means of 'self reliant defence'[5] without having to spend more than about 1.7 percent of Gross Domestic Product on the ADF. Despite cracks appearing in this 'Defence of Australia' (DOA) strategy almost immediately[6], however, and despite numerous calls on the ADF to operationally deploy well outside Australia's so-called 'Area of Direct Military Interest'[7], the first concrete policy moves away from DOA didn't come until 2003 when the government finally admitted that 'Australian national interests could be affected by events outside of Australia's immediate neighbourhood.'[8] This well overdue realisation continues to gain significantly greater attention[9], is forcing procurement decisions in its own right[10], and is a major factor influencing government to issue a new Defence White Paper.

Much of this shift in policy is due to the realisation that the geo-strategic rationale behind much of the DOA strategy, that is the primacy of the threats associated with the so-called 'arc of instability'[11] to our North, is grossly out of perspective. The belief that the greatest threat to Australian national security is a direct armed invasion by a hostile foreign power from or through the 'sea-air gap' reflects an astonishing failure to come to grips with the post-Cold War nature of world affairs. Not only is there no state within the immediate region with either the capability or the intention to launch such an attack, but there is no prospect of any state with such capabilities seeking to exploit the (sometimes over-rated) institutional weaknesses in our neighbours with the end goal of launching such an invasion.

A major conventional state on state armed invasion of a democratic medium-power like Australia is so far outside of the contemporary nature of interdependent world affairs as to require a major long-term change in the international strategic setting. Such a drastic change in strategic circumstances must by its nature involve primarily the major powers. As a result, while the states of the immediate region remain critical in terms of communications security, counter-terrorism and soft security challenges like drug and people smuggling, resource security and climate change, the major long-term geo-strategic areas of focus must be the major power states whose actions will decide the long-term strategic and economic balance in the Asia-Pacific, and therefore the future survival and prosperity of Australia.

Having said this, it is imperative to understand that the greater interdependence between states and the greater relative importance of trade, energy and economic factors to the security of states and the strategic balance, means that vital strategic focal points now exist further and further from the states themselves. Indeed, as the world experiences challenges regarding its future energy requirements, the boundaries that used to separate energy, trade and national security have all but disappeared; this is especially obvious for the major powers. China, for instance, is rapidly expanding its maritime forces with a view to securing its energy supplies, both from the Spratly Island area and from the Persian Gulf[12]. These changes to the nature of strategic power are of extreme relevance to Australia whose economy, perhaps to a greater extent than almost any other, is defined by the sea[13].

Over 95 percent of our trade comes over the oceans[14] through extended and vulnerable Sea Lines of Communication (SLOCs), meaning our security interests may be found in distant parts of the globe; may be transient rather than enduring, may be subject to threats requiring fast responses, and which may require responses across the full spectrum of military capability. As one of the world's most renowned strategists has said, if a foreign power did want to cripple Australia, they'd go for our trade and energy supply routes.[15]

Because our SLOCs are long, and because ships heading for Australia or New Zealand are identifiable a long way off, and because hitting our trade would result in such an overwhelming and instantaneous effect with far fewer resources, and because (following the sale of ANL[16]) Australia has extremely limited state-flagged cargo ships which it can control, this would be a far simpler strategy than a direct military attack and it could be launched without such a drastic change in the international strategic setting.

The Air Warfare Destroyer will be both the vital enabler and an integral supporting and coordinating unit in future Australian expeditionary operations. (RAN NAVSYS Computer Modeling Group)

Such threats to our strategic communications may also develop as a by-product of events where

Australia is not a direct target at all; terrorist attacks or significant political destabilisation in or around the Indonesian archipelago, especially in the strategically vital Malacca Strait, or in the Strait of Hormuz for example, could have disastrous effects on Australia. It is also true, no matter how much we like to ignore the fact, that even in the incredibly remote circumstance where a major power did directly attack us militarily, with our limited population and military resources we could not hope to defend ourselves with a defensive strategy alone, as Dr Norman Friedman has said, 'You can't defend yourself by defending the coast, not even with ten times your population.'[17]

To defend ourselves against these and other threats, including terrorism, we need to be able to show legitimate and sustained presence wherever such threats originate, rather than waiting for them to escalate and come to us. We need to be able to shape and influence the strategic environment at source. This is especially true in an environment where SLOCs can be disrupted by terrorists and pirates using sophisticated anti-ship missiles[18], and where weapons of mass destruction are traded by repressive and despotic regimes. In the globalised world, security and geography have never been less connected.

In meeting these security challenges it is obvious that we will need to continue to deploy forces at some distance from Australia, sometimes to areas subject to high threat at great distance from secure allied bases. Currently the ADF has significant forces in Iraq, the Persian Gulf, Afghanistan and the wider Middle East in these circumstances. We are fortunate in that deploying and sustaining these forces we are able to leverage off sea control[19] provided through the United States Navy (USN). This may not always be the case. In Timor it was not the case, and we were fortunate that the Indonesian Navy (TNI-AL) of the time was not as sophisticated as many other regional navies, and that TNI chose not to oppose our forces. It is likely, perhaps certain, however, that we will in the future need to project our forces into an area where we cannot rely on US sea control, especially as the US draws down its forces in Japan and South Korea and is concerned with other pressing requirements. We would be foolish to send our forces into such an environment without establishing our freedom of movement through sea control.

Land Based Air Power

It is often argued that the advertised roles of the AWD could be carried out by land-based air power. This is simply not the case. Australia's land-based air power is useful, however it is useful in a very limited set of highly unlikely scenarios. Should Australia be attacked by an amphibious force as predicated under DOA, for example, and assuming we did nothing about such a scenario until it was within the range of our strike aircraft, then our F/A-18s would be an excellent contribution to a hopeless cause. This, however, as outlined above, is extremely unlikely in the modern globalised world.

In the more realistic threats to Australian security, whether they be threats to our SLOCs, our energy supplies, through terrorism, weapons of mass destruction, transnational crime, the need to support friendly nations at long distances or to provide stability in distant regions, land-based aircraft are of little use as they are limited to high-end conflicts at very short range from base. These aircraft, whilst able to respond quickly and with significant force to high-end threats within 400 miles of Australia, are not capable of gaining or maintaining sea control. They lack flexibility in that they do not provide for a graduated response, they cannot poise or be persistent[20], they are not resilient to attack, and their reach is highly limited. Whilst it is true that we have in the past based our strike aircraft at friendly bases in theatres overseas, this significantly limits our strategic flexibility, reduces our exit options, creates a strategic footprint that may cause more problems than it solves, and still doesn't allow for graduated force[21]. Moreover, fighter/strike aircraft are not independent units, they require radar, communication, coordination and control measures from other platforms. Currently the ADF can only provide such support from land-based units or from ships at sea.

The AWD'S Role in Australia's Strategic Reality

As outlined above, it is crucial to Australia's security to be able to gain and maintain sea control, both in our immediate region and in distant parts of the world. In the 1999 Timor conflict we were lucky that sea control was not contested by Indonesia, and in the Middle East we have been equally lucky in that we can rely on US sea control. This, quite obviously, may not always be the case. The need for sea control is true of almost all conflicts, and it applies across the conflict spectrum.

Sea control is 'fundamental to the exercise of maritime power.'[22] Whether Australia is engaged against states, rogue regimes, terrorists or smugglers, the ability to control the sea and to gain freedom of manoeuvre is the fundamental enabler[23]. Unfortunately, with the failure to replace the guided missile destroyers, the RAN's capacity to gain and maintain sea control, even within the immediate region, has been significantly curtailed. Indeed, with it now confirmed that terrorists can hit and mission-kill medium-capability surface combatants from the shore with sophisticated weapons[24], with a massive expansion in threatening anti-ship missiles in the region and beyond[25], and with previously third-world militaries gaining sophisticated equipment thanks to globalisation and the Russian weapons market, the sea-control game has changed: area air defence is no longer a 'nice to have', especially when major sovereign power is moving on the oceans, such as in an expeditionary mission like Timor.

Noting that the current *Adelaide* class frigates were only ever designed as a low capability platform[26], and that they are now well below regional standards in surface combatant capability, and that the *ANZAC* class frigates were designed as a low cost patrol ship with only a limited self-protection air defence system, it may even be reasonably argued that the RAN no longer has the ability to maintain sea control in a contested environment at all. In Australia's strategic maritime reality this is a serious problem. The AWD's advanced Aegis area air defence system – the real key in this environment – and its modern multi-mission capabilities, together with all the characteristics inherent in naval ships including mobility-in-mass, access, adaptability, reach and persistence[27], mean the RAN will be able to begin re-establishing this critical enabling capability, and through that contribute significantly to the security of Australia's vital communications.

Aside from re-establishing Australia's ability to control the maritime environment, the AWD will offer a total package of advantages across the conflict spectrum. As a high-end capability platform with the capacity to undertake several missions simultaneously, the AWD will be able to safely and autonomously perform the full range of low and medium-level tasks such as escort and trade protection, interdiction, border security, resource protection and policing. Diplomatically, through their presence and legitimate combat potential alone they could be used to reassure, impress or deter as the case requires, and their inherent flexibility means one AWD could go from reassurance to high-end combat power in a single mission. As a naval unit the AWD will be able to reach to every corner of the globe without the requirement for close-in basing and leaving no political footprint. As opposed to non-naval platforms, the AWD also allows for an instant exit strategy, by simply sailing away.[28]

With the ability to control the sea and project power re-established, and noting Australia's inability to provide air support at long ranges[29], the AWD will also enable Australia to support its forces ashore in expeditionary operations. With weapons such as the Extended Range Guided Munition, Tactical Tomahawk[30], SM-6 and other future systems, Australia will be able to exploit our sea power and undertake missions using Operational Manoeuvre From the Sea (OMFTS) and Ship to Objective Manoeuvre (STOM)[31]. By utilising the AWD to provide fire-support to friendly forces from the sea, the landing force can land without heavy weapons, in turn meaning they can avoid having to establish a beachhead and therefore become air-mobile, this is a major factor influencing government's decision to procure large air-capable amphibious ships. When commentators say that the AWD's mission is only to 'protect' amphibious ships, they totally miss the point[32]. The AWD will not only *enable* amphibious operations by gaining and maintaining sea control, they will integrate into the mission as a whole, directly supporting and coordinating land and air operations simultaneously. This capability cannot be overstated. The strategic reality means that the ADF needs to be able to project power and the AWD is the only way of doing it short of acquiring a replacement aircraft carrier. Finally, the AWD will allow Australia to continue to be interoperable with the USN, to contribute to coalition operations, and to join other maritime powers in the 1000 Ship Navy[33].

How to fund Australia's most important Defence Acquisition

As the defence budget becomes tighter and tighter, the pressures on major capability acquisitions becomes greater and greater[34]. Despite the fact that the three AWDs[35] will replace the three retired DDGs and all six FFGs, the program still requires justification against other platforms. Three funding options are therefore presented below should it be necessary to competitively fund the AWDs over other programs.

Firstly, by building the AWDs in Australia we are not taking advantage of economies of scale. As ASPI has forecast, by building the ships in Australia we are paying a 33 percent premium[36]. Government contends that by doing so we will be investing in Australia's maritime self-sufficiency. Two things are evident here: as the combat system and all the ordnance and several other systems (not least of which is the design itself) are sourced overseas, even if we could build the ships we can practically never be self-sufficient; and, as it happens, in 1925 the Bruce-Page government was faced with a similar decision regarding the building of HMA Ships *Australia* and *Canberra*. By building the ships in Britain instead of Australia, they were able to invest the money saved in the local building of Australia's first aircraft carrier, *HMAS Albatross*, and in doing so inject money into the Cockatoo

Island Dockyard, Australian jobs, and almost as a by-product substantially increase the RAN's capability[37]. This creative initiative could be repeated today, but has not even been discussed.

Secondly, as has been proven above, land-based fighter aircraft are significantly less important to Australia's modern strategic circumstances than are AWDs. Therefore, consideration should be given to abandoning the Super Hornet interim fighter replacement ($6.1B[38] – almost the same cost as the entire AWD project). Consideration should also be given to abandoning the much troubled Joint Strike Fighter project (a massive $16B or more[39], almost three times the cost of the AWDs) or, perhaps, cancelling the F-35A procurement and investing in fewer F-35B Vertical/Short Takeoff and Landing (VSTOL) variants for use on the new amphibious ships. This would enable Australian airpower to integrate, for the first time in 25 years, into Australia's strategic reality.

Thirdly, serious consideration should be given to improving economies of scale within the ADF by integrating air power, that is the current Royal Australian Air Force (RAAF), into the Navy and Army. This is attractive for a number of reasons: for instance, as opposed to landlocked states with contested land borders but no ocean frontiers, Australia has no identifiable 'air strategy' and in the 'integrated-force' we can no longer argue that we should maintain a separate air force merely to operate platforms because they have wings; it is also hard to see how a nation with such a massive coastline, no immediately conceivable threats to our airspace and such a small relative population, can economically justify a separate air force. The RAAF currently numbers 13,289 personnel[40] to operate 140 combat or support aircraft[41], amazingly that is almost one hundred people for each individual airframe, most of which are crewed by only one person. Absorbing fixed-wing airpower into the Navy and Army would allow a significant reduction in support and administrative personnel and would therefore save significant long-term funding. It would also reduce the ideological opposition to Australia's strategic reality inherent in the RAAF[42].

This paper has demonstrated the critical role the AWDs will play in Australia's national interests. It has done so by outlining the strategic applicability of their capabilities in a changing world, and by proving that other platforms often cited by misinformed commentators are not able to provide similar capabilities. It has also provided some options for paying for this capability. No matter what the future holds though, even if – as regularly happens – it presents challenges we cannot predict, we can be sure of one thing: in an unpredictable world flexible power is attractive43. The AWDs will make Australian power flexible because their capabilities span the spectrum of conflict, and because they are not limited by reach and range – AWDs will go places no other platform can.

Lieutenant Fairall-Lee joined the RAN College in January 2000, graduating from ADFA in 2003 with a BA majoring in history and politics. In 2005 he received his Bridge Warfare Certificate in HMAS Newcastle, and following a brief period at the Defence Signals Directorate, recently commenced Principle Warfare Officer training. Lieutenant Fairall-Lee has interests in naval history and maritime strategy, especially concerning RAN capability procurement decisions of the 1980s.

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1 The AWD will replace both the 3 *Perth* class guided missile destroyers (DDG) and the 6 *Adelaide* class guided missile frigates (FFG), a total of nine ships. The 3 AWDs and the 8 *ANZAC* class frigates (FFH) represents a Fleet still 6 ships short of the Fleet forecast for pure DOA roles in *Defence of Australia 1987*. See: Department of Defence, *The Defence of Australia 1987*, Australian Government Publishing Service, Canberra, 1987, p.43.

2 The Spanish F-100 is actually a frigate. See: Themistocles, 'The Claytons Class – The Destroyer you have when you're not having a Destroyer', *The Navy: The Magazine of the Navy League of Australia*, 69 (3), Jul-Sep 2007, p.2.

3 A creation of Paul Dibb in his 1986 'Review of Australia's Defence Capabilities', the 'sea and air gap' has been the focus of Australian Defence planners for over 20 years. See: P. Dibb, *Review of Australia's Defence Capabilites: Report to the Minister for Defence*, Australian Government Publishing Service (Canberra: 1986), p. 50. For a good outline of the failure of this strategy, see: 'Respected Brigadier Warns Army is Ill-Equipped', *The 7:30 Report*, 25 September 2002 and Submission No 22 to the Joint Standing Committee on Foreign Affairs Defence and Trade Defence Sub-Committee, Inquiry into Australia's Maritime Strategy, Brigadier JJA Wallace AM (Retd).

4 The combat range of the F/A-18 Hornet is 740kms (RAAF website, <www.airforce.gov.au/aircraft/hornet.htm>, even allowing for air-air refueling, the aircraft is limited by payload, endurance, and lack of controlling platforms, the 400 mile range assumes the aircraft could be forward deployed in time. The combat range of the JSF is not much better, at 1093 kms (Jane's All The World's Aircraft, Aircraft – Fixed-Wing – Military – United States, www.janes.com).

5 See: Dept of Defence, *The Defence of Australia….*

6 The ADF's response to the coups in Fiji in May and September 1987 by Sitiveni Rabuka revealed significant shortfalls in the RAN's ability to project power, even within the region in a low-threat environment.

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10 Up to this point, DOA meant that procurement decisions were based on defending the sea-air gap, with the extraordinary assumption that: 'forces built primarily to defend Australia will be able to undertake a range of operations to promote our wider strategic objectives.' See Department of Defence, *Defence 2000: Our Future Defence Force*, (Canberra: Defence Publishing Service, 2000), p.48.

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12 For an outline of China's 'String of Pearls' strategy for securing energy and trade routes from the Persian Gulf, see: N. Nankivell, 'Gwadar: China's eye on the Indian Ocean?', *Journal of the Australian Naval Institute*, Winter 2005, pp.33-36.

13 Sea Power Centre – Australia, 'Air Warfare Destroyers', *Semaphore: The Newsletter of the Sea Power Centre - Australia* , 2007 (11).

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15 N. Friedman, *Why Naval Power Matters*, Address to the Lowy Institute for International Policy, 25 July 2007 (www.lowyinstitute.org/Publication.asp?pid=642).

16 The Australian National Line (ANL) was sold by the federal government to the French company CMA CGM in 1998 (www.anl.com.au).

17 Friedman, *Why Naval Power Matters*.

The Air Warfare Destroyer and Australia's Strategic Reality

18 On 14 July 2006, the Israeli *Saar* class corvette *HANIT* was attacked by the Lebanese terrorist organisation Hezbollah using an advanced Chinese developed C-802 Anti-Ship Missile. *HANIT* was forced to withdraw from the theatre due to damage. It has been assessed that despite good anti-air capabilities, *HANIT's* small size meant she could not perform both AAW and her aircraft control duties at the same time, and as such her defensive systems were not active at the time of the attack. Large ships with multi-mission capabilities such as the AWD would prevent this. See: Themistocles 'More Destroyers!', *The Navy: The Magazine of the Navy League of Australia*, 68(4), Oct-Dec 2006, pp.2-3.

19 Sea control means 'that condition which exists when one has freedom of action to use an area of sea for one's own purposes for a period of time and, if required, deny its use to an opponent. The state includes the air space above and the water mass and seabed below as well as the electro-magnetic spectrum.' In Australia 'Sea Control' is often confused with 'Sea Denial'. See: Dept of Defence, *Australian Maritime Doctrine…* p.39.

20 The ability to poise off a coast and be persistent in doing so is particularly important when governments are attempting to resolve a course of action in complex and ambiguous situations, it allows national leaders to be both proactive and reactive in a way non-naval platforms cannot. See: Dept of Defence, *Australian Maritime Doctrine…* pp.50-51.

21 See: S. Fairall-Lee, 'Sea Power, Grand Strategy & the War on Terror', *Journal of the Australian Naval Institute*, Winter 2004, pp.14-18.

22 Sea Power Centre – Australia, 'Why the ADF Needs Surface Combatants', *The Navy: The Magazine of the Navy League of Australia*, 66(1), January-March 2004, p.26.

23 See: S. Fairall-Lee, 'Sea Power…'.

24 See: Themistocles 'More Destroyers!'.

25 Regional navies are significantly improving their ASM capabilities, the TNI-AL alone may be procuring Chinese C-802s and advanced Russian ASMs. See: N. Friedman, 'Air Warfare Destroyers, Why They Matter', *The Navy: The Magazine of the Navy League of Australia*, 68(4), Oct-Dec 2006, p.5.

26 The Mk-92 Fire Control System used in the FFGs is a US version of the WM-20 series originally developed by the Dutch company Signaal in the 1950s. The associated missile system has been removed from all US FFGs as it is obsolete. When the upgrade to the Australian system is complete, the ships will still be limited to low-medium level contingencies. See: *Janes Naval Weapons Systems*, 'Command, surveillance and weapon control systems, Netherlands, M20/WM20/Mk-92' <www.janes.com> and 'Australia's Hazard(ous) Frigate Upgrade', *Defense Industry Daily*, 14 January 2008 (www.defenseindustrydaily.com).

27 See: Dept of Defence, *Australian Maritime Doctrine…*, pp.47-50.

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29 *Ibid*.

30 The AWD will have a growth path to Tactical Tomahawk and SM-6, See: R. Thornhill, 'The Case for the Fourth Air Warfare Destroyer: *HMAS* MELBOURNE (IV)?', *The Navy: The Magazine of the Navy League of Australia*, 68(4), Oct-Dec 2006, pp.12-13.

31 For an outline of OMFTS and STOM, as well as their strategic application, see: N. Friedman, *Seapower as Strategy: Navies and National Interests*, Naval Institute Press (Annapolis: 2001), pp.223-225.

32 Hugh White, for example, has repeatedly stated that the AWDs will be used only to 'defend themselves and other ships from air attack'. This inability to appreciate the more complex integration of sea power and land power is typical of the community's lack of understanding about the strategic maritime domain. See, for example: H. White, 'A logical decision on a warship that should be moved to a grey area', *Sydney Morning Herald*, February 14 2005, p.13 and H. White, '*Buying Air Warfare Destroyers: A Strategic Decision*, Issues Brief, Lowy Institute for International Policy, June 2005, p.1.

33 US Navy strategy is now based on the '1000 ship Navy', See: J.T. Conway, G. Roughead and T.W. Allen, *A Cooperative Strategy for 21st Century Seapower*, United States Navy, United States Marine Corps and United States Coast Guard (Washington: 2007).

34 K. Henry, 'Australia's Defence to 2045: The macro-economic outlook', *Defender*, Vol. XXII, No.3, Spring 2005, p.19.

35 3 AWDs alone may not be sufficient to re-establish Australian sea control for the missions discussed by government. See: S. Fairall-Lee 'The Royal Australian Navy in 2030: Strategy', in A. Forbes (ed.), *Sea Power: Challenges Old and New*, Halstead Press (Sydney: 2007), p.327 and R. Thornhill, 'The Case for the Fourth Air Warfare Destroyer…', pp.11-12.

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37 A. Wright, *Australian Carrier Decisions: The Acquisition of HMA Ships* Albatross, Sydney *and* Melbourne, Royal Australian Navy Maritime Studies Program (Canberra: 1998), pp.25-38.

38 M. Thomson, 'Australian Defence Spending: As Good as it Gets?', *Defender*, Vol. XXIV, No.2, Winter 2007, p.12.

39 H. White, '*Buying Air Warfare Destroyers…*, p.4.

40 Department of Defence, *Defence Annual Report 2006-2007*, Vol. I, Department of Defence (Canberra: 2007), p.125.

41 17 F-111, 4 RF-111, 71 F/A-18, 19 P-3C, 24 C-130, 4 C-17 and 1 B707. From: A. Davies, *ADF capability review: Royal Australian Air Force*, Policy Analysis 26, Australian Strategic Policy Institute (Canberra: 2008), p.3.

42 For a good discussion of the ideological opposition to maritime power projection from both the RAF and RAAF, as well as the way they sidetrack debate by 'situating the appreciation', see: D. Hobbs, 'The Colour of the Uniform Does Matter', *Journal of the Australian Naval Institute*, Spring 2004, pp.4-6.

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PETER MITCHELL
ESSAY COMPETITION 2008

The Sea Power Centre - Australia (SPC-A) is conducting the 2008 Peter Mitchell Essay Competition, which is open to all members of British Commonwealth navies (full time and reserve) of commander rank and below who have served at least 20 days in the 12 months prior to 29 October 2008. Full details of the competition can be found at www.navy.gov.au/spc/mitchell.html; and enquiries should be directed to: seapower.centre@)defence.gov.au.

One prize is awarded in each of the following three sections:

- Open section (one prize only - AUS$750) all essays are eligible for this prize.
- Officers section (one prize only - AUS$500).
- Sailors section (one prize only - AUS$500).

The topics for the 2008 Competition are:

How might navies provide geographical stability ashore to members and their families to ensure they remain in the service?

Have medium navies concentrated too much on maritime power projection at the expense of sea control?

Many contemporary strategic commentators claim that the role of geography in strategic planning has been diminished by technology, globalisation and the threat posed by terrorism. Is this a correct assessment?

'Military-off-the-shelf' or 'Commercial-off-the-shelf'? Where is the balance in building future naval capabilities?

Essays can be any length up to a maximum of 3500 words, but if they exceed that length, they will incur a penalty of 10 per cent. Essays must be original works, in a suitable layout, in English on international a4 size paper. The author's name is not to appear on the essay; a pseudonym, which is to appear on the title page of the essay, is to be used. Essays should be in electronic copy in Microsoft word format and emailed to seapower.centre@defence.gov.au, accompanied by the declaration form located in the competition rules at www.navy.gov.au/spc/mitchell.html. Entries are to be received at the SPC-A by no later than 29 October 2008. Late entries will not be accepted without a compelling reason.

The Surface Warship as Force Multiplier: *The Lessons of History**

JOHN REEVE

Anti-aircraft observers on duty on a U-boat's conning tower bridge.

What do strategic trends in the early 21st century Asia-Pacific region mean for Australia's future naval operational and force structure requirements? A naval historian considers this question against the background of modern history.

History, Policy and Procurement

History is indispensable to military forces. It is a vehicle of tradition, of service education, and an invaluable tool for force planners, strategists and commanders. One may speculate about discontinuity and a different kind of future, but history remains essential. Sun Tzu and Clausewitz, in their different ways, recommended the study of history. Julian Corbett was a great strategic thinker – the most brilliant analyst ever to reflect on maritime warfare – because he was first a great historian. The great commanders have frequently studied the long sweep of history as a function of their successful approaches to war. MacArthur used the case of Wolfe's approach to Quebec in 1759 to explain his planned amphibious attack at Inchon during the Korean War. None of this should surprise us. History remains a known quantity – real, unclassified, and with a verifiable outcome, and a rich source of experience in its infinite variety of case studies. It is a vast extension of personal experience, and historical ignorance can lead to serious losses. The Royal Navy, for example, learnt the lesson of convoy three times between the 1790s and the 1940s. History teaches, above all, that there is a dialogue between change and continuity in human and military affairs, and a need for strategic awareness combining readiness for the likely and unlikely. It teaches the need for flexibility.

Military force structure decisions should be historically literate. They should also be policy-driven. The Australian defence policy tradition has always been a balance (perhaps an oscillation) between local and wider concerns. Today, as ever, our defence policy must encompass issues of local regional stability as much as essential concerns as distant as Afghanistan and the Gulf. In the future Australia may need to act nearby or far away in defence of its territory, landward or maritime, or its interests. Those interests comprise its role as a good international citizen as well as its own national security and prosperity. History suggests that all these priorities will remain part of the policy-strategy continuum. This means a need to consider both global and nearer regional constants and trends, building force structure and capability accordingly.

Australia's Evolving Strategic Environment

The world has changed since the optimistic days of Cold War victory in the 1990s. Australia's major strategic partner, the US, has potential rivals in our wider region, the Asia-Pacific. They include, in different ways, China, India, and perhaps Russia – all developing maritime powers. There is global competition for resources, especially oil, an issue bound up with sea transport. International terrorism has become an ideological enemy and lethal threat. It has struck on land and sea and required maritime power projection as far inland as Afghanistan.[1] Environmental change implies security and humanitarian issues. Failing states in the archipelago to Australia's north mean a need to help maintain stability in its near neighbourhood. Fulfilling this responsibility can also obviate opportunities for hostile or unhelpful outside involvement. In South East Asia, prosperity and rivalries are causing an expansion of military capabilities which might be termed an arms race.

Certain factors, however, are enduring. The wider Asia-Pacific remains maritime-littoral: a land-sea interface between great oceans and characterised by vast distances. Military operations within it are predicated on the need for reach.[2] Australia shares interests with other regional states, as it has historically, in terms of international stability and the security of the sea lines of communication (SLOCs).[3] Australia remains a maritime nation not only in its geography and territoriality, but in its dependence on the sea for economic well being. The great bulk of its trade, by value as well as volume, is seaborne and within the Asia-Pacific. The mineral boom being fuelled by the economic expansion of China and India, and by the continuing resource needs of the rest of East Asia, means that this is unlikely to change suddenly.[4] SLOC security is doubly important for Australia: the SLOCs of its trading partners are also essential to its own economic success.

Australia's key strategic interests, and their local and wider contexts, are all unquestionably maritime ones. The region involved is vast, both geographically and demographically, and stretches potentially from the Gulf to North East Asia. Australia's population is small. It must seek to leverage technology, military capability and diplomacy to maximise strategic policy outcomes. Force multiplication is, for Australia, a strategic necessity.

MARITIME STRATEGY

There is a fundamental point about maritime strategy. The sea is one, a single and unified environment. Sailors have made big charts for generations for good reason. That environment can be a tool for oneself or a highway for one's enemies. There is no option but sea control, when and where required, for a maritime nation. Without it a maritime power is eligible for defeat. One dimensional denial strategies, usually the preference of continental powers - whether utilising privateers, surface raiders, submarines or land-based air power - have lost to maritime powers with sea control for centuries. France in the age of sail, Germany in the two World Wars, the USSR in the Cold War and Argentina in the Falklands all opted for sea denial and were defeated. For a denial strategy to succeed, it must itself be predicated upon sea control. Nothing illustrates this better than the two major submarine campaigns of the Second World War. German U-boats could not deny the Atlantic powers the use of the sea since they could not control it in every dimension: over, on and under it. US submarines, by contrast, empowered by the controlling dominance of the US Pacific fleet, prosecuted one of the most devastating blockades in naval history. This was consistent with the conclusion of both the classical maritime strategists, Mahan and Corbett, that denial is not feasible without sea control.[5] A case study in Australia's near region, which it can never afford to forget, is how sea control enabled Japanese forces to lodge in the northern archipelago in 1941-42, and how it was needed to dislodge them, defeating their denial strategy based upon land-based air power.[6] The minimal 'capability edge' for Australia must in fact be an effective strategy of sea control. Here lies the significance of the role of the future RAN Air Warfare Destroyer (AWD) in conjunction with other naval and joint (and possibly coalition) capabilities: as an operational enabler by facilitating sea control.


HMS Sheffield


HMS Sheffield struck


View of the bridge and forward 8-in turrets of heavy cruiser HMAS Australia, 4 September 1944

THE OPERATIONAL AGENDA

Sea control can enable a menu of maritime operational missions in defence of Australia's strategic interests. Nothing is more important than the security of the commercial SLOCs. These are essential not only to a maritime nation's economic viability but also to its financial sinews of war, its ability to sustain a fight. As Prime Minister Alfred Deakin wrote in 1905, 'Nowhere are maritime communications more important than to Australia, seeing that our dependence upon sea carriage is certain to increase rather than diminish as population and production advance.'[7] Such foresight inspired Deakin to promote the building of the Australian fleet which was ready in 1914. Today, his words are as true as ever. Submarine forces are also growing globally. SLOC defence is an international responsibility, necessarily undertaken in conjunction with friends and allies, so interoperability is essential.

Joint force operational capability will also be essential: to be able to lift, deploy, protect, supply, and perhaps evacuate Australian forces in the near region. This mission is implicit in the building of the new amphibious ships (the LHDs), as well as in the history of national operations in the archipelago from the First World War to the Timor deployment of 1999-2000 and beyond. General Peter Cosgrove has stated: 'Another military blinding glimpse of the obvious is the utility of sea power in the East Timor operation. The persuasive, intimidatory or deterrent nature of major warships was not to me as the combined joint force commander an incidental, nice to have 'add on' but an important indicator of national and international resolve and most reassuring to all of us who relied on sea lifelines.'[8]

Australia's strategic situation implies a variety of other maritime missions: lower intensity operations in the form of counter-terrorism, as in the Gulf since 2003;[9] continual constabulary duties relating to border protection, fisheries, drugs and contraband, piracy, and environmental protection; diplomacy, presence, and support for peace monitoring, as in Bougainville in 1998; and humanitarian assistance as in Sumatra in 2005 after the earthquake and tsunami. Some of these activities can involve high threat environments, operational endurance, the need for visibility and an impression of power, or all three, and are best performed by major warships.

This agenda involves a multiplicity of roles and levels of force, consistent with a new emphasis within maritime nations on a wide variety of sea power roles.[10] It also implies operational reach, likely to be as necessary in the future as when Australian forces served together, for example, in the Mediterranean and North Africa during the Second World War. Capability will need to be interoperable, as well as joint, and deployable on multiple missions and in multiple theatres simultaneously. This is a tall order for a small to medium power whose force structure will be limited. At the operational level, therefore, force multiplication must again be the key, leveraging capability in terms of functions, political-diplomatic contexts, space and time. The solution has been at hand, and worked so well, for so long that one might be forgiven for forgetting its merits. The surface warship is one of history's most successful weapons systems, perhaps the most successful, and intrinsic to the force structure of a maritime power.

The Surface Warship as Force Multiplier

The modern surface warship came on the scene about the year 1500. Today infinitely more capable, strategically it remains what it was then: a strike platform with trans-oceanic reach. Its inherently strategic character derives from this combination of mobility and lethality. Everything in maritime strategy flows from this. The surface warship has been one of history's greatest force multipliers, alone creating global strategy and international relations. It allowed small states (Portugal, Spain, Holland and England) to create world-wide empires. Here is a lesson for Australia, with no imperial ambitions but disadvantaged in size, in 'the leverage of sea power.'[11] When employed to the extent of its potential, the surface warship has been a natural instrument for the establishment and exercise of sea control.

The operational capability of the twenty-first century destroyer or frigate is remarkable. It has battlespace awareness and warfare capability in four dimensions: on, over and under the sea and in the electro-magnetic spectrum. Its fuel capacity and sea-keeping and carrying abilities enable its reach, endurance and logistic self-sufficiency, like those of the British ships-of-the-line during the long blockades of France. It can cross the deepest oceans but has shallow draft to penetrate waterways. It can poise in the area of operations and needs no forward operating base. Operating in international waters, it does not require entry permission or host nation support. It can cover or threaten large areas, tying down or confusing opponents – in Kuwait in 1991 as at Quebec in 1759. It can operate independently, in task groups, in joint operations, or interoperably as part of a coalition. It bridges a gap between the patrol vessels employed for policing duties and higher capability warships such as cruisers and aircraft carriers.[12] RAN frigates are the smallest ADF units regularly deployed alone on extended military missions, thus allowing political and financial economy of force. They have been rightly called the workhorses of the fleet. The modern intermediate surface combatant has the same versatility as its ancestor, the British 74-Gun ship-of-the-line.

The ability to hit, threaten and protect is intrinsic to all operations of the surface warship. In modern terms this can range from simple gunfire to cruise missiles with enormous range for precision strike, able to reach Afghanistan in 2002, for example, from the Gulf of Oman.[13] Warships can also carry significant quantities of munitions. Carrier-based organic air power is effectively an extension of traditional surface strike capability. *HMAS Sydney* in the Korean War, for example, conducted strike missions against enemy supply lines as well as giving ground troops accurate close air support. Its operations enabled Australia to avoid having to commit additional troops.[14] The advantage of organic air power at sea is range beyond that of land-based air. The issue is not the specified range of any particular land-based aircraft, because it is not quantitative but qualitative. There is no guarantee that the need to operate will not occur beyond that range, whatever it may be. Many carrier operations during the Pacific War, for example, occurred beyond the range of land-based air.

The surface warship also has graduated force, with many things it can do short of using lethal force. These include declaratory blockade, as during the Cuban Missile Crisis and the Iraq sanctions regime. This can avoid escalation, give time for negotiations, or apply a containment policy. Graduated force makes the surface warship a political as well as military force multiplier, invaluable in the broadening of options it gives to government.

Two Key Missions

Various historical case studies show the effectiveness of the surface warship in key mission roles for Australia. From the Portuguese at the hands of the Dutch in the sixteenth and seventeenth centuries to Japan under American blockade, maritime powers have been fatally weakened by failure to defend their SLOCs. Britain, by contrast, survived two world wars by securing its sea lanes. By the 1940s the Atlantic was a joint operational environment, with RAF Coastal Command playing a key role, but adequate numbers of escort vessels were critical in the outcome of the campaign. Australia cleared its sea lanes, and ensured the safety of its troop convoys, within months of the outbreak of war in 1914 by deploying the deterrent power of the battlecruiser *HMAS Australia* and destroying the raider *Emden*. By the 1950s the RAN had made anti-submarine warfare a specialty, but its surface force structure has remained integral to its ASW capability.[15]

The value of warships in joint operations was never more evident than in the Mediterranean and New Guinea during the Second World War. The defence of Tobruk during the siege, of great political as well as strategic value, was made possible by the famous naval 'ferry', including Australian destroyers, which brought in supplies and evacuated wounded and prisoners. New Guinea was a maritime-enabled campaign, fought in an archipelago with poor land communications. Naval forces conducted surveys, minesweeping, amphibious lift and logistic support for ground and land-based air components. Australian warships escorted landing forces and provided gunfire support and air defence.[16] Allied ability to project power into the archipelago contrasts with German inability to invade Britain in 1940. The fundamental obstacle to a threadbare surface *Kriegsmarine* was the critical mass of the Royal Navy.[17] The ability to evacuate troops aboard warships was clear at Dunkirk (where most were taken off on destroyers) and Crete (where naval forces took terrible casualties rescuing the Army).

The Myth of Surface Warship Vulnerability

All military units can become targets and are potentially vulnerable. But the notion that the surface warship has an undue lack of 'survivability' has never been proven. Its death has been predicted for over a century in the face of new weaponry such as torpedoes, aircraft and missiles, which it has itself adopted, just as it adopted the gunpowder, industrial and information revolutions. Threats have advanced, but so have warship defences, taking a quantum leap in the last quarter century. Layered and networked defence, to which warships are intrinsic – part of a system of systems, is enhanced by the difficulty of targeting a warship at a distance. The two salient cases of warships struck by missiles, *HMS Sheffield* and *USS Stark*, are over twenty years old, and involved ships presenting co-operative targets.[18] Ship design can also optimise survivability in the event of a missile hit. Norman Friedman observes how bigger can mean safer and less sinkable.[19] The surface warship is also tactically a moving target (unlike for example landward air bases), hard to locate in the vastness of the sea, with its own high level capability, awareness and defences. Unlike land and air forces, it can also mitigate lower level threats such as terrorism by the expedient of putting to sea for an extended period.

The Necessary Force Structure

A military capability is bound up with the force structure which ensures it. For reasons which have everything to do with technical issues of maritime warfare, naval forces must be balanced and adequate. The more complex the operational environment and the higher the operational tempo, the greater is the need for balance and adequacy. The traditional naval concept of a 'balanced fleet' is not sentimental but professional. It means having a functional force, prepared for likely eventualities, and sufficiently flexible for unlikely ones. The successful fleets of history, such as the Royal Navy in the Revolutionary, Napoleonic, and Second World Wars or the US Navy in the Pacific War, have been balanced fleets. Good naval commanders have appreciated the balance of their fleets and sought to unbalance those of their opponents. This was why Nelson cried out about 'want of frigates,' and effectively why he wanted a 'battle of annihilation.' Unbalancing the Japanese fleet, by destruction of its carriers, was what the Allies achieved at Coral Sea and Midway. For a smaller power such as Australia, with a big operational agenda, balance, flexibility and force multiplication are at a premium. This means adequate numbers of surface combatants without over commitment to another arm, for example submarines.

The British naval historian Stephen Roskill had a phrase: the fallacy of the single weapon. An unbalanced fleet, with over investment in one kind of platform, can have serious consequences in the form of truncated capability. Submarines alone, for example, cannot provide the dominance needed for sea control, and have never succeeded in doing so in outright maritime warfare. The defeat of the German U-boats in the Battle of the Atlantic was victory over a navy profoundly unbalanced in favour of submarines. Neither do submarines alone have the breadth of operational capability to exercise sea control. They lack, unlike surface ships, the visibility, accessibility, and graduated force for many diplomatic and constabulary duties. And they lack the three dimensional capability, which the surface warship has, to defend SLOCs and support joint operations. They are important components of the fleet, and perform valuable tasks by way of surveillance and strike for example. But compared with surface warships, they are not in the same way strategic units.

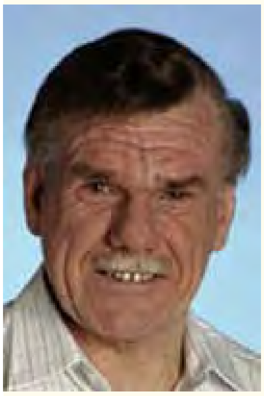
The surface warship is a platform, as well as a set of capabilities, and quantity matters as much as quality. Sea control is a function not just of capability but of numbers. This was Britain's problem during the early Battle of the Atlantic when it lacked sufficient escorts, and Australia's when the decline of its naval surface force between the wars had serious consequences when Japan attacked in 1941-2. The US Navy, by contrast, could prosecute the Pacific War not only because it won fleet actions but also because it had cumulative critical mass. Conversely, inadequate fleets, especially those facing high operational tempo, have suffered many defeats.

Thinking and Investing

Australia must think flexibly and broadly in the complex, uncertain and demanding environment of the early twenty-first century Asia-Pacific. It must realise that the reach of naval-maritime power does not represent the ill-considered risk of global entanglements or imply a dangerous indulgence in 'expeditionary warfare,' but constitutes an invaluable ability to engage in good international citizenship, protect and promote Australia's wider and nearer interests (without necessarily putting boots on the ground), sustain alliances and friendships, help in shaping the strategic environment, and deal with threats and situations, foreseen or unforeseen, at a distance before they reach our shores and perhaps even before lethal force, with all its human and political consequences, needs to be employed. In warfare, as in medicine, prevention is better than cure.

History has lessons for Australia's strategic policy context, maritime operational agenda, and naval capability and force structure requirements. The surface combatant is indispensable and enormous value for money. For five hundred years sea power has never lost, and the intrinsic capabilities of the surface warship are the reason why. The more one considers the strategic context and the greater the need for fiscal efficiency, the more attractive is the flexibility and synergy of this remarkable weapons system and force multiplier whose effectiveness historically has been infinitely greater than the sum of its parts. Its pay-offs go even beyond the political-diplomatic, strategic-operational and administrative-fiscal realms. In the defence of vital trade and the promotion of techno-industrial capacity and exports - through shipbuilding, logistic support, maintenance, repair and refits - it constitutes an investment in national economic health.

The implication of all this is the need to replace the RAN's ANZAC class frigates adequately in terms of both capabilities and platforms, by means of the SEA 5000 project, while mindful of the demanding environment in which the ships will serve. The surface combatant force has been stretched during the last decade. Maritime operations, and more of them, are continually taking place. The question of a precise future force structure is beyond the scope of this article, but two things should be said. One is that for every warship deployed there must be one simultaneously in refit and one working up ('the rule of three'). The other is that naval shipbuilding has economies of scale. Expenditure on research and development, design, and set-up costs is amortised over the life of a project, so the cost per unit decreases as more ships are built. An adequate number of surface combatants, within a balanced fleet, are the minimal naval capability for a maritime nation such as Australia. A belief otherwise could be fairly suspected of lacking strategic foresight. Certainly, history would be against it.



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Land-based Aircraft for Naval Protection?

BY LIEUTENANT TOM LEWIS

Is it possible to protect naval ships at sea by using solely land-based aircraft? Many supporters of this theory argue that it is quite feasible.[1] But has this been proved empirically, and is it realistic to propose it as a model for the future?

Obviously if ships are deployed for some tasks near a country's coastline, and there is a convenient airfield nearby, this is a workable proposition. But just as obviously as the ships move further away the aircraft's range is a compromising factor.

What sort of aircraft cover is needed by naval ships? Certainly the lessons of WWI and post-1943 WWII are significant. Bitter experience showed that the only way to survive submarine attacks on merchant shipping was through convoys, with air assets along to keep the submarines down. One historian noted of WWI that "Of the 96 ships sunk out of the 16, 000 sailed in ocean convoys and the 161 lost from the 68, 000 sailed in coastal and short sea convoys, only five were so sunk when an air escort was present as well as surface escorts."[2] The next world conflict was to reinforce these lessons. When aircraft were present, submarines were not. "The provision of air escort, even only for a few hours, at the crisis of a convoy battle could turn the scales," was how one writer put it.[3] In the last two years of the war the German U-boat command only succeeded in sinking 16 ships from north Atlantic ocean convoys – for the loss of 70 of their submarines, half of these being sunk by aircraft. The presence of the aircraft prevented the U-boats from being able to get within targeting range of their prey – a factor that was not there earlier in the war, and a prime factor in the massive amounts of shipping the U-boats had been able to sink.[4]

The message that ships were vulnerable to air attack had been there for some time, but it was slowly and painfully learnt. The captains of ships such as *HMS Glorious* failed to understand that naval aviation was by then an essential part of sea warfare. In the case of the loss of this carrier, surprised in 1940 by the *Scharnhorst* and *Gneisenau* without a single aircraft flying in defence, it was a failure to understand and operate the surveillance and strike capacity that could have saved the ship and her two escorting destroyers. The losses of the Royal Navy in the Mediterranean in operations such as Crete were also instructive. Similarly it slowly and painfully became understood that without aircraft to protect them warships were vulnerable to aircraft attack, despite the presence of layers of anti-aircraft guns. The loss of the British battleships *Repulse* and the *Prince of Wales*, both quickly overwhelmed by scores of seemingly endless numbers of attacking Japanese aircraft, was the final lesson that needed to be learnt by proponents of capital ships protecting themselves. Significantly for this argument, 11 Buffalo fighters took off to aid the two ships – they were not in time to defend them.[5]

The Italians found out to their cost what happened when you did not have "an air umbrella" of fighters to protect ships at sea, and writer Giuseppe Fioravanzo reflected gloomily after the war on what had happened. He is worth quoting at length on the deficiencies which… "could only have been corrected with the presence of aircraft carriers. Since we had none, we tried to speed the participation of aircraft in naval battles by means of a quick, direct system of communications between sea commands and air operations centers (until the end of May 1941 every request for air support had to be transmitted through Naval Headquarters, which sent the request to Air Force Headquarters, with delays of hours and hours). The situation improved, but under the circumstances it was always unsatisfactory.

After the unfortunate experience off Cape Matapan (28 March 1941), it was directed that ships should not confront the enemy further than 100 miles from the nearest airport, in order that the Air Force could ensure a minimum of air protection by dispatching wave after wave of fighter aircraft into the skies above the naval forces. If this order had been strictly observed, we would have abandoned the idea of continuing the war. Instead, ships were risked just the same."[6]

SBD Dauntless dive bombers from USS Hornet approaching the burning Japanese heavy cruiser Mikuma to make the third set of attacks on her, during the Battle of Midway. Mikuma had been hit earlier by strikes from Hornet and Enterprise-courtesy US Navy

Fioravanzo outlines some attempts to improve the situation, but concludes that only aircraft carriers could have solved the Italians' problems. By the end of the war the Royal Navy had reached the same conclusion. Its 1939 Fighting Instructions had discounted the role of naval embarked aviation as being of any value in ocean convoy defence. By the end of the war the same Instructions stressed the importance of carriers

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with a convoy to provide a tactical air force.[7]

The argument was then, and it is now, not so much as to whether aircraft to defend ships are essential, but as to whether they could be flown off land bases or not. Aircraft carriers have always been expensive; some see them as vulnerable, and they require a logistics provision which is complex and demanding. Certainly land-based aircraft played a valuable role in WWII convoy protection: sterling work was done in the area in many air forces with such mighty workhorses as the Sunderland, the Focke-Wulf 200, and the Catalina. But these aircraft could not cover all of the areas of sea needed. To combat enemy submarines operating beyond the reach of land-based aircraft the escort carrier was born; often converted merchant ships in the 5-10,000 ton range. *HMS Audacity*, for example, was 5,500 tons, and equipped with Grumman Wildcat fighters.[8] Across the Atlantic, it was decided by the US Government to assign several small carriers of the converted type to anti-submarine duty.[9] The first of these was *USS Bogue.* The escort carriers filled the role ideally, and the combination of good intelligence work, aggressive air patrolling from land and sea-borne platforms, coupled with capable tactical doctrine, ended the U-boat menace. The usefulness of embarked air defence for ships is demonstrated by the numbers of carriers in use at the end of the war: 50 by the RN, and 99 by the USN.[10]

The nuclear weapons used at the end of WWII changed the strategic outlook forever – or so many thought. If a future major war would be nuclear, then suddenly warfare was all about effective delivery of such weapons. As John Winton has pointed out, in America after WWII there was acrimonious debate as to the future composition of the United States armed forces. The same arguments as to who should provide what and where raged, with an aircraft carrier being cancelled five days after work on it began, and the Secretary of the Navy resigning in protest. For while, it looked as if the Navy "was to become a convoy and escort force, with some submarines".[11] One commentator even said that "the phrase 'sea power' will lose all real meaning. All military issues will be settled by relative strength in the skies."[12]

There was indeed a school of thought that reasoned that naval fighter aircraft were too heavy because of the need for a strengthened undercarriage and tailhooks, and therefore they might have to be done away with altogether.[13] However, a counter-argument was effectively put by the increasing development of the jet engine, which gave the naval aircraft all the power they needed.

What focused the debate on the need for air power at sea was the outbreak of the Korean War in 1950. United Nations efforts to contain the North Koreans required air assault from the sea, and indeed this was delivered by the aircraft of *HMS Triumph* and *USS Valley Forge*. The *Valley Forge* provided air cover for an amphibious assault. When the call for close-air support was the desperate call of the hard-pressed ground troops this too was delivered by sea-based air assets. Where else could these essential attacks have come from? The geo-politics of the region constrained most land-based aircraft activities. Land airfields were too far away; too constrained by the lack of organic assets, and the politics of the situation. The flexibility of the carrier concept of a floating airfield was ably demonstrated.

USS Bogue

Nevertheless, Air Force assets began to get involved by flying from Japan. But these aircraft - F80 Shooting Stars - could not loiter in the target area because of limited fuel endurance, and moreover were lightly armed because of the extended range.[14]

Crewmen use flight deck tractors with power brooms to sweep snow from the carrier USS Valley Forge's flight deck, during operations off Korea, circa early 1951. The aircraft parked in the foreground is a F4U-4 "Corsair" fighter. Those on the forward flight deck are an AD "Skyraider" attack plane and a HO3S helicopter. (Official US Navy Photograph)

The lessons of Korea have not been forgotten by the US Navy. Its many deployments in the years since have always seen the protection of its naval forces by embarked aircraft, and a Combat Air Patrol (CAP) flown over the ships. Significantly, the argument of land-based aircraft protection for ships has never seriously been embraced by the USN. The heady assumption that all future warfare would be nuclear did not last long, with more realistic judgements emerging. There was good reason to maintain naval air assets, in particular to protect ships at sea from airborne attack. A further attribute was the ability to strike at submarine bases which harboured the undersea threat.[15] Sensibly, the USN has often welcomed the contribution of land-based aircraft to deliver assistance, for example in WWII as its forces moved upwards after New Guinea was taken. The great argument of the late 1940s and beyond was how attacks on America's enemies might be best delivered: by long-range bombers, or naval strike, or Inter-Continental Ballistic Missile. In the end, all three won, although in the case of naval attack it was by means of the submarine-launched missile, as opposed to strike aircraft flying from aircraft carriers.

It is in the smaller navies that suggestions of land-based air cover have been principally made, often because of the cost of carriers. Demonstrations of the flexibility shown by aircraft carriers were shown by the Royal Navy in the Suez crisis, Confrontation in Malaysia, the defence of Kuwait against Iraq in 1961, and in other operations. But by the late 1970s, scuppered by the Labour Party Defence Review of 1966, the RN Fleet Air Arm was on the way out. It had been forced to accept smaller carriers and constant sniping from its enemies, while in America aircraft carriers were getting bigger. Writing in 1970, Vice Admiral Sir Arthur Hezlet concluded that "The air defence of the Fleet is also to be taken over by the Royal Air Force using fighters from the shore".[16] And so the future seemed set, when the Falklands crisis arrived to demonstrate the folly of this idea. But as the Duke of Wellington once said, "It was a close-run thing". When the task force to rescue the Falklands sailed south in 1982 it had just 19 Sea Harriers as its protective air component. Small carriers mean a possibly-dangerously low number of aircraft.

The Falklands is one of the proving grounds of seeing the necessity of organic air defence for naval assets. The distances were simply too far for land-based aircraft to be deployed to any great effect in any role, let alone fighter defence of the ships. The RAF, however, set out to demonstrate their strategic reach. The British-owned Ascension Island in the South Atlantic is a lengthy 3, 300 nautical miles from the Falklands. Flying from Ascension, on 1 May a Vulcan bomber attacked the Islands with a Herculean effort. A sixteen hour flight, with six in-flight refuellings from 10 Victor tankers saw the bomber deliver 21 thousand pound bombs. A single hit was made on the Port Stanley runway, and a psychological blow[17] inflicted, but only a feeble military strike delivered at massive effort and expense, as were later similar raids.

The commander of one of the Air Groups operating from the two British aircraft carriers, Lieutenant Commander "Sharkey" Ward, commented on the efforts the RAF made after the war was over, to still maintain the argument that land-based cover was all the Royal Navy would ever need. This was even after the demonstrable success of the Sea Harriers in defending the Task Force against Argentine attacks. He calculated that even if just defending Britain "to put twenty-four hour fighter cover over the fleet at just a few hundred miles would take up all the tanker resources of the RAF and most of the fighters."[18] A flight of fancy positing the effective deployment of Argentine aircraft to Port Stanley and the increase in effective range that would have given them is an even more sobering scenario – and recognition that air cover for ships must be immediately effective and omnipresent.

Avro Vulcan XL319, North East Aircraft Museum, Sunderland

The impossibility of providing fighter protection for the ships of the Falklands task force is quite evident from the example above. The Vulcan, as a bomber, engaged in lengthy "straight and level" flight, and further was not required to engage in evasion manoeuvres when it reached its target. Nor was it required to stay on station, merely to deliver its payload and depart. To posit a 24/7 CAP of fighters, supplied by air-to-air refuelling over the Falklands Task Force, is simply the stuff of fantasy.

How are ships best defended at sea from air attack? If we discount any strike role, it is necessary to have surveillance and interception air assets. The Americans are the world's masters at this; unfortunately an expensive level of protection few forces can afford. They have Hawkeye surveillance aircraft to orbit over the flotilla of ships below, or even positioned further "up threat" to gain maximum warning of any foreign aircraft coming towards the force to release anti-ship missiles. Along with the surveillance aircraft, there is a CAP of interceptor aircraft. These are usually FA/18 Hornets, now replacing the aged F-14 Tomcats. If hostile contacts are detected, then these "area" interceptors deployed in the CAP are vectored towards the enemy aircraft, and they hopefully shoot it down with an air-to-air missile, or their onboard guns. Peace and quiet descends once more.

This is an aircraft carrier scenario

however. The Americans carry their airfield with them, and the Tomcats, Hornets and Hawkeyes are housed on board. But what of nations that do not have carriers? For them, the task of providing area defence is a different demand.

If ship air defence is mounted from land, and we discount all of the lessons learnt above, how would land-based fighter cover operate? The land-based air defence scenario advocates that air cover be deployed from airfields on land, either your own, or those provided by a friendly nation near the area of deployment. Aircraft take off from the land, deploy over the embarked ships, "loiter" or "orbit" there to provide a CAP, and when their fuel is depleted, return to the land. Obviously they are replaced by other land-based aircraft, who would take off in sufficient time to cover any gap in the coverage. Getting there on time is most important. Aircraft based on a carrier can get up to intercept very quickly – the USN in 1949 was demonstrating the ability of their F2H Banshee fighter to take off and reach 40, 000 feet in seven minutes.[19]

A critical pair of factors is the range and endurance of the aircraft. "Range" refers to, in this scenario, how far the aircraft can travel, measured in nautical miles, configured for a type of role. "Endurance" is how long it can stay there when it reaches the ships it is supporting. The number of aircraft needed is dependent on the type of threat one faces. If the best intelligence available suggests that a threatening country can only deploy four attack aircraft, and you are sure of your aircrafts' abilities to cope with the threat, then you might have four of your own up at any one time. Another way of providing the coverage may be to have the aircraft "ranged and ready" with literally a pilot sitting in the cockpit waiting for take off orders. If a threat is detected, the aircraft take off and fly to meet it.

Imagine a scenario where your CAP has to engage. The target is identified, and your aircraft move from flying long slow "racetracks" in the sky towards the, let us say two, hostile aircraft. The impetus is there to engage as soon as possible, before the aircraft releases its cruise missile, which will then constitute a threat usually dealt with by the ships' defence systems. So the onus is on the aircraft to shoot the attacker down before his missiles are within range. Of course, if these aircraft are armed with conventional bombs, then more time is available.

But back to the cockpits of the defending aircraft. They are now moving faster. When engaged in combat, any aircraft uses up more fuel than it consumes when it is in "loiter" or "orbit" mode. The pilot may need to accelerate suddenly to catch a target; or to evade a missile or gun shot. The use of afterburner speed – usually deployed if trying to evade a missile – melts away an aircraft's fuel most dramatically. But luck is with us this time. We engage with missiles at around 20 nautical miles; the enemy are both shot down, and our pilots' maintenance teams will paint little aircraft on the machines' sides later that day.

But now, our aircraft have a lot less fuel, and must return to their land base. Of course, any combat aircraft may also need to return for another reason – its missiles are gone.

Once combat is joined, then the need for replacement aircraft is even more important. Aircraft readied on the land have to take off to be in position as the aircraft that has just fought exits the area. There might be another strike on the way. And it is crucial that the overhead cover be maintained all of the time. Failure to have such assets in place led to the loss of the Japanese cause in the WWII Battle of Midway. Their covering fighters, having been needed to strike at an American air attack, did not have the height and time to get back to cover another enemy strike. In six minutes three out of four Japanese carriers were in flames and beyond saving.

The critical factor is obviously the combination of endurance and range. As soon as an aircraft departs the protection zone, another is needed, and therefore it will have to be on its way before the first aircraft departs. The situation, in simplified terms, might look like this:

Aircraft en route to area	Aircraft in protection area	Aircraft en route to base	Aircraft being refuelled and re-armed
Aircraft Group A	Aircraft Group B	Aircraft Group C	Aircraft Group D

The centre of the problem is Aircraft Groups A and C. As the ships move further away from the coast they must spend more time in the air. It must not be forgotten that its flight time in terms of being "on the spot" must be zero – there cannot be a gap where no aircraft is on CAP. As the ships move away from the coast the flight time of the arriving aircraft becomes longer and longer, and therefore the amount of time it can assume its role as Aircraft Group B becomes less and less, because it carries less fuel. The fuel factor can be improved by drop tanks or air-to-air refuelling, but these are not factors one can take into account for a permanent solution.[20]

Logically it follows that time spent in transit – both to and from the protection zone – is also going to be longer the further away from the land-based airfield the ships move. The problem will be compounded by the fact that the airfield is not necessarily going to be in a straight line from the coast to the ships, but often at a diagonal which lengthens the flight time. As the ships move further away the time aircraft spend in transit increases. Eventually the flight time becomes a discrete factor in itself. In essence at least double the amount of aircraft are needed by comparison with having the aircraft's landing field nearby. In other words if a carrier is the aircraft's home then we may make do with two groups of aircraft to complete the model of force area protection; with a land-based model four groups are needed. To make matters worse the land-based aircraft have to cover not only the distance to the ships but beyond that to orientate themselves towards the threat, which logically enough will not come from the land where the fighters are based. The difficulty of flying over ships armed with Surface to Air Missiles (SAM) is also worth pondering over: the Identification Friend or Foe system should ensure safety, but nervous gun and missile crews tend to shoot first and ask questions later, particularly when they have been successfully attacked by hostile aircraft. The many instances of ships shooting at their own side's aircraft in WWII should not be forgotten.

It is worth noting that most SAMs in themselves are only a self-defence for individual ships and do little contribute to area defence needs such as coverage for amphibious landings or supply ships. However, command systems such as Aegis and modern missiles such as the SM-2 and SM-6 can provide area coverage for a considerable distance. But these systems are very specialised, and cannot be bolted onto any vessels. Ships dedicated to such roles are needed, particularly if no aircraft carriers are present.

The scenario of relying on land-based cover is also a nightmare for a flotilla commander, or even the captain of a single ship. If he is forced to hug the land for air cover he is doomed to occupy a certain strip of water through which his enemies know he must move. Limited to that strip, his movements may be predicted sufficiently so that his forward movement may be checked with waiting submarines, mines, or the surface forces of his enemy. He is within range of the land-based missiles and guns of any enemy land force able to target him – as *HMS Glamorgan* was targeted from a land-launched Exocet in the Falklands War.[21] He cannot venture out of that strip to pursue an enemy. Tied to a narrow strip of water, he lacks tactical and strategic freedom.

A further nagging thought for the Navy flotilla commander is whether those vital aircraft on which he is so dependant are available. They might be limited by weather factors which prevent them taking off. The airfield itself might be under attack and the assets on which he is relying are in fact burning wrecks, with an enemy mortar team retiring triumphantly, having not only destroyed the aircraft but left a lonely collection of grey ships now vulnerable to air attack. The airfield's communications might be disrupted or jammed, preventing the vital message that 12 aircraft are quickly needed rather than the routine patrolling two. All of these factors count against the use of land-based aircraft.

Finally, though, comes the time when the land-based aircraft simply cannot reach the area ships might operate. As has have shown, this was the case in the Falklands. And the aircraft Australia employs and even those it will acquire in the future, have the same limitations. The FA-18 Hornet, which Australia has used for some years, has a combat radius of 740 kilometres.[22] This aircraft can defend the Australian coastline, but cannot defend ships moving up through the Indonesian archipelago. They cannot defend ships operating in the South China Sea. They cannot defend ships operating south of India. They cannot even protect vessels out to Vanuatu. They cannot provide fighter cover for ships operating in the Antarctic.

There are plenty of places on the planet where naval vessels may need to deploy to prosecute the interests of their country. In Australia's case, that might be as far afield as the Antarctic, or remote parts of the Pacific, or off the coast of Africa; or anywhere really, in large blocks of ocean where land-based aircraft cannot have a presence, either because they are too far from a friendly runway or there are indeed no runways in that part of the world. Proponents of air cover for naval assets by land-based aircraft are limited in their strategic vision. They imagine that the only place on the planet where navy ships will need to operate will be in convenient reach of airfields, probably close to home. Modern strategic needs means a country's interests are best pursued by proactively deploying its forces to where the centre of gravity

FA-18F Super Hornet- courtesy Boeing

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suggests force is best applied.

Significantly, recently the UK's Ministry of Defence announced the building of the biggest aircraft carriers in the RN's history. Two 60, 000 tonne carriers will be built by BAE Systems. The plan will see elements of the RAF, joined by the Fleet Air Arm with the new Joint Strike Force fighter, being deployed to take all of the capacities of a carrier battle group, including land target attack, to anywhere where the British government think it will be needed.

In Australia we once had the capacity to make safe our ships from air attack. We had embarked airpower in the early 1950s to the early 1980s with aircraft carriers. Then, with the decision to do away with the loss of *HMAS Melbourne* and all of the capabilities she represented we largely discarded that. But the need for protection against air attack remained. Three capable destroyers of the US *Charles F. Adams* class then at least presented some notion of area anti-air defence before they were retired. Now Australia is building three Air Warfare Destroyers to provide the area protection deployed ships need. These ships, capable of tracking and destroying many targets simultaneously, are the less expensive alternative to carriers. They are a lesser answer, it must be admitted, but one that is necessary. Naval forces need organic defence from air attack. Land-based aircraft cannot realistically provide air cover for ships deployed anywhere outside of an extremely narrow coastal zone, and even then, such a concept is militarily and strategically flawed.

Lieutenant Tom Lewis, PhD, MA, OAM, RAN, is the author of several military history books and holds a doctorate in Strategic Studies. He is the Editor of Headmark.

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32F

NCSM: The Collins Class Submarine: National Benefits and Costs

BY CAPTAIN CHRISTOPHER J. SKINNER, RAN (RTD.)

This paper is a report on my work following receipt of the 2006 Maritime Advancement Australia [MAA] award, which has addressed the national benefits and costs for the New Construction Submarine project to develop and deliver six Collins class submarines for the RAN.

In my research I have taken a thematic approach based on a taxonomy that I have developed for the purpose (see Annex A). I originally intended to cover all 16 of the topics in this report but was counselled to distinguish' the wood' more clearly from 'the trees'. I have therefore decided to cover a dozen or so aspects of the Collins class submarine program that departed from previous experience and conventional wisdom of the day.

Chronology

As I have attempted to show on the Gantt chart, there were a number of interrelated events and activities that influenced the program.

Value = f(Benefits, Costs, Risks)

My research plan has been directed at national benefits and costs, but there have been many matters to address along the way. And my work is still in progress…

Benefits have been discussed indirectly and by inference. Some of them are contentious but I assert them nevertheless.

Costs also are open to interpretation. The news media and other analysts place great store by the bottom-line cost of each capability project, yet with little consideration of cost of ownership or even of the related costs that must be incurred to support or introduce the project prime deliverables.

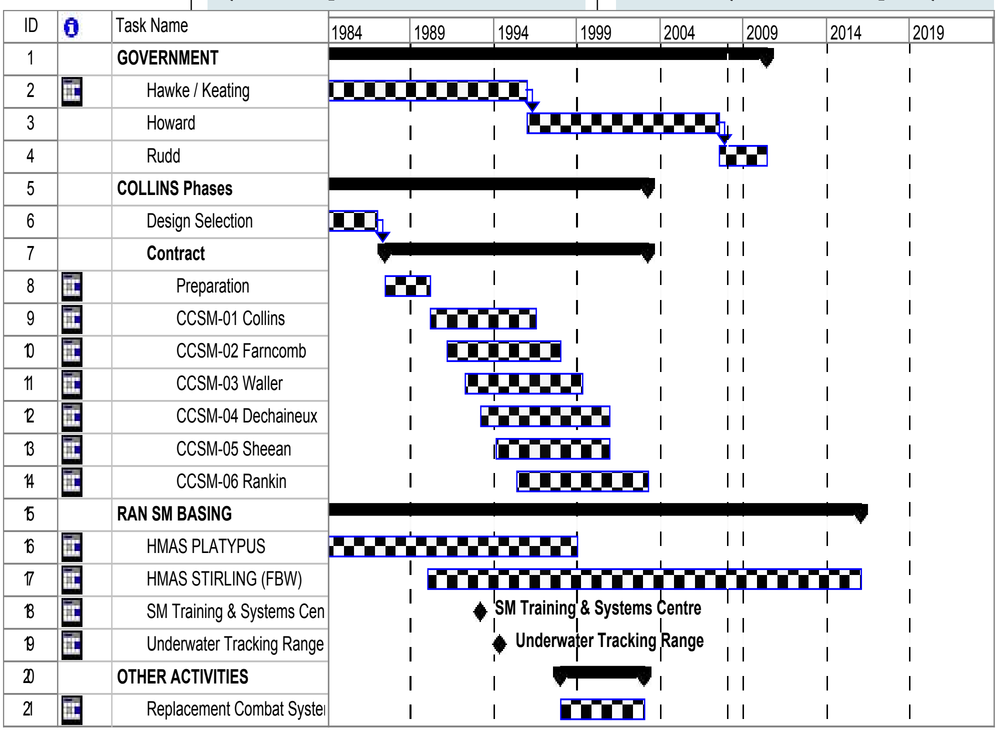
Similarly there will be investments needed for design, development, production and deployment. Yet much of this investment will be amortised over not only the life of type, but also in related programs. Even when the asset is no longer fit for their original purpose there may be residual value for modification to another role or for disposal.

Risk is inherent in any project; the more novelty, the more complexity and the more constraints, the greater the risk. Until the risk is mitigated, that is. To this day the best practice risk management approach world-wide is the humble Australian standard AS 4360. Thus Australia knows how to manage risk and in the COLLINS program this was done. Risks, even when mitigated, never give assured outcomes – or they would not be risks. Some negative outcomes do eventuate, that is, the risk is realised. The COLLINS program had some challenges that arose because of this inevitability. Many other possible risks did not arise. Some have not yet arisen but may still do so in the future. Such is the nature of risk management

Unfortunately the wider community, without any insight from the media who share the same ignorance, nor from professionals who do know better, views any risk that eventuates as some failing of project management or some cynical failure to meet contractual obligations. This is patent immaturity in Australia's industrial development, and we must grow up to know better. Notwithstanding the grudging acknowledgement by a growing minority that the COLLINS program has produced some of the best submarines in the world, we still see statements from otherwise reputable journalists writing in 2008 that the Collins program was 'most infamous Defence [troubled project] in recent years.' What arrant and cynical nonsense! Such media predilection for hyperbole is not merely about cutting down 'tall poppies' and indulging in sensationalism; but rather it shows an inability to admit earlier misjudgements and exaggerations regarding the inevitable 'teething troubles' of any large complex project.

There has also been an overtone of

Figure 1 Chronology of Some Key Events and Activities that influenced the COLLINS Program.



Three of the Collins-class on surface

The revolutionary success of submarines in WW1 was evidenced by the necessity for the adoption of the convoy system for merchant shipping, and the recognition of the disproportionate defensive requirements needed for Anti-Submarine Warfare.

The RAN was given or purchased several more submarines in the 1920's but was unable to sustain the capability so that by the start of WWII Australia was once again without a submarine capability, and hence could only observe the effective use of submarines by others.

The Battle of the Atlantic has been the subject of numerous accounts and did not bear directly on Australian experience except to highlight the need for effective ASW escorts for convoys. British submarines operated effectively in the Mediterranean and helped bring about the defeat of the Afrika Korps.

The Pacific War saw the highly successful submarine campaign waged against the Japanese primarily by the USN Pacific and Asiatic Fleets from bases in Hawaii, Brisbane and Fremantle.

The lesson taken from these campaigns was the need for development and maintenance of ASW skills. This led Australia and New Zealand to request the stationing of the Royal Navy Far East Fleet Fourth Submarine Division at *HMAS Penguin* in Balmoral, Sydney from 1949.

A decade later this arrangement could not be continued as the RN had made the same decision as the pioneer USN to move to nuclear powered submarines and that meant insufficient diesel-electric submarines for the ANZ task. As a consequence Australia ordered six Oberon class submarines to be built in the UK for the RAN.

Over this same period Cockatoo Island Dockyard in Sydney had become proficient in the docking and depot level maintenance of the SM4 boats. Nevertheless when Cabinet insisted that Codock be invited to tender to build the Oberons they were unable to do so, perhaps due to the opposition of Navy Minister, Senator John Gorton..

Thus Australia was once again involved directly in submarine operations and support for the first time since 9 April 1931 when the first HMA Submarines *Oxley* and *Otway* were handed over to the RN.

More than a generation and WWII were to pass before the second Oxley, commissioned on 18 April 1967, arrived for the commissioning of their new submarine base *HMAS Platypus* at the RAN Torpedo Establishment in Neutral Bay, Sydney. Over the intervening period the UK had withdrawn its forces from Singapore, following the Suez Crisis in 1956 and the Cold War had reached an intensive level.

The dialogue with the USN had gathered strength from the acquisition of DDG ships, US aircraft for Australia's Fleet Air Arm, and, not least, collaboration for the Cold War as well as the hot war in Vietnam.

The Oberons gave outstanding service and established the Submarine Arm of the RAN in a permanent manner that endures to the present and into the future.

political point scoring applied to official statements regarding earlier project decisions. In Australia this phenomenon is probably unavoidable but should be discounted by commentators and historians.

Australian Commitment to Submarine Capability

The RAN has a long involvement with naval submarine capability. Prime Minister Alfred Deakin was persuaded by the iconoclastic Admiral Jackie Fisher that Australia should order two submarines *AE1* and *AE2* and tender *HMAS Platypus* at the same time as battle cruiser *HMAS Australia* and accompanying ships. This was contentious at the time when the effectiveness of submarines, even for coastal defence let alone oceanic operations, was subject to debate.

Even the revolutionary development of the dreadnought battleships is relevant because they were intended to enable effective engagement from outside the range of torpedoes of the day. As time passed the most effective platforms for torpedo engagement had come to be recognised as aircraft and then exclusively as submarines.

New Basing for the COLLINS

HMAS Platypus served Australia well with its unique combination of: operating base, intermediate-level support base and, after the Submarine Weapons Upgrade Project, the training school, all in one compact site only

Collins-class & Seahawk

metres from private land and under the intense scrutiny of closely packed residents of Neutral Bay.

For the Collins class there were clear needs for a new approach, and these, together with strategic and security issues, led to the decision to base the squadron in Western Australia as part of the purpose-built Fleet Base West at *HMAS Stirling*.

This same base has also hosted visiting USN nuclear submarines.

Specialised facilities for submarine support, maintenance, shore training and support for sea training and test and evaluation, have all been added, such that the FBW basing is now a coherent and comprehensive capability that will persist and evolve for future submarines of the RAN.

Collaboration with SUBPAC

Following the ANZUS agreement and with ever increasing levels of operational and support liaison between RAN and USN, it was inevitable that a close rapport should have grown up with the USN Pacific Submarine Force.

The participation of RAN submarines in the multinational RIMPAC exercises in Hawaii has always been welcomed as providing an extraordinary conventionally-powered submarine participant that has enjoyed notable success in free-play exercises.

Operationally the RAN has also contributed greatly in the Intelligence, Surveillance and Reconnaissance mission for intelligence gathering in the Cold War and other regional contexts.

The collaboration increased even further with the adoption of the Mk48 torpedo and Submarine-launched Harpoon anti-ship missile [Sub-Harpoon] in common use in the USN.

This collaboration has continued with the advent of the Collins class and, in some ways, has increased due to the resolution of some of the Collins' teething troubles sometimes drawing greatly on USN scientific and engineering expertise.

Source and Execution of the Design

Notwithstanding the long tradition of RN design and sourcing of RAN vessels, nor the more recent similar process with the USN, the selection of two finalists for the COLLINS program did not include designs from either, although a UK design was offered.

Instead the proposals chosen were from two highly regarded designers of conventionally powered submarines – Kockums and IKL/HDW. This was a courageous decision but one that was borne out by the end result.

The ultimate Kockums selection, while larger than any previous Kockums design, was conventionally laid out and dimensioned. This was not at all a dramatic departure from proven, previously-implemented designs.

Produceability was well considered and the engagement of Australian industry for materials, subsystems and components, and for specialised services, was well done.

Indeed in many ways the Collins approach to Australian Industry Involvement [AII] through attention to detailed design in Australia was to set the norm for the contemporary ANZAC frigate program and the later Minehunter Coastal program.

Non-Nuclear Propulsion

For the COLLINS there was never any serious consideration for nuclear propulsion, and this was a major reason for seeking designs from other than the USN or RN, which had both committed exclusively to nuclear propulsion for submarines.

Australia had no nuclear industry, nuclear power was an unpopular concept for civil power generation in Australia especially following the incidents at Three Mile Island in the USA and the later Chernobyl incident in the Ukraine.

The USN itself had lost two nuclear submarines in accidents and there was still some doubt as to the causes.

The Soviet Navy with so much effort in the Cold War to establish a counter to the USN nuclear strike capabilities from firstly the USN carriers and then from the strategic ballistic missile submarines [SSBN], had also adopted nuclear propulsion as a major capability but sustained several accidents and other setbacks.

Canada, another country to operate Oberons, also went through a deliberate study process for its next generation submarine capability and decided against nuclear power, notwithstanding two factors in its favour, neither of which applies to Australia:

- Canada does have a civil nuclear power industry and even exports its nuclear engineering capabilities. And
- To exercise sovereignty over some of its northern islands and exclusive economic zone requires capabilities to operate in ice-bound seas for which nuclear powered submarines are well suited.

Domestic Training, Exercising, Test and Evaluation

RAN submarine training was repatriated from the UK when the Submarine Weapons Upgrade Project upgraded the Oberons with a fire control system and weapons from the USA, and sensors from other sources.

Submarine escape training was later also repatriated with the opening of the Submarine Escape Training Facility in WA. Even Perisher Prospective Commanding Officer training was no longer available after the RN moved to a nuclear-powered submarine fleet, due to the differing operating characteristics and information management challenge for the command. Perisher is now conducted for conventionally powered submarine PCOs by the Royal Netherland Navy.

The RAN Submarine Training and Systems Centre was opened in *HMAS Stirling* in 1993 in time for CCSM-01 standby crew, and continues to support submarine training and systems development.

It is interesting to note that when the Replacement Combat System was procured for the COLLINS to resolve a chronic performance shortfall in combat systems integration, nine ship-sets were intended to be acquired – six for submarine installation, two for the STSC and the last for integration, test and trials elsewhere.

Exercising for submarines is now performed in the WA area where there is a highly instrumented underwater range facility. The RAN's major ASW exercises are held in WA as are other pro-submarine exercises, while multi-national exercises such as RIMPAC continue elsewhere.

Reduced Manning and Automation

A trend world-wide in military platforms has been to reduce manning, reflecting the ever increasing investment in the training and other overheads to support more highly skilled manpower needed for complex technology.

A further constraint on ship and submarine (and aircraft) design is the survivability and habitability needs for the crew. This has even reached the stage where the numbers in ships' complements are no longer driven by the operational needs of high-readiness conditions but rather by the numbers of people needed for damage control and other non-warfare evolutions that are unsuitable for automation.

Another trend is the increasing availability of assets due to increasing reliability and maintainability of equipments and hence the need for excess crewing, either spare or partial spare-crew or even multi-crewing as in SSBNs, to achieve the optimum asset utilisation.

A related factor is the degree of automation in hull, mechanical and electrical machinery and in combat systems operation, supervision and monitoring. This applies especially to ship control, safety and survivability, where a prudent level of conservatism has traditionally been applied.

Australian Production

For all six COLLINS submarines to be produced in Australia was a critical milestone in Australian industrial capability.

We had built warships in Australia before and since, but the design criteria that apply, and the production quality and expertise required are significantly more demanding for submarines than for other shipbuilding. This is less striking when the broader steel fabrication capability for offshore resources and chemical processing facilities were considered, for which Australia has proven expertise.

Again there are historical factors to be considered.

In the period up to and including WWII, the industrial capability in Australia for production of arms and munitions, aircraft and small ships and boats was critical to the success of allied efforts to defeat Japan. Yet in the opinion of one historian 'Australian

Collins-class calm day

Collins-class maintenance

naval construction was comparatively insignificant in the critical period of the war, although this changed after the peak war production effort had passed in 1943.'

The official history of the period noted that from a minimal capacity at the start of the war, ultimately warships constructed in Australia included three destroyers, 14 frigates and 60 corvettes including 20 for the Royal Navy.

When later major acquisitions of the DDG destroyers and Oberon submarines were set in train again there was no commitment to Australian production.

Archival records show that the debate on premiums for the initial cost of local production compared with lower cost of overseas purchase have invariably overlooked the benefits for reduced cost of ownership resulting from local production.

The newly elected Rudd Australian Government has made it clear that local production will always be preferred, provided premiums are acceptable.

Even the most recent force acquisition contracts for the Air Warfare Destroyers [AWD] and Landing Ship Helicopter, Dock [LHD] have mandated a significant percentage of Australian Industry Involvement with the final systems integration and delivery all to be in Australia.

Compare this with the aircraft production for the Australian Defence Force whereby final assembly of most aircraft and manufacture of selected subassemblies is the best that can be achieved. Warship building has come a long way since the WWII situation mentioned earlier. The COLLINS has been a major factor in this progress.

Strategic Concepts for the COLLINS

Before COLLINS, Australian maritime strategic concepts had been developed without explicit submarine roles defined, other than the traditional coastal defence, commerce raiding and sea denial roles.

With the experience of the Oberons in the Cold War, the COLLINS requirements stated explicitly that the force element group must be able to maintain two submarines on patrol task at a range of a few thousand nautical miles. A further expansion of this mission requirement is proposed for the FSM, but with the addition of other roles, as discussed elsewhere.

Such an operational requirement can only be comprehended in a strategic context because it is without reference to any force tactical close support or even distant support role.

This highlights the continuing lack of an Australian maritime strategic framework that includes a clear articulation of the submarine roles and their contributions to many missions.

A primary mission is ASW and with their intimate knowledge and situational awareness of the underwater environment and optimised sensors, knowledge management and effectors, submarines are excellent ASW platforms. With the steady increase in regional submarine numbers and capabilities this is important, as others have noted.

However the further development of strategic concepts to exploit COLLINS capabilities fully is still an important need. For example the need for effective realisation of network-centric warfare including submarines.

Sensors from New Sources

From the days of Submarine Weapons Upgrade Project RAN submarines had become familiar with the availability of excellent acoustic, optical and radiofrequency [RF] sensors from a number of sources, including the results of innovation by the Australian Defence Science and Technology Organisation [DSTO].

Thus for COLLINS there was no doubt that the selection of sensors would be on a best available basis, and this has transpired.

The supportability of sensors from such disparate sources has not resulted in any reported issues although this can never be taken for granted. The experience gained in the integration design and implementation in country will have helped in this regard.

Weapons from USN

In WWII and to a lesser extent in the Vietnam War there were concerns that munitions might not be made available in time of sudden critical need. Think of the Falklands War and the need for UK to source weapons from USA and Argentina to seek weapons from France.

The same concerns arose in the lead up to WWII and hence the attention then to munitions production in Australia.

Even torpedoes, the quintessential new

HMAS Torrens under Mark 48 torpedo testing

weapon from the 19th century that changed maritime warfare forever in the 20th century, were a concern for Australia to the extent that the RAN Torpedo Factory was established in Neutral Bay in 1942, on the same site later to include the Oberon submarine base *HMAS Platypus*.

<Figure 2 attached>??what is Fig 2?

The Mk 48 torpedo is an awesome weapon, witness the sinking of the former HMAS Torrens in 1999 and is also designed for ASW. As a wire-guided weapon, re-attack and other engagement options can be controlled from the launching submarine. Australia is collaborating with USN in the development of the new Advanced Capability [ADCAP] version of the Mk 48.

The USN Harpoon anti-ship missile is also a powerful weapon that the ADF can deliver from air, surface and submarine platforms. However as an autonomous weapon there are many targeting and other rules of engagement constraints in its use.

Submarine-laid mines are more difficult to locate and neutralise than those laid by overt means – surface or air.

Finally the option exists for the use of the Tomahawk tube-launched long-range land-attack cruise missile, albeit not in current inventory.

In conclusion this paper comments on the benefits and costs of the NCSM program, both in its delivery and in the ongoing service of submarines of the Collins class.

Value

The value of the class is inestimable and extraordinary. That Australia possesses such a capability that has been forged, through some adversity, to a fine level of perfection, is testimony to the vision and persistence of the many people that have been involved. The Collins class is regarded as a benchmark for capability and effectiveness in conventionally powered submarines.

Further value comes from the universal understanding of Australia's preparedness to take responsibility for all levels of its national security to the full extent of its capability.

Benefits

It is not merely the economic benefits of performing the project largely in Australia; even taking into consideration the know-how that has been developed.

Rather it is the increased self-reliance that Australia has demonstrated to the world in taking on a complex project knowing there was risk and uncertainty involved, and then delivering an outcome that, notwithstanding a number of issues, has demonstrated success by the world's assessment.

The depth and extent of the expertise that has been built up and confirmed in the final outcome is enormous, for which the full benefits have not yet been fully appreciated. The bipartisan position that the next generation of submarines would be built in Australia speaks volumes of the confidence that has been built up. Even the construction and integration of the Air Warfare Destroyers [AWD] by ASC has been hailed as only possible due to the expertise developed in the NCSM program.

Costs

Costs of the NCSM have been documented in an accounting sense. There have also been indirect and opportunity costs of investment foregone elsewhere. Nevertheless in the period of steadily increasing defence expenditures and government surpluses the costs have been regarded as acceptable.

In terms of original budgeted figures plus approved variations, the costs of the project have only exceeded budget by a modest figure that is well within the experience of similar large projects in the non-defence sectors.

Most significantly the Cost of Ownership has been reduced by the level of local production, due to the timeliness and adaptability of local industry.

Significance

The significance of the project has been mentioned a number of times. In the view of some it has been of similar significance to iconic projects like the Snowy River scheme or the America's Cup win. Whatever else may be said, there is no ignoring the NCSM project and its challenging path to current capability.

So Australia has gone much further – perhaps in recognition that Australia is truly the most obviously maritime nation and its national security requires capabilities that are appropriate to that situation.

Further Work

This paper reports on what has been discovered and progress on the analysis and conclusions thereon. Further work will also be considered on the perennial discussion of the case for local warship building and other topics as in Annex B.

Chris Skinner had a distinguished career as an engineer officer in the RAN between 1959 and 1989, reaching the rank of Captain and having service in several major RAN surface ships, including a 1970 deployment to Vietnam in the guided missile destroyer HMAS Hobart. Shore project postings included secondment to the DSTO and as the New Surface Combatant Project Director, precursor to the ANZAC Ship Project. His final posting was as Director, RAN Trials and Assessing Unit. Since his naval service, Chris has been involved in Australian industry in senior managerial and consultancy roles in a number of major defence projects. He holds a BSc in Electrical Engineering and an MSc in Software Engineering.

Annexes:

A. Taxonomy
1. Chronology
2. Financial
3. Geopolitical and maritime strategy and policy
4. International, military, scientific and industrial collaboration
5. Facilitation and enablement
6. Organisation and responsibilities
7. Science and industry in Australia
8. Engineering design and technology
9. The human dimension
10. Ship construction and design authority
11. Systems analysis, engineering and integration
12. Physical resources, energy and waste products
13. Application domain
14. Warfare capability development
15. Communication and comprehension of information
16. Value to stakeholders and others

B. Further work proposed

Expansion of SM roles eg Antarctica, AAW, UUV, UAV

There are a number of additional roles that submarines can perform that can contribute to emerging concepts of networked joint forces, such as anti-air warfare [AAW]. There are also further roles that can be performed by submarines in special environments such as polar regions and for reconnaissance in the presence of biological, toxic and radiation effects.

The use of unmanned vehicles both aerial and underwater from submarines is feasible and has been demonstrated. The potential for enhanced role performance using these vehicles is still to be explored.

Expansion of Sea Power Reading List

Another work product that is intended is a reading list that emphasises undersea warfare and the technology of submarines. There are a lot of publications in this domain but not many of them are widely known.

Proposed Revision of National Maritime Strategy

The National Maritime Strategy is well developed and articulated but includes submarine capabilities as more of an adjunct to traditional sea power than as the agent of a new dimension of geopolitical and maritime strategy. The work here would be to investigate in an objective way the manner and degree to which the evolution of Australian grand strategy and maritime policy has yet reflected the advent of the submarine.

Roles of Deakin, Gorton & Beazley in Submarine promotion

There have been some notable political personalities in the development of the Australian submarine capability and this thread is worthy of more focussed research and writing. Key figures will include Deakin, Gorton and Beazley.

Cost of Ownership

Finally there is research needed to support my thesis that domestic design, production and support has a positive influence on the costs of ownership of a defence asset, taken over its service life.

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Figure 2 – The former HMAS Torrens dispatched by Mk48 Torpedo

Replenishment at Sea: Motions of Ships Operating side by side in head seas

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SUMMARY

This paper reports on a study into the motions of two vessels when travelling side by side into head seas, a common operating condition for naval vessels when undertaking replenishment at sea activities. A series of model tests was conducted and the influences of various parameters, including transverse and longitudinal separation, on the ships' motions were determined. The data obtained from the experimental study has been used to validate a theoretical ship motion prediction method, *FD-Waveload*, which is based on a 3-D zero-speed Green function with a forward speed correction in the frequency domain. The results were also used to estimate the expected extreme roll angle of the receiving vessel, and the relative motion between the vessels, during replenishment at sea operations in a typical irregular seaway. An increase in transverse and longitudinal separation between the vessels was found to have a significant influence on the roll motion of the smaller vessel; though only a small reduction in relative motion was found to result from an increase in transverse separation or reduction in longitudinal separation.

1 Work undertaken whilst a student at the Australian Maritime College, Australia

NOMENCLATURE

$[A]$	Ship added mass matrix
$[B]$	Ship damping matrix
$[C]$	Ship hydrostatic stiffness matrix
$\{F\}$	Wave exciting force vector
GM	Metacentric height (m)
k	Wave number (m^{-1})
LBP	Ship length between perpendiculars *(m)*
LCG	Longitudinal centre of gravity (m)
$[m]$	Ship inertial matrix
RM'	Non-dimensional distance between RAS points
VCG	Vertical location of the CG (m)
x_g	Longitudinal location of the CG (m)
x_p	Longitudinal location of the RAS point (m)
y_g	Transverse location of the CG (m)
y_p	Transverse location of the RAS point (m)
z_g	Vertical location of the CG (m)
z_p	Vertical location of the RAS point (m)
Δx	Point motion in the x direction (m)
$\Delta x'$	Non-dimensional point motion in the x direction
Δy	Point motion in the y direction (m)
$\Delta y'$	Non-dimensional point motion in the y direction
Δz	Point motion in the z direction (m)
$\Delta z'$	Non-dimensional point motion in the z direction
η_k	Displacement in k direction where k = *1-6 (m)*
$\{\ddot{\eta}\}$	Ship acceleration vector
$\{\dot{\eta}\}$	Ship velocity vector
$\{\eta\}$	Ship displacement vector
ω	Wave frequency (rads^{-1})
ζ	Wave amplitude (m)

1. INTRODUCTION

In today's global military environment, the Royal Australian Navy (RAN) is required to participate in deployments for longer periods away from home ports. Replenishment at sea (RAS) is therefore a critical aspect of these operations. A typical RAS operation consists of one or more navy vessels transferring cargo and/or fuel from a supply vessel whilst travelling in close proximity to each other as shown in Fig. 1. Typical speeds for RAS operations are in the order of 10-15 knots and they may be performed in sea environments up to and including sea state 6. When the ships are in such a formation, the presence of the larger vessel can greatly influence the motions of the smaller. These motions can make RAS a difficult and dangerous procedure due to their effect on RAS equipment, the manoeuvring capability of the ships and crew safety.

Figure 1: Replenishment at sea operation (photograph courtesy RAN)

Fig. 2 shows Navy personnel undertaking refuelling procedures during a RAS operation. It is critical that these operations are performed in such a manner that any associated risks are kept to a minimum. The increased motions as a result of the interaction will in most cases affect the relative separation between the replenishment points on the vessels and hence the tension in the cable connection. The cable must be able to withstand the tension forces applied in order for the replenishment operation to be successfully and safely conducted. To date it has been left to the Commanding Officers' (COs) knowledge and experience to determine the suitability of conditions to undertake RAS.

There is a requirement for operator guidance to be developed for use by COs of the ships in the selection of suitable conditions for replenishment operations. There are several key factors which may influence the overall successful outcome of this type of

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operation. These include wave height and period, ships heading and speed as well as the lateral separation of the vessels involved.

Figure 2: Navy personnel attaching fuelling line during RAS operation (photograph courtesy RAN)

In the past twenty years, limited research has been conducted into the hydrodynamic interactions between two vessels in close proximity. Kodan [1] conducted a study of two bodies in close proximity at zero speed using a two-dimensional method. Fang and Kim [2], Fang [3] and Chen and Fang [4, 5, 6] extended this work by first introducing a forward speed component and then developing a three-dimensional panel method taking into account hydrodynamic interaction effects. McTaggart et al. [7] developed a three-dimensional panel code independently from Fang and Chen. However, one major limitation to all the studies conducted is the lack of experimental data available to validate theoretical predictions. Of the studies, only Kodan [1] and McTaggart et al. [7] have conducted experiments to validate the numerical codes developed. Kodan conducted model tests at zero forward speed only; whilst McTaggart et al. conducted semi-captive model tests with the two models constrained in surge, sway and yaw for forward speeds of up to 12 knots in head seas.

The Defence Science & Technology Organisation (DSTO) and the Australian Maritime College (AMC) have recently undertaken a collaborative research program to study the hydrodynamic interactions between vessels whilst travelling in close proximity. The program of work included both experimental and numerical analysis. A series of model tests was conducted where the motions of both vessels were recorded and the influence of various parameters on the ships motions determined. The data obtained from the experimental study has been used to validate a theoretical prediction method, *FD-Waveload*, which is a program based on a 3-D zero-speed Green function with a forward speed correction in the frequency domain [8]. Once fully validated, FD-*Waveload* can be used as part of the development of operator guidance tools for vessels operating in close proximity to each other. Results from both the experimental work undertaken and the numerical analysis are presented in this paper.

2. THEORETICAL PREDICTIONS

The numerical analysis was carried out using *FD-Waveload* [8] which is a potential flow, three-dimensional panel method seakeeping code. It is based on the zero-speed Green function with a forward correction in the frequency domain. The motions of a single vessel in waves are governed by the equation of motion given in Equation 1 [9]:

$$[m+A]\{\ddot{\eta}\}+[B]\{\dot{\eta}\}=[C]\{\eta\}=\{F\} \qquad (1)$$

where $[m]$ is the ship inertial matrix, $[A]$ is the added mass matrix, $[B]$ is the damping matrix, C are hydrostatic stiffness terms and $\{F\}$ is the wave exciting force vector which includes terms due to both incident and diffracted waves, $\{\ddot{\eta}\}$ is the acceleration vector, is $\{\dot{\eta}\}$ the velocity vector and $\{\eta\}$ is the displacement vector. The damping matrix includes terms due to wave radiation, lift forces, and viscous forces; the viscous roll damping consists of contributions from bilge keels, eddy-making resistance of the hull, hull friction and the viscous effect of other appendages.

Equation 1 is solved, for six degrees of freedom using six simultaneous equations, by first estimating the roll amplitude in order to evaluate the nonlinear roll damping forces. Therefore a final solution is obtained after iterating until, for a given set of conditions, the roll amplitude converges.

To determine the motions of two ships in waves, for the full 6 degrees of freedom of each ship, 12 coupled equations of motions need to be solved. This ensures that the presence of both ships simultaneously within the wave field is represented.

$$\begin{bmatrix} m^a+A^{aa} & A^{ab} \\ A^{ba} & m^b+A^{bb} \end{bmatrix}\begin{Bmatrix} \ddot{\eta}^a \\ \ddot{\eta}^b \end{Bmatrix}+\begin{bmatrix} B^{aa} & B^{ab} \\ B^{ba} & B^{bb} \end{bmatrix}\begin{Bmatrix} \dot{\eta}^a \\ \dot{\eta}^b \end{Bmatrix} + \begin{bmatrix} C^a & 0 \\ 0 & C \end{bmatrix}\begin{Bmatrix} \eta^a \\ \eta^b \end{Bmatrix}=\begin{Bmatrix} F^a \\ F^b \end{Bmatrix} \qquad (2)$$

The matrices and vectors are divided into terms dependent on ship *a* and ship *b*, with corresponding superscripts added to terms. For example, the added mass and damping sub-matrices $[A^{ab}]$ and $[B^{ab}]$ represent the forces on ship *a* due to the motions of ship b. The hydrodynamic components *A*, *B* and *F* are then computed by solving a model consisting of two ships with 12 radiation modes.

Reproducing the approach used for single vessel motions, the nonlinear roll damping forces for two ships are evaluated by solving Equation 2 iteratively until the roll motion amplitudes for both ships converge.

The numerical analysis was undertaken using full scale parameters. The hydrodynamic meshes for the two hull forms were generated from the lines of form for each vessel. An initial series of numerical analyses was performed on the vessels separately to ensure that an optimum hydrodynamic mesh was used.

3. EXPERIMENTAL PROGRAM

McTaggart et al. [7] studied the influence of speed and heading on ship motions, given a specific lateral separation distance between the vessels. Although this study produced a wealth of experimental data, the need for additional experiments was recommended. McTaggart and Turner [9] undertook a numerical investigation into the factors that affect the motions of two ships whilst operating in close proximity and this study also highlighted the need for additional data. With this in mind, an experimental program was devised to complement existing data, which would enable a better understanding of all the parameters that influence the motions of vessels whilst operating in these conditions.

3.1 MODEL DETAILS

The 1:70 ship models selected for the experimental program were: a frigate typically used by the RAN and an S-175 container ship. Both the model and full scale particulars of the ships are shown in Table 1. The frigate model was fitted with bilge keels which were 205 mm in length and 17 mm in depth.

3.2 EXPERIMENTAL SET UP

The experiments were undertaken in the AMC's towing tank which forms part of the Australian Maritime Hydrodynamics Research Centre (AMHRC). This collaborative research organisation was established in late 2002 as part of the Commonwealth Government's Major National Research Facilities Program by the AMC, DSTO and the University of Tasmania. The towing tank is 100 m in length, 3.6 m wide with a water depth of up to 1.6 m. Waves are generated by a hydraulically operated wet backed, single flap paddle. A wide variety of wave forms can be generated by the paddle including regular and irregular wave systems.

Table 1: Model Particulars

	S-175		Frigate	
	Model Scale	Full Scale	Model Scale	Full Scale
LBP (m)	1.75	122.5	1.578	110.5
Beam (m)	0.254	17.78	0.198	13.9
Draft (m)	0.095	6.65	0.055	3.85
LCG fwd midships (m)	-0.025	-1.75	-0.061	-4.27
GM (m)	0.017	1.192	0.042	2.938
TCG (m)	0	0	0	0
Roll Gyradius (m)	0.089	6.23	0.071	4.97
Pitch Gyradius (m)	0.418	29.26	0.356	24.92

Both models were towed using a two post system, utilising a ball joint forward, and a ball joint and slide aft as shown in Fig. 3. The ball joints were located on the roll axis of the model. This system allowed the models to move freely in heave, pitch and roll whilst being constrained in surge, sway and yaw. The heave, pitch and roll motions of the vessels were measured using a total of eight linear voltage displacement transducers (LVDTs). Four LVDTs were fitted to each model; fore and aft LVDTs were attached to the fore and aft posts, while the port and starboard transducers were attached via a string and pulley system to the model topside. A stationary wave probe was positioned near the wave maker to measure the water surface profile and hence determine the wave elevations and frequencies. Data logging was conducted at 100 Hz for each run period of approximately 15 seconds. A visual record of the experiments was achieved using both still and video photography.

Figure 3: Models set up in RAS configuration in towing tank

3.3 TEST CONFIGURATIONS

Typical lateral separations between vessel centrelines during RAS operations are in the order of 25 to 55 m. For this experimental program two lateral separations were studied. The "narrow gap" separation was 39.69 m full scale between vessel centrelines, whilst the "wide gap" was 62.3 m. These distances equate to 0.567 and 0.890 m respectively in model scale. These distances were chosen due to restrictions on the placement of the models from the framing of the towing tank carriage. The influence of longitudinal separation on vessel motions was also studied. The models were set up with the frigate model trailing the S-175 model by a distance between midships of 0.125 and 0.62 m model scale. These distances correspond to 8.75 and 43.4 m respectively full scale. The motions of the frigate without the presence of the S-175 were also measured. The model configurations tested are illustrated in Figure 4.

Table 2: Experimental Test Program (Model Scale)

Configuration	Speed (m/s)	Wave Height (m)	Longitudinal Separation (m) midship to midship	Lateral Separation (m) centreline to centreline
1	0.925	0.030	Single Vessel	
2	0.925	0.030	0.125	0.890
3	0.925	0.025	0.125	0.567
4	0.925	0.025	0.620	0.567

All tests were conducted in head seas at a speed 0.925 m/s, equivalent to 15 knots full scale. The wave heights varied depending on the test configuration but were kept constant for all frequencies for that configuration. Calculations were performed to determine the range of wave

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frequencies over which there were no interference effects from the tow tank wall [10]. This frequency range also varied with configuration due to the separation between the models. The experimental test program is shown in Table 2.

4. RESULTS & DISCUSSION

The heave and pitch motions of the frigate alone were determined from the towing tank experiments and are shown in Fig. 5. Clearly with the absence of the other vessel when operating in head seas no roll motion was evident, therefore no roll RAO is included. The results show that *FD-Waveload* agrees reasonably well with the experimental results, although some over prediction of the pitch is apparent.

The experimental results for Condition 2 (Fig. 6) clearly demonstrate the effect on the motions of two vessels operating in close proximity. Although both vessels are travelling into head seas rolling motions are seen to occur. Whilst the larger vessel only exhibited a small amount of roll motion, with a peak RAO of approximately 0.4 being measured; the smaller frigate experienced substantial roll motions, with a peak roll RAO of 3.5 being recorded.

The comparison between the numerical and experimental results for Condition 2 shows that *FD-Waveload*, in the main, predicts the motions of both vessels satisfactorily. The key exceptions are the heave motion of the S-175, which it over-predicts the resonance peak by a factor of 1.5, and the roll motion of the frigate which is again over-predicted. In addition the numerical results for the heave and pitch motions of the frigate tend to exhibit more pronounced oscillations in the RAOs than were seen in the experimental results.

When the vessels were tested

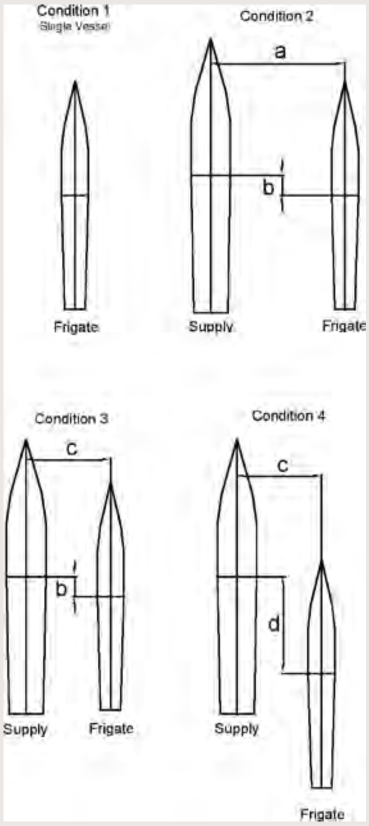

Figure 4: Test configurations (full scale)

a = 62.3 m, b = 8.75 m, c = 39.69 m, d = 43.4 m

experimentally with a reduced transverse separation, Condition 3, the roll of the frigate was found to increase as expected (Fig. 7). The peak of the roll RAO was found to be approximately 5 times the incident wave slope being recorded. Such roll motion may have a significant influence on a vessel's ability to perform RAS operations satisfactorily and safely. Whilst the roll response of the frigate increased significantly, very little change was found for the S-175 with the reduced separation. The numerical analysis does not predict this increase in roll response with reduced transverse separation. In fact it predicts a reduction in the roll response of the frigate with the peak RAO reducing to 5.0 from a predicted peak of 5.8 for the wider separation. The reason for this discrepancy in the numerical predictions is not known at this stage; however it may be due to a wave resonance occurring between the vessels at this particular transverse separation. In reality, this resonance wave may break and the wave height will not be very large; though at present breaking wave phenomena are not modelled within *FD-Waveload*. The remaining motions of the two vessels are predicted reasonably well by *FD-Waveload*, though again the heave responses are slightly over-predicted.

When the longitudinal separation between the vessels was increased (compare Condition 3 (Fig. 7) to Condition 4 (Fig. 8)) the roll and pitch response of the frigate was found to reduce. The theory also predicts a significant reduction in roll and pitch motion for the larger longitudinal separation. However, the theory tends to over-predict all three frigate motions for this operating condition. Good agreement between experiment and theory can be seen for the roll and pitch motions of the S-175. However the heave motion is once again over predicted at the resonant peak.

Whilst the magnitude of the motions of each vessel during a RAS operation is important, of greater consequence is the relative motion between the two vessels. As discussed in Section 1, the relative motion between the replenishment points on the vessels, and hence the tension in the cable connection, will be critical for a successful operation. Therefore the relative motion between the two vessels, which accounts for their heave, pitch and roll motions, was investigated for the various operating conditions.

The point motions in the *x*, *y* and *z* directions can be expressed using the following set of three equations:

$$\begin{aligned} \Delta x &= \eta_1 + (z_p - z_g)\eta_5 - (y_p - y_g)\eta_6 \\ \Delta x &= \eta_2 + (x_p - x_g)\eta_6 - (z_p - z_g)\eta_4 \\ \Delta x &= \eta_3 + (y_p - y_g)\eta_4 - (x_p - x_g)\eta_5 \end{aligned} \quad (3)$$

where η_k is the displacement in the *k* direction for k = 1 to 6. The location of the replenishment point in each of the directions *x*, *y* and *z* is denoted by the subscript *p* whilst the subscript *g* denotes the vessel's centre of gravity in the specified direction. Thus, for example, $x_p - x_g$ represents the distance from the vessel's centre of gravity to the replenishment point in the *x* direction. For this study, surge, sway and yaw are neglected and hence these terms are reduced to give the following equation set which are non-dimensionalised with respect to the wave amplitude, ζ.

$$\begin{aligned} \Delta x' &= \frac{1}{\zeta}(z_p - z_g)^2\,\eta_5 \\ \Delta y' &= -\frac{1}{\zeta}(z_p - z_g)^2\,\eta_4 \\ \Delta z' &= \frac{1}{\zeta}[\eta_3 + (y_p - Y_g)\,\eta_4 - (x_p - x_g)\,\eta_5] \end{aligned} \quad (4)$$

Using equation (5), the non-dimensional relative variations in separation were determined for conditions 2, 3 and 4. In this equation, the three terms consider the instantaneous location of the RAS point on each vessel relative to the other. The RM' was then determined over a given time-step. This method ensures that the phase relationship between the different vessel motions is considered.

$$RM' = \sqrt{(\Delta x')^2 + (\Delta y')^2 = (\Delta z')^2} \quad (5)$$

The RAS point locations used for the change in relative separation analysis are given in Table 3. The frigate aft RAS point was used for conditions 2 and 3 while condition 4 used the frigate forward RAS point.

Table 3: Location of RAS Points

	Frigate		S-175
	Aft	Forward	
x (m)	-6.45	28.20	-15.20
y (m)	6.85	6.85	8.89
z (m)	10.77	10.77	10.77

The relative motion RAOs are shown in Fig. 9. The experimental results indicate that the largest relative motion between the RAS points was found for Conditions 3 and 4. Although Condition 4 had reduced vessel motions compared to Condition 3 the use of the forward RAS location meant that the influence of relative pitch motion was increased for this condition.

A significant reduction in relative motion was found as the transverse separation between the vessels was increased from Condition 3 to Condition 2. This indicates, of the conditions tested, that Condition 2 would be the most appropriate replenishment condition to use for these vessels in head seas. The numerical results for relative motions do not exhibit the same trends as those found by experimentation. Little difference can be seen due to a change in both transverse and longitudinal separation.

If full scale data for vessel motions during RAS operations could be obtained in the future it may provide further valuable validation data. Although attaining such data would require a significant effort to overcome a variety of technical and logistical issues.

RAS operations are currently covered by Classification Society rules [11]; however they state that only the dynamic behaviour of the supplying ship needs to be considered when designing RAS systems. Results from this program of work clearly indicate that the motions of the receiving ship should also be accounted for during the design process.

5. VESSEL RESPONSES IN IRREGULAR SEAS

Vessel separation is a vital RAS operational consideration. In order to establish the effect of separation on the responses of the vessels in an irregular seaway, wave spectra were applied to both the experimentally and numerically derived RAOs. Four different sea states were modelled using the two parameter Bretschneider (ITTC) spectrum in accordance with the Def (Aust) 5000 Materiel Requirement Set [12] for seakeeping to represent sea states 3, 4, 5 and 6 (Table 4). These sea states represent the range of typical sea conditions experienced during RAS operations. The significant wave height and period combinations of these spectra are based on the typical conditions in the waters around Australia.

Table 4: Sea State Parameters [12]

Sea State	Significant Wave Height (m)	Modal Period (sec)
3	0.875	8.9
4	1.875	10.3
5	3.25	11.7
6	5.00	12.8

The motions of the vessels in irregular seas were examined in terms of the extreme displacement with 1 percent exceedence probability in 3 hours [13]. A time period of 3 hours was chosen since this is the usual duration of a RAS operation.

The spectra were applied to both the frigate roll and relative motion RAOs with the results being plotted against the vessel separation to indicate the effect of separation on the respective motions in irregular seas. The experimental results in Fig. 10(a) show that maximum roll angles of up to 16 degrees may be expected for the frigate in sea state 6, although as the transverse separation is increased to 62.3 m the extreme roll angle reduces to 10 degrees. For the two transverse separations investigated, in sea state 3 extreme roll angles of between only 3 and 5 degrees may be expected. An increase in longitudinal separation to 43.4 m significantly reduces the expected extreme roll angle; in sea state 6 it reduces to 4 degrees, Fig. 10(b). The numerical method appears to reasonably accurately predict the trends found through the experimental results, although the absolute values of extreme roll are somewhat over-estimated. It should be noted that the intermediate numerical points represent the motion between the S-175 RAS point, and an interpolated point on the frigate (i.e. parallel and perpendicular to the S175 RAS point).

The expected extreme relative motion in sea state 6 was found to be 2.75 m for the narrower transverse and longitudinal separations (Condition 3) based on the experimental results, Figs 11(a) and 11(b). With a reduction in sea state the relative motion decreased, and the extreme value in sea state 3 was found to be only 0.75 m. The experimental results show that significant reductions in the extreme relative motion are likely to occur with an increase in transverse and longitudinal separation. It is important to note that for the larger longitudinal separation the relative motion was based on the forward RAS point on the frigate. The numerical method does not accurately predict the trends found through the experimental results. For example in Fig. 11(a) the theory predicts a very small reduction in extreme relative motion due to an increase in transverse separation. Fig. 11(b) indicates that an increase in longitudinal separation produces a reduction in the predicted extreme relative motion.

Comparing the influence of separation on frigate roll and change in relative separation, it is clear that in order to determine the optimal separation for minimal motions it is vital that the motions of the vessels are not considered in isolation. In order to properly examine the suitability of a given separation configuration, all three main motions (heave, pitch and roll) should be considered for each vessel

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involved simultaneously.

5. CONCLUSIONS

A study into the motions of two vessels when travelling side by side into head seas, a common operating condition for naval vessels when undertaking RAS activities, has been undertaken. A series of model tests was conducted using a generic frigate model and a larger supply vessel (S-175) travelling in close proximity. The following conclusions, for the vessels and conditions tested, may be drawn from the experimental study:

When both vessels were travelling side by side into head seas rolling motions were found to occur. Whilst the larger vessel only exhibited a small amount of roll motion, with a peak roll RAO of approximately 0.4 being measured for the wider transverse spacing case; the smaller frigate experienced substantial roll motions, with a peak roll RAO of 3.5 being recorded.

As the transverse separation between the vessels was reduced, the roll of the frigate was found to increase to a peak roll RAO of approximately 5; though very little change in roll motion was found for the S-175 with the reduced separation.

When the longitudinal separation between the vessels was reduced it resulted in increased roll and pitch motions for the frigate. Little change in the motions was found for the S-175 as the longitudinal separation was reduced.

When the motions of the vessels in irregular seas were examined in terms of the extreme value that would not be expected to be exceeded in a 3 hour period with a confidence of 99 percent; roll angles of up to 16 degrees may be expected for the frigate in sea state 6 and the expected extreme relative motion in sea state 6 was found to be as much as 3.25 m.

The following conclusions may be drawn through comparing the theoretical *FD-Waveload* predictions with the experimental results:

For the single vessel *FD-Waveload* agreed well with the experimental results, although some over-prediction of pitch was apparent.

For the wider transverse separation *FD-Waveload* predicted the motions of both vessels satisfactorily, except for over-predicting the S-175 heave and frigate roll. As the transverse separation was reduced *FD-Waveload* predicted a slight reduction in roll motion for the frigate whereas the experimentally determined roll motion of the frigate increased.

When the motions of the vessels in irregular seas were examined in terms of the extreme value that would not be expected to be exceeded in a 3 hour period with a confidence of 99 percent; *FD-Waveload* over-predicted both the extreme roll motion of the frigate and the relative motion between the RAS points.

Results from this program of work clearly indicate that the motions of the receiving ship should be taken into account; whereas existing Classification Society rules [11] state that only the dynamic behaviour of the supplying ship needs to be considered when designing RAS systems.

6. ACKNOWLEDGEMENTS

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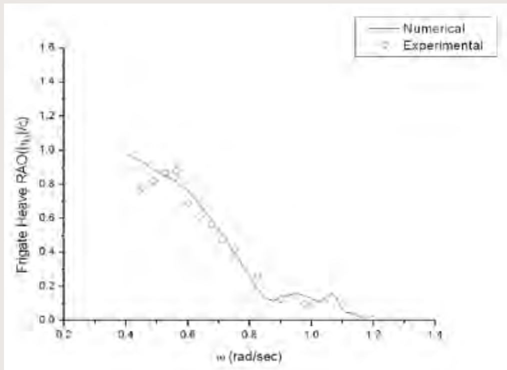


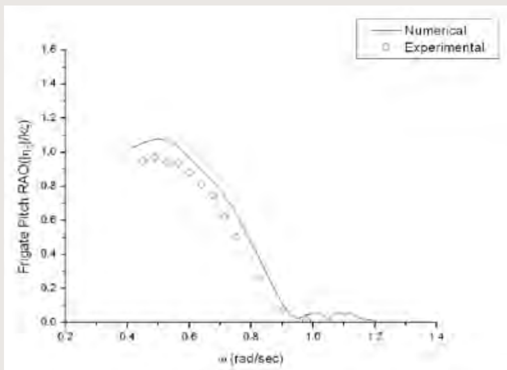


Figure 5: Numerical and experimental frigate heave and pitch RAOs, single vessel (Condition 1)

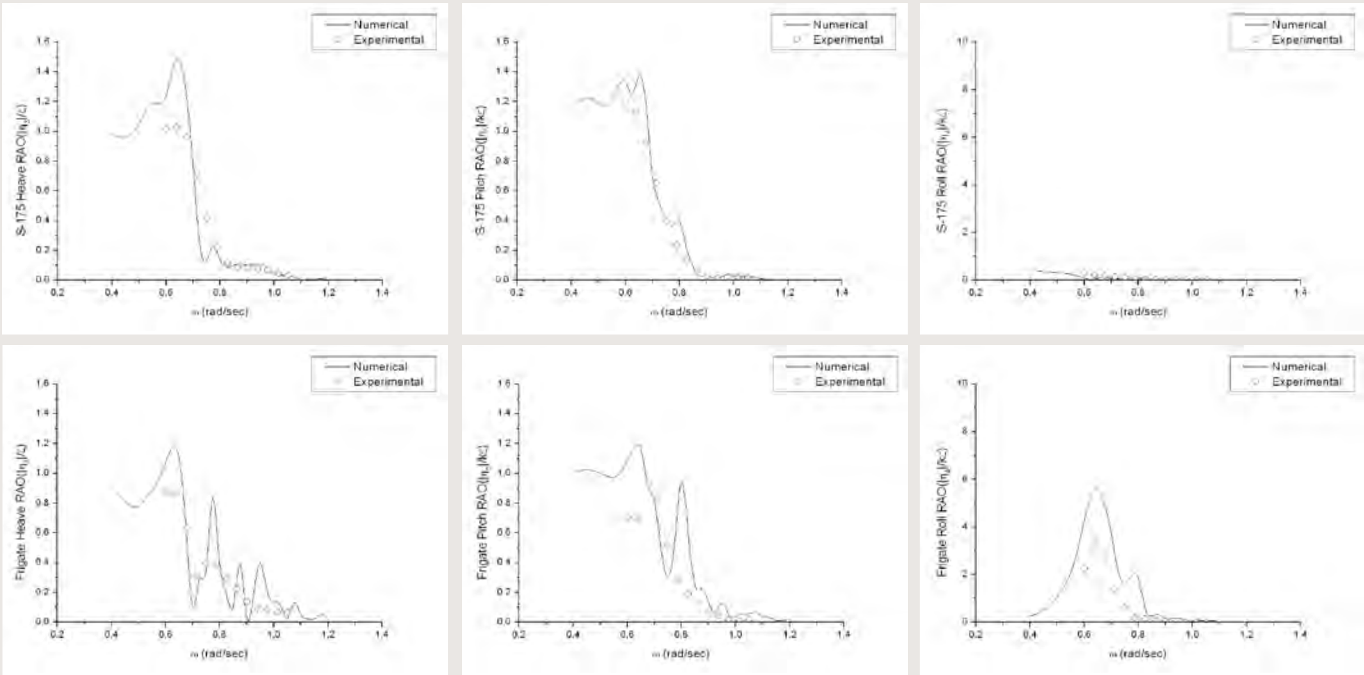


Figure 6: Numerical and experimental S-175 and frigate heave, pitch and roll RAOs (Condition 2)

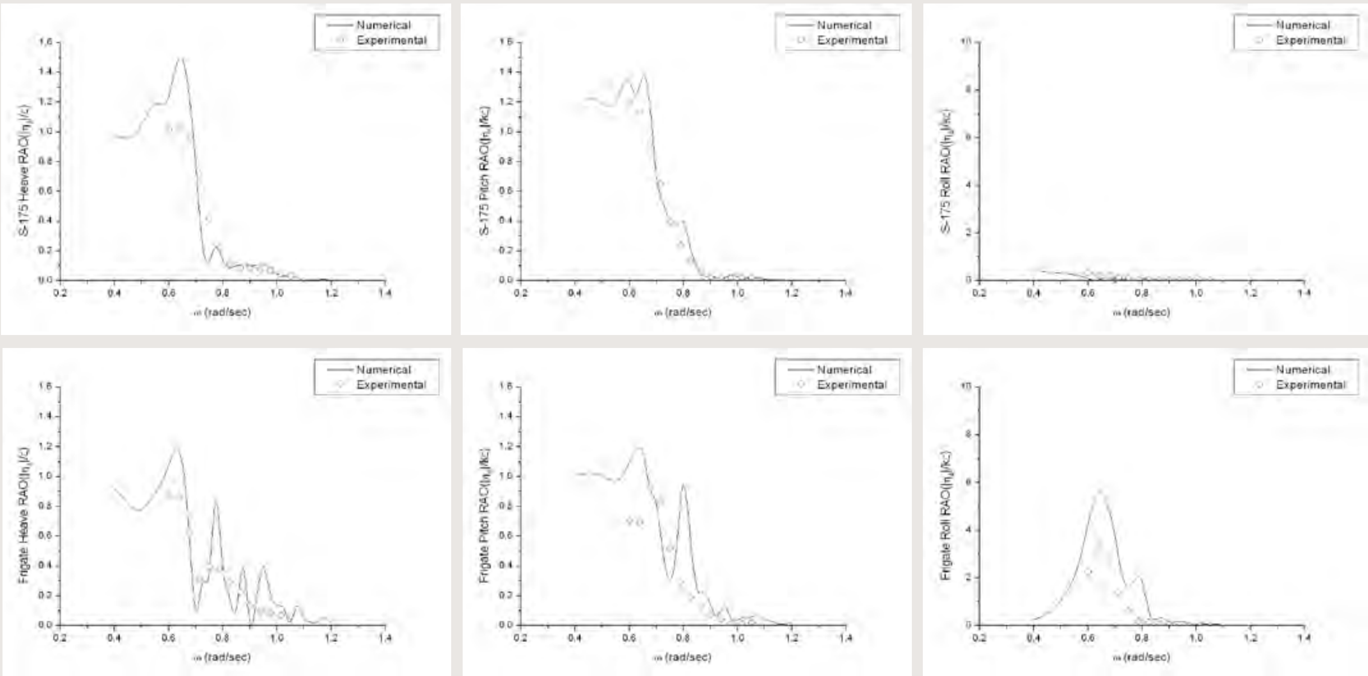


Figure 7: Numerical and experimental S-175 and frigate heave, pitch and roll RAOs (Condition 3)

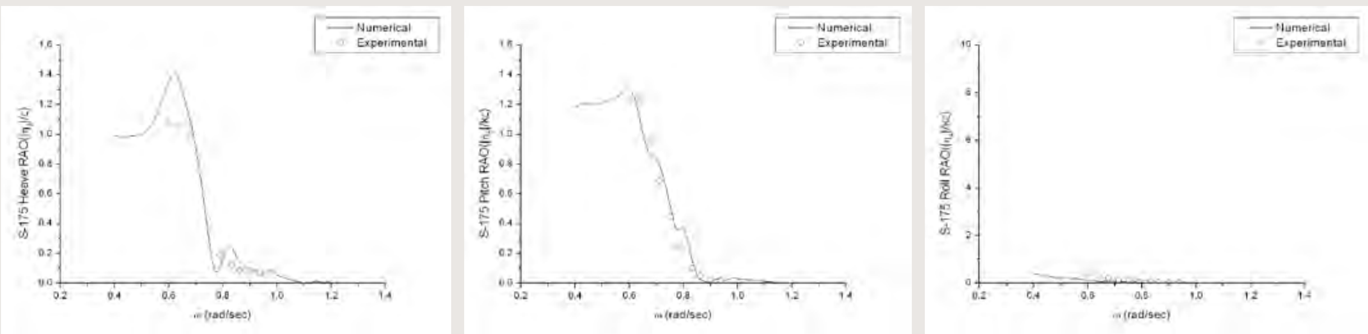


Figure 8: Numerical and experimental S-175 and frigate heave, pitch and roll RAOs (Condition 4) *Continued next page...*

Replenishment at Sea: Motions of Ships Operating side by side in head seas

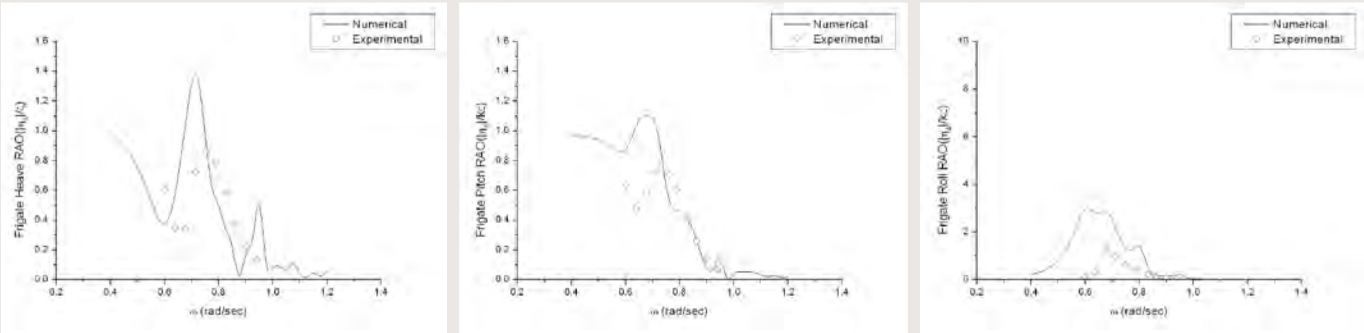
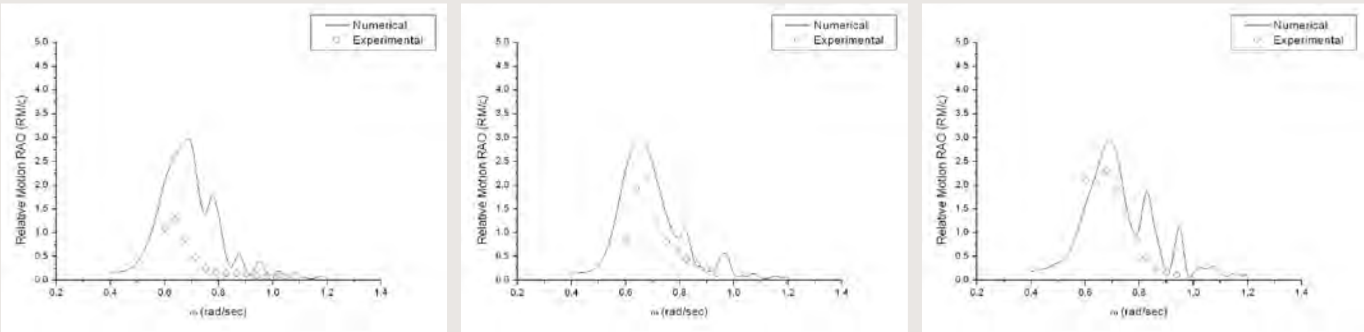


Figure 8: Numerical and experimental S-175 and frigate heave, pitch and roll RAOs (Condition 4) Continued from previous page.



(a) Condition 2 *(b) Condition 3* *(c) Condition 4*

Figure 9: Relative motion RAOs for S-175 and frigate in RAS configuration

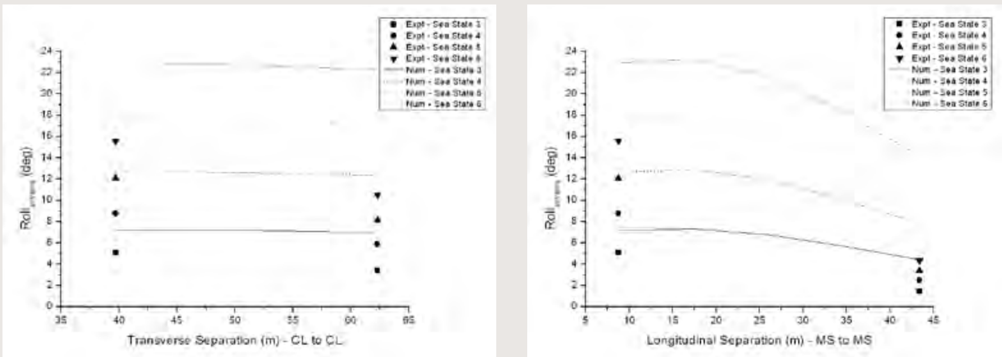


Figure 10: Expected extreme roll angles in a 3 hour period with 99 % confidence in irregular sea state

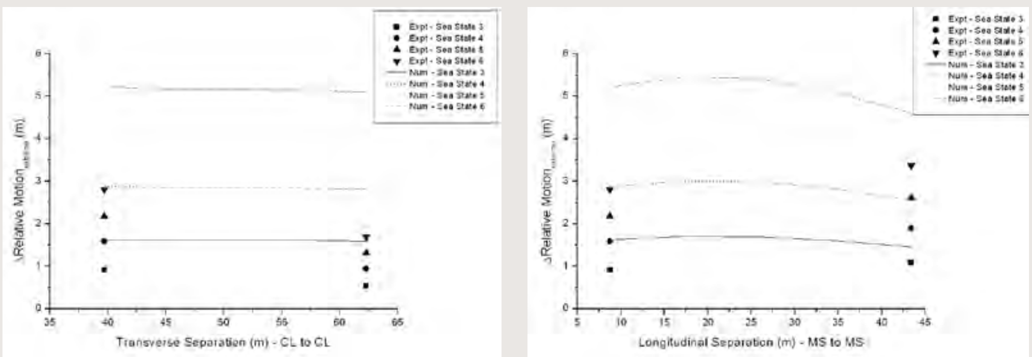
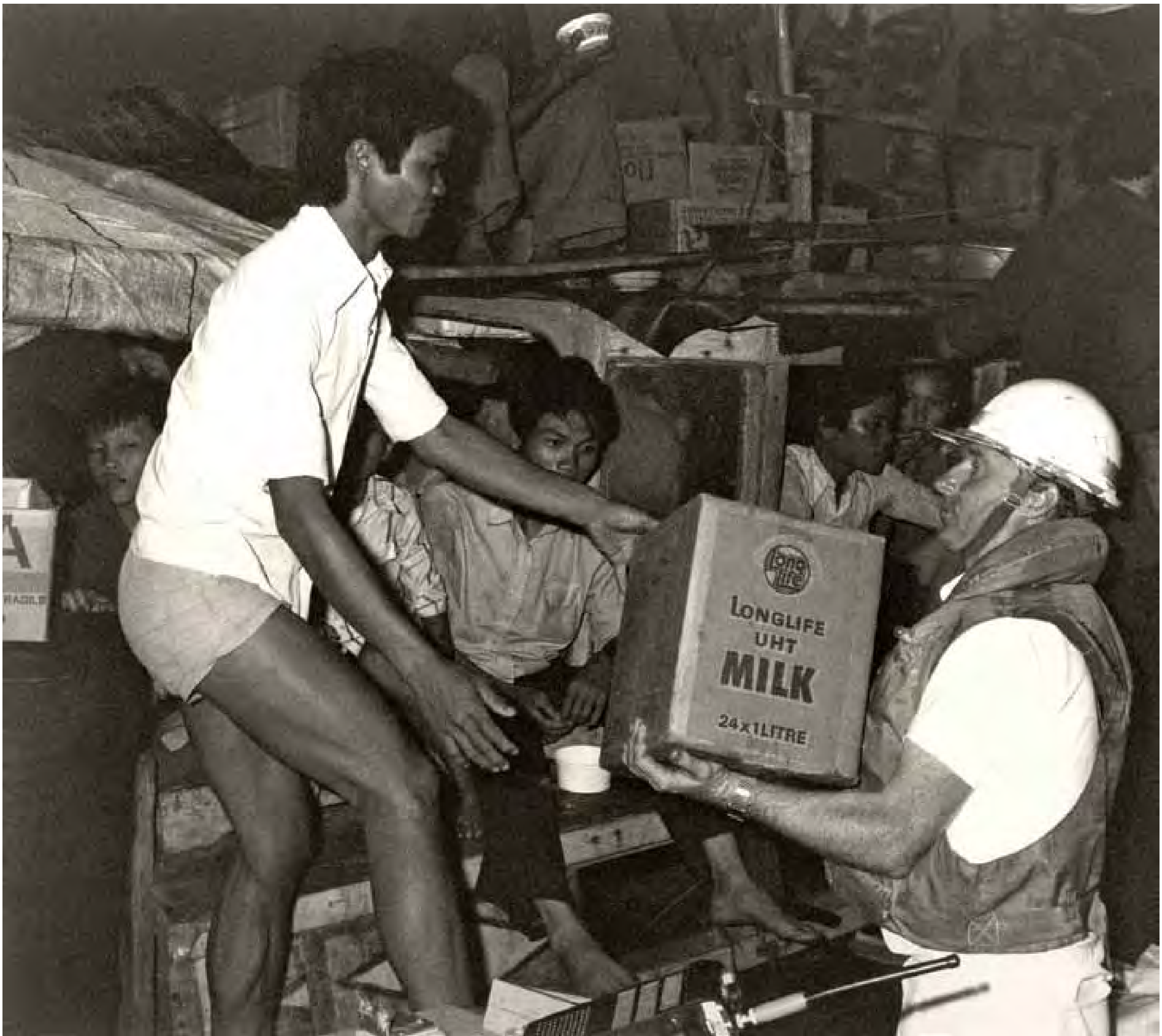


Figure 11: Expected extreme change relative motion in a 3 hour period with 99% confidence in irregular sea state

Visions from the Vault

Visions from the Vault
Visions from the Vault



The fall of South Vietnam in 1975 initiated an exodus of refugees, and over subsequent year the interception of 'boat people' became common in the waters to Australia's north. In 1981, during her last year of service, the aircraft carrier *HMAS Melbourne* rescued 99 refugees from their overloaded boat in the South China Sea. On other occasions RAN warships provided assistance in the way of food, water, fuel and medicines. On 6 April 1983 the destroyer tender *HMAS Stalwart* and guided missile frigate *HMAS Adelaide* were on passage to Hong Kong when they came across a fishing boat 200 miles south-east of the Vietnamese coast. A sea-boat from *Stalwart* proceeded to investigate and found that the boat contained 74 men, women and children, ranging in age from 2 to about 70. After a lengthy period of examination by *Stalwart's* medical officer and engineer, the boat was found to be seaworthy and the occupants in good health. The boat's captain stated that their destination was Indonesia and he was given a chart, a compass and directions to the nearest Indonesian island, which lay some 100 miles to the south-east. This picture shows LSQMG Phil Anglim transferring some of the supplies provided to the refugees.

"The gremlins of the editorial world caused the wrong caption to be printed in the last issue's "Visions". So we're running the right one this time. Ed."

Book Reviews

Storm and Conquest: The Battle for the Indian Ocean, 1809

by Stephen Taylor
380 pp Faber and Faber $35.00
ISBN 978-0-571-22466-1

In 1910, one hundred years after the Napoleonic Wars – essentially the same distance that lies between today and the First World War – the Australian historian Ernest Scott described in *Terre Napoléon* how the global struggle between Britain and France encompassed even the tiny British outposts in New South Wales and Van Diemen's Land.

In 1810, the French emperor ordered General Charles Decaen, the Governor of Ile de France (now Mauritius), to use his naval squadron to capture 'the English colony of Port Jackson.' But Decaen would never be able to follow Napoleon's command. His ships were engaged with a British fleet in the Indian Ocean, and by the end of the year the British had taken Mauritius.

Storm and Conquest tells the story of this naval campaign in which two empires fought for control of the Indian Ocean and the vital trade to India. Stephen Taylor, a South African-born journalist who works for the *Times*, has written a stirring account that vividly evokes the ships, the officers and the sailors of the Royal Navy in Nelson's era.

In 1809, the French frigates based at Mauritius had sunk or captured 14 Indiaman merchant ships sailing from India to Britain. Each Indiaman was loaded with saltpetre, a vital ingredient for making gunpowder. The East India Company, whose taxes bankrolled the British war against France, faced financial disaster. The British Government, which needed gunpowder to fight the war at sea and the Peninsular campaign, faced military disaster.

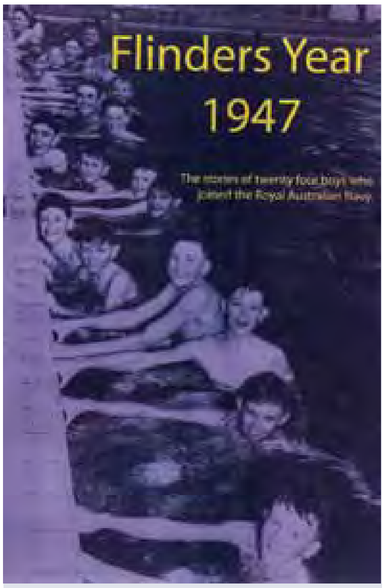
The Government despatched the East Indies and Cape squadrons and the East India Company embarked its troops. Ships were caught in two hurricanes that put the word 'storm' into the book's title. The frigate *Nereide* mutinied at the brutal beatings meted out by Captain Robert Corbet. The mutiny resulted in two courts martial held in Cape Town. In the first, ten sailors were found guilty. Nine were granted clemency and pardoned, and one, Joseph Wilkinson, was hanged. In the second trial, Captain Corbet faced the accusations of his crew. Man after man recounted beating after beating. The ship's surgeon testified that he had to place ten men on the sick list for a week after they had been flogged. But the officers of the court found Corbet guilty merely of inflicting punishments 'with sticks of an improper size' and ordered that he be reprimanded.

As the British ships stood off Mauritius and waited for the troop convoys to arrive, Captain Nesbit Willoughby became impatient and sought battle with the French ships in the confines of Grand Port harbour. In what would become the only French naval victory of the Napoleonic War, Willoughby was killed and his ship was lost. A similar fate befell the brutal Corbet. Despite this defeat, Captain Josias Rowley, the Commodore of the Cape Squadron, regained the initiative and ten thousand troops landed unopposed to capture the colony. The French threat to the India trade was removed.

The capture of Mauritius and the establishment of British naval predominance in the Indian Ocean had a significant effect upon Australia. As Ernest Scott concluded in *Terre Napoléon*: 'Indeed, we can scarcely realize how much Australia owes to Britain's overwhelming strength upon the blue water at the beginning of the nineteenth century. But for that, not only France but other European powers would surely have claimed the right to establish themselves upon the continent.'

Reviewed by Dr John Connor, Senior Lecturer in the School of Humanities and Social Sciences at UNSW@ADFA.

Book Reviews



Flinders Year 1947

Edited by Alun Evans, Ian Knox and John Waller

Published by the Navy Historical Society of Australia, Sydney, 2008. 272 pages, soft cover, illustrated.

This book, subtitled "The stories of twenty four boys who joined the Royal Australian Navy" is the collected recollections of the Flinders Year of 1947. The entries are either by the subjects themselves, a fellow classmate or a surviving wife.

The Flinders Year of 1947 produced one Admiral (Michael Hudson), one Vice Admiral (Ian Knox), one Rear Admiral (Sir David Martin) and three Commodores (Peter James, Eric Eugene Johnson and Mike Rayment). Equally remarkable is that two would hold vice-regal offices.

In the style of an oral history, this book is very readable and evokes a Navy quite different from today's RAN. As a collection it illustrates the incremental career development that remains a great strength of the Navy. It also highlights the social cohesion that is so necessary in a Navy which undertakes substantial and repeated overseas deployments. The book itself is a tribute to the bonds that form among College classmates. That bond remains one of the Navy's greatest gifts.

The Navy which these young 13 or 14 year old boys joined was slowly emerging from the rigors of a long and difficult world war. While victorious the Fleet and its men were tired and worn. It was led by Vice Admiral Sir John Collins and many of his senior officers were household names following their wartime exploits. It was a Navy that was strict and conservative. Flinders is described in the book as having an "oppressive" atmosphere.

It is clear from the accounts in this book that it took some time for the RAN to reshape itself. As is so often the case it was new classes of ship and their inherent technology that drove change. The new post-war Navy was built around the aircraft carrier and an increasing number of guided missile warships. Some of these men became among the most highly regard seagoing Captains of their time.

The book seeks through its recollections to add personal colour to four decades of the Navy's history. In that it succeeds. It does not attempt to critically analyse the development of the Navy. There are others to do that. Having said that, it is tragic that Admiral Hudson died before this book project was undertaken. I feel he would not have missed the opportunity it presented to make some observations on the Navy's development.

There is therefore still more to tell in a more professional vein. Some of these officers played a significant part in the shaping of the modern Navy and indeed some were also founders of the Australian Naval Institute. There is a challenge therefore for naval historians to engage these men and seek their reflections and wisdom.

While the achievements of the RAN are quite remarkable for a navy of its size and age, the Navy's officers and sailors have largely left its deeds to be told by others. There are too few memoirs in any form and the remarkable class of 1947 have made one more contribution to the Navy that they clearly love.

Reviewed by RADM Peter Jones, DSC, AM, RAN

I-400: Japan's Secret Aircraft Carrying Strike Submarine. Objective Panama Canal

by Henry Sakaida, Gary Nila and Koji Takaki,

Hikoki Publications 2006, 144 pp (h/cover), ISBN 1-902-109457, (www.specialtypress.com 1-800-895-4585, US$49.95 + $ 4.95 S/H)

One of the most guarded secrets of the Imperial Japanese Navy during World War Two, the I-400 class of submarines were the largest ever built during the conflict, only to be surpassed by the entry of nuclear submarines in the early 1950's.

Several books have been written on specific types and classes of German U-Boats, but only a few shed light on the submarine force of Germany's ally in the Pacific. In this highly fascinating account, authors Henry Sakaida, Gary Nila and Koji Takaki delve into one of the secret weapons of the war. Through years of research, readers are taken to the design, construction, commissioning and operation of the *I-400* and its sister sub, the *I-401.*

The book begins with a discussion of how it was conceived (another interesting story). This is followed by a foreword by former LT (jg) Kazuo Takahashi and Captain Joseph McDowell, USN (Ret.). The former is a Seiran pilot of the *I-400*, while the latter is the skipper of the prize crew which brought the submarines to Hawaii after Japan's surrender.

The opening chapter covers the Japanese Submarine Force, looking into its beginnings, the interwar years, submarine force dispositions of the Imperial Japanese Navy and the combined Allied Navies in the Pacific on the eve of hostilities, and operations after the attack on Pearl Harbor. The authors then turn their attention to how the type was conceived to attack cities on the eastern seaboard of North America. They then take us into the construction phase of the submarine and to a discussion of its technical details. The *I-400* involved the latest technology of the era.

Solely designed for the *I-400* was the Aichi M6A Seiran Bomber. The aircraft's history is thoroughly covered from its conceptual stage, design and first flight. Notable and of importance are the inputs of the Seiran Pilots and observers into the aircraft's characteristics. Six pages of plans clearly illustrate the Seiran in different views. Two consecutive chapters look into the plan of attack and of Operations *Hikari* and *Arashi.* The Panama Canal was the primary target as destroying it would delay Allied forces in Europe in traversing the Pacific for the final push toward Japan. The preparation and execution of the attack plan is well examined. Notable was the participation of another large type of aircraft-carrying submarine in the IJN: the sister boats *I-13* and *I-14.* There also biographies of the key officers and personnel of the operation: the mission commander, the submarine skippers and the Seiran pilots, as well as details of the formation and training of the Seiran Air Group.

The Panama Canal attack plan is thoroughly discussed, from the stage of gathering intelligence to consideration of specific bombing techniques to be used. After the fall of Okinawa, the target was changed from the Canal to Ulithi Atoll, where the massive *USN TF 38* was anchored. Another interesting aspect revealed is the Seiran's use of US Markings for the operation rather than the national insignia.

The final chapters narrate the quartet's transit to Truk and Eniwetok for the Ulithi mission, where several encounters with US Navy destroyers and torpedo bombers resulted in the sinking of the *I-13* with all hands. It was after this that the message of Japan's surrender was received, and later on the vessels surrendered to American warships in Japanese home waters. From the trio's voyage (*I-14, I-400, I-401*) to Pearl Harbor for evaluation by US and British submarine experts, to its final fate in 1946, to the recent discovery of *I-401*, we read a great story.

The naval war in the Pacific - or even the Atlantic - might have been influenced had the type been constructed and produced in large numbers earlier than it was actually built.

The book is divided into seven chapters. Each is fully illustrated with photographs (most of which never before published). The three dimensional computer graphic images of *I-400* and Seiran aircraft are impressive. Appendices give details of Japanese Navy Ranks, the submarines' radio equipment, the dry-dock report, and the crew lists of both Japanese and American vessels. The bibliography supplements the book well. Noteworthy are the vignettes on the IJN technical schools and on the USS *Tench.*

In sum, the book is finely researched and well written. The authors are to be commended for this remarkable reference work which I believe will be a classic and become the definitive history of the *I-400* and the Panama Canal Operation. The book is highly recommended and would be a valuable addition to the library of naval officers, specifically in the submarine, ASW, aviation, and sea systems communities, as well as of naval and military historians, academy and service college professors, scale modelers and enthusiasts.

Reviewed by LCDR Mark R Condeno, Philippine Coast Guard Auxiliary, Manila, Philippines

Australian Naval Institute Events Program

Event	Date	Location	Comments/Contact
Warfare Seminar & Cocktail Party	4th Sept 2008	HMAS Watson	For more details of ANI events visit the website: www.navalinstitute.com.au
ADFA Breakfast -Project Sea 1000 New Submarine Capability	11th Sept 2008	ADFA	

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Use single quotation marks for quotations. Do not use hyphens for any rank except Sub-Lieutenant.

Citations:

Endnotes rather than footnotes. Use footnotes to explain any points you want the reader to notice immediately. Book titles follow Author surname, first name, title if any. Title. Place of publication: publisher, year of that edition.

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Adler, Bill (Ed.) *Letters from Vietnam*. New York: EP Dutton and Co., 1967.

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ANI On-line: A guide to the new website.

Our new website is now on-line! In addition to the features available on the previous site, the new site also features a library of past journals, a discussion forum, a news section and member list. This short guide is designed to help you take full advantage of the new features.

Figure 1

Obtaining an account

In order to access the new features of the site you must have a user account for the website. If you have a current subscription to the ANI, navigate to the website www.navalinstitute.com.au using your web browser (figure 1), click the "Members Login" menu item (figure 2), then click the link to download an application form. Fill in the form, then fax or post it to the ANI Business Manager. Once your account has been created, you will receive an email that outlines your member ID and password.

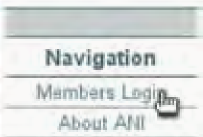

Figure 2

Figure 3

Logging in to your account

Once you have your account details, you are ready to login and access the new features of the site. In order to login, navigate to the website (figure 1) and click the "Members Login" item (figure 2). Enter your member ID and password as they were provided to you, then click the "Login" button. The case of the member ID and password are important: i.e. "CaSe" and "case" are considered entirely different words by the authentication system. Each letter of the password will appear as a single "*" to prevent others from seeing your password as you type. If you have entered your details correctly, you will be presented with the news page. The grey status bar at the top notifies you of the account you are using (figure 4). You are now able to access all of the new features of the site.

Figure 4

Logging out of your account

In order to protect your identity and to prevent malicious use of your account by others, you must log out of the site when you are finished browsing. This is especially important on public computers. In order to log out, click the "Logout" link in the grey status bar (figure 4).

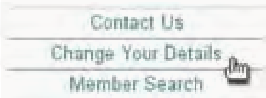

Figure 5

Figure 6

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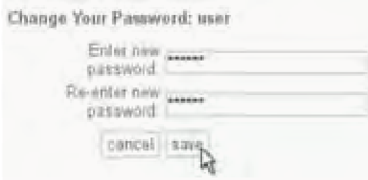

Figure 7

Figure 8

Participating in the forum

In order to post topics and replies in the discussion forum, first login and click the "Forum" menu item (figure 8). Then select a forum that you would like to view by clicking its "View Topics" button (figure 9). Select a topic that you would like to read by clicking its "View this topic" link (figure 10). If you are not interested in any particular topic, you may add your own by clicking the "Add New Topic" button (figure 10). Similarly, once you are viewing a topic, you may post a reply by clicking "Add New Post". Fill in the heading and body of your reply and click the "Submit" button to add your reply to the topic. If you change your mind while writing your reply, you may click the "Cancel" button and your reply will not be added to the topic.

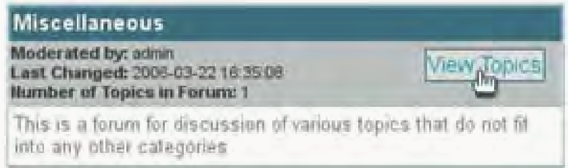

Figure 9

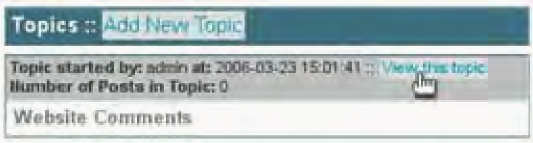

Figure 10

Further questions

If you have specific questions regarding website features or even a feature request, post a topic in the "Website Questions" forum and a site administrator will reply. Otherwise, happy browsing!

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