

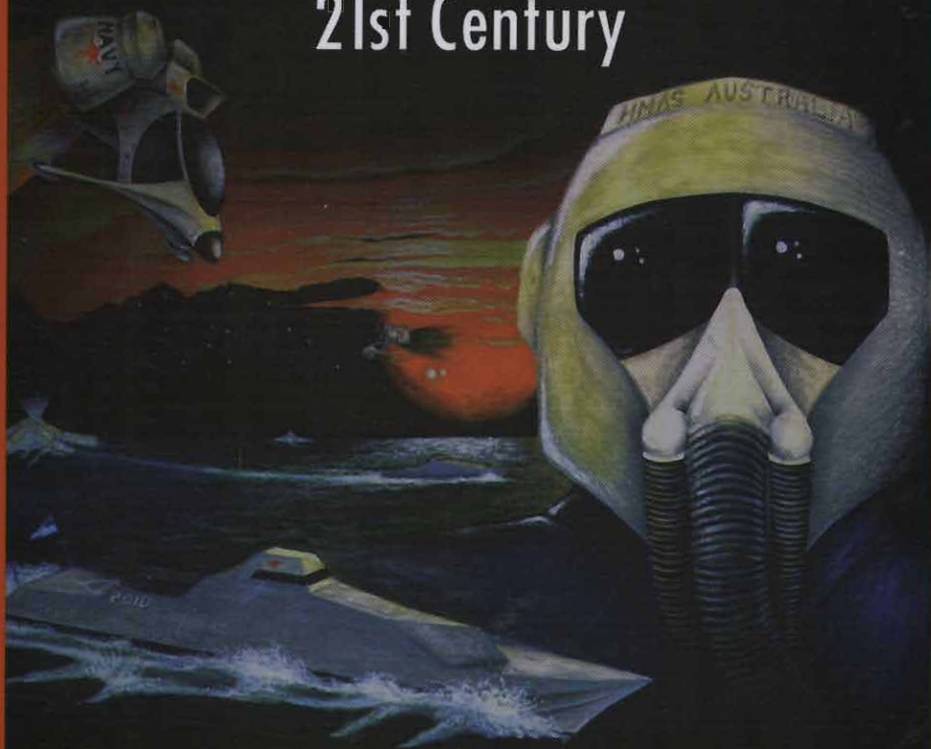
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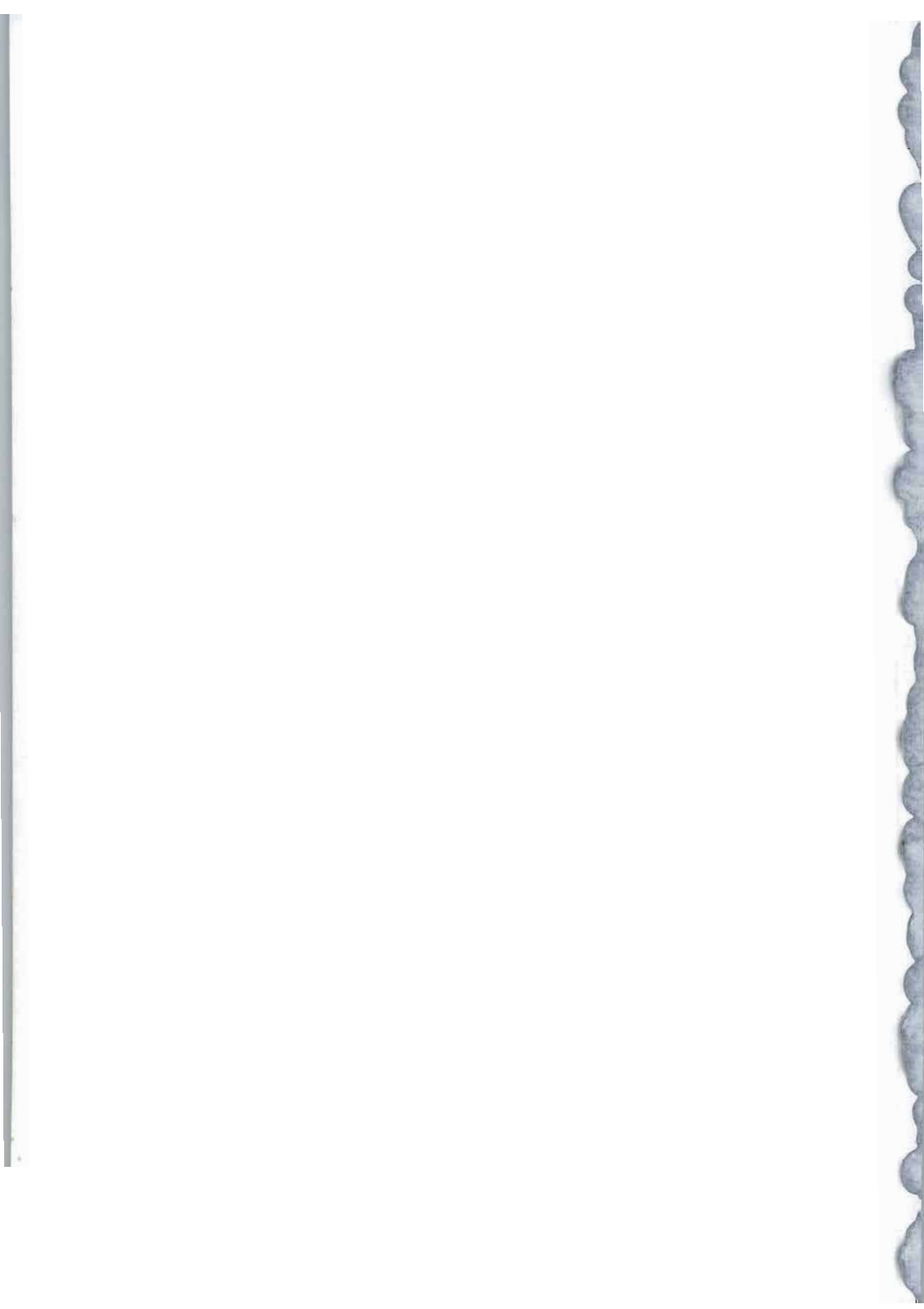


Royal Australian Navy
Sea Power Centre

Maritime War in the 21st Century



Edited by David Wilson





MARITIME WAR IN THE 21ST CENTURY

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MARITIME WAR IN THE 21ST CENTURY

The Medium and Small Navy Perspective

Edited by David Wilson
RAN Sea Power Centre

**Royal Australian Navy
Sea Power Centre**

Papers in Australian Maritime Affairs

No.8 *Maritime War in the 21st Century: The Medium and Small Navy Perspective* edited by David Wilson

The 'Papers in Australian Maritime Affairs' series is a vehicle for the distribution of substantial work by members of the Royal Australian Navy as well as members of the Australian and international community undertaking original research into regional maritime issues. Papers will be drawn generally from manuscripts not scheduled for publication elsewhere but that nonetheless merit extensive distribution. Candidates are considered by an editorial board under the auspices of the Director of the RAN Sea Power Centre.

Other volumes in the series are:

- No. 1 *From Empire Defence to the Long Haul: Post-war defence policy and its impact on naval force structure planning 1945-1955* by Hector Donohue
- No. 2 *No Easy Answers: The Development of the Navies of India, Pakistan, Bangladesh and Sri Lanka 1945-1996* by James Goldrick
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- No. 7 *Maritime Aviation: Prospects for the 21st Century* edited by David Stevens

Foreword

Medium and small navies face extraordinary challenges in their efforts to adapt and remain effective at the dawn of the twenty first century. Perhaps even more than contemporary air forces and armies, they must reconcile conflicting demands to innovate and exploit emergent technology while at the same time operating within tightly constrained budgets. 'Maritime War 21' was a conference explicitly intended to examine the key problems which smaller navies face. It succeeded in doing this with a package of presentations which analysed a range of issues ranging from the strategic situation which medium and small navies face to detailed examination of the technological opportunities which are open to them. Much of the futures thinking in the maritime environment since the end of the Cold War has had a focus directly upon the United States Navy, whose capabilities are so much greater than that of any other maritime force as to make it unique in many of the problems it faces and the solutions it must adopt. This conference represented an opportunity to use not only the enormous body of work done in the United States, but that undertaken elsewhere in the world and from different perspectives. In this context, the wide ranging backgrounds of the conference speakers ensured that new and innovative insights were gained on many subjects.

The clear message within every presentation was that maritime forces, even those operated by smaller countries are here to stay and have much to contribute, not only in the future battlespace but in a wide range of other contingencies. Developments in sensor technology in particular are certainly increasing the ability of adversaries to detect and engage seaborne forces, but this reality is one being faced by warfighters in all environments. On the other hand, stealth technology offers considerable promise for platforms over, on and under the water, while all maritime units have the potential to contribute to and exploit the capabilities of the computer based networks which are becoming central to future warfighting.

Unmanned aerial vehicles (UAVs), higher capacity data links and vastly increased computer power, as well as long range precision weapons promise to give maritime units a previously inconceivable ability not only to dominate the battlespace at sea, but to contribute to operations on land. Although smaller nations will probably always be constrained by the available bandwidth in the extent to which they can network and improve their 'battlespace awareness',

it is clear that there are a multitude of opportunities emerging for alternative approaches which are not so demanding on communications capacity. Furthermore, all these developments are increasing the opportunities for smaller defence forces to operate more effectively on a Joint basis and with allies and coalition partners.

'Maritime War 21' examined all these issues and more in a lively two days of presentation and debate. It served to increase awareness of the future maritime warfighting environment amongst not only those from the Navies represented, but for a wide range of delegates from the other elements of the ADF and from defence industry and academia. As the first in the biennial series which have now been designated as the 'RAN Sea Power Conferences', 'Maritime War 21' should provide a firm foundation for continuing to raise the level of debate on issues of maritime security and technology.

James Goldrick
Captain, RAN

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Acknowledgments

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The success of the conference is due in large part to the effort of the small staff of the RAN Sea Power Centre. Assistance with the organisation and running of the conference was provided by: the Directorate of Coordination in Navy Headquarters; the Aerospace Foundation of Australia; and the Sydney International Convention and Exhibition Centre. The generous financial assistance provided by BAE Systems, Thomson-Marconi Sonar, Raytheon and Tenix Defence Systems is also gratefully acknowledged.

The opinions expressed in the book are entirely the views of the individual authors. They should not be taken to represent any official policy or position.

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Abbreviations

ADCF	air defence and command frigate
ADF	Australian Defence Force
AEW&C	airborne early warning and control
AIO	Action Information Organisation
AIP	air independent propulsion
AOR	area of responsibility
AOR	auxiliary, oiler and replenishment ship
ARF	ASEAN Regional Forum
ARPA	automated radar plotting aid
ASEAN	Association of South East Asian Nations
ASM	anti-ship missile
ASW	anti-submarine warfare
AW	air warfare
AWD	air warfare destroyer
BG EMAIL	battle group e-mail
C2T	command and control terminal
C3I	command, control, communications and intelligence
C4I	command, control, communications, computers and intelligence
C4ISR	command, control, communications, computers, intelligence, surveillance and reconnaissance
C4ISREW	command, control, communications, computers, intelligence, surveillance, reconnaissance and electronic warfare
CAP	combat air patrol
CDC	compositional design component
CEC	cooperative engagement capability
CIC	combat information centre
CINC	Commander-in-Chief
CNN	Cable News Network
CNO	Chief of Naval Operations (US)
COMSEC	communications security
COTS	commercial-off-the-shelf
CTOL	conventional take off and landing
CVE	small escort carrier
DERA	Defence Evaluation and Research Agency (UK)

DF	direction find
DPA	Defence Procurement Agency (UK)
EEZ	exclusive economic zone
EFA	European Fighter Aircraft
EHF	extremely high frequency
ERGM	extended range guided munitions
ESM	electronic support measures
EW	electronic warfare
FAC(M)	missile-armed fast attack craft
FCC	Fleet Command Centre
FFG	guided missile frigate
FMS	foreign military sales
FMV	Swedish Defence Materiel Administration
FOAS	future offensive air system
GCCS-M	Global Command and Control System-Maritime
GNP	gross national product
GPS	global positioning system
HF	high frequency
HMAS	Her Majesty's Australian Ship
HMCS	Her Majesty's Canadian Ship
HMNZS	Her Majesty's New Zealand Ship
HMS	Her Majesty's Ship
INTERFET	International Force in East Timor
IPO	International Programs Office (USN)
ISAR	inverse synthetic aperture radar
IT	information technology
IT-21	Information Technology for the 21st Century (US)
JASDF	Japanese Air Self Defence Force
JDA	Japanese Defence Agency
JDS	Japanese Defence Ship
JGSDF	Japanese Ground Self Defence Force
JMSDF	Japanese Maritime Self Defence Force
KD	Kapal Di Raja (Malaysia meaning King's Ship)
KDX	Korean Destroyer Program
LF	low frequency
LOSC	Law of the Sea Convention
LST	tank landing ship
MAF	Malaysian Armed Forces
MCDV	maritime coastal defence vessel
MCM	mine countermeasures

MCMV	mine countermeasures vessel
MCV	missile corvette
MF	medium frequency
MGB	missile gunboat
MIDS	multifunction distribution system
MOD	Ministry of Defence
MOF	Maritime Operations Force (Japan)
MOU	Memorandum of Understanding
MPA	maritime patrol aircraft
MSO	Maritime Staff Office (Japan)
NATO	North Atlantic Treaty Organisation
NCCS	new central command system
NCO	non-commissioned officer
NCW	network centric warfare
NDP	National Defence Policy
NGPV	new generation patrol vessel
NZ	New Zealand
OODA	observation, orientation, decision and action
OPV	offshore patrol vessel
OTH	over-the-horizon
PCG	Police Coast Guard
PERISTA	Malaysian Armed Forces Special Expansion Program
PFI	private finance initiative
PLA(N)	Chinese Peoples Liberation Army (Navy)
PV	patrol vessel
R&D	research and development
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RF	radio frequency
RIMPAC	Rim of the Pacific
RMA	revolution in military affairs
RMAF	Royal Malaysian Air Force
RMN	Royal Malaysian Navy
RN	Royal Navy
RNLN	Royal Netherlands Navy
RNZN	Royal New Zealand Navy
ROE	rules of engagement
ROK(N)	Republic of Korea (South Korea) Navy
ROV	remotely operated vehicle
RSN	Republic of Singapore Navy

RSS	Republic of Singapore Ship
RSwN	Royal Swedish Navy
SAF	Singapore Armed Forces
SAR	search and rescue
SAREX	search and rescue exercise
SCC	subsystem cooperation component
SDR	Strategic Defence Review (UK)
SEAD	suppression of enemy air defences
SHF	super high frequency
SIPRNET	Secure Internet Protocol Router Network
SLOC	sea lines of communication
SSK	conventional ASW capable submarine
SSN	nuclear attack submarine
STOBAR	short take off but arrested recovery
STOM	ship to objective manoeuvre
STOV/L	short take off and vertical landing
<i>TacTom</i>	<i>Tactical Tomahawk</i>
TAS	towed array sonar
TBMD	theatre ballistic missile defence
TFCC	Tactical Flag Command Centre
TLAM	<i>Tomahawk</i> land attack missile
UAV	unmanned aerial vehicle
UCC	user cooperation component
UHK	ultra high frequency
UK	United Kingdom
UN	United Nations
UNPROFOR	United Nations Protection Force
US	United States
USCG	United States Coast Guard
USN	United States Navy
USS	United States Ship
VDS	variable depth sonar
VHF	very high frequency
VLS	vertical launch system

Notes on contributors

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Rear Admiral Ron Buck, OMM, CD, CF joined the Royal Canadian Navy in 1967. He has served in various seagoing and shore appointments including: Commanding Officer HMCS *Restigouche*; Project Manager of the Maritime Coastal Defence Vessel Project; Commander of the Fifth Canadian Destroyer Squadron; Commander Canadian Forces Training System; and Commander of the Canadian Fleet Pacific. He is currently Commander Maritime Forces Pacific.

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Graeme Dunk is the Business Development Manager at Codarra Advanced Systems, a Canberra-based consulting and management company. After leaving the Royal Australian Navy in 1994 he ran his own consulting company for 5 years, specialising in the provision of strategic, operational and project advice, principally of a maritime nature to Australian and overseas industry and the Australian Department of Defence. Graeme served as an officer in the RAN from 1974 to 1994, where he specialised in anti-submarine warfare. He holds a Bachelor of Science degree in pure mathematics, a Master of Science degree in Maritime Defence Technology, and a Master of Defence Studies degree. He also holds an Insignia Award in Technology from the City and Guilds of London Institute. He has published numerous articles on strategic and defence subjects.

Captain Allan Du Toit, RAN was born and raised in South Africa and joined the South African Navy in 1975. He qualified as a principal warfare officer and sub-specialised in mine warfare. He served in a number of appointments with the South African Navy before moving to Australia in 1987 where he accepted a commission in the Royal Australian Navy. His appointments in the RAN include: Commanding Officer of HMAS *Tobruk*; Director of Mine Warfare and Clearance Diving; Operations Director in the Minehunter Coastal Project; and Deputy Commander Australian Amphibious Forces. He is currently Commander Amphibious and Afloat Support Group. Captain Du Toit is a keen naval historian and student of international naval developments. He has written two books on warships and naval history and is a regular contributor to various naval journals.

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Lieutenant Commander Mike Lupow, USCG is a 15-year veteran of service in the US Coast Guard and has served three tours as a search-and-rescue helicopter pilot and flight instructor in the HH-3F and HH-60J helicopters at Coast Guard Air Stations in Cape Cod, Massachusetts, Kodiak, Alaska, and Elizabeth City, North Carolina. He completed graduate studies at the University of Wisconsin-Madison in 1997 after which he reported for duty at Coast Guard Headquarters. He is currently Strategy and Communications Director of the Coast Guard Deepwater Project. His decorations include the Coast Guard Commendation

Medal, two Coast Guard Achievement Medals, the National Defence Service Medal and the Humanitarian Service Medal.

Commodore Jonathon Lyall, MBE, RN joined the Royal Navy in 1965 specialising in submarines and qualifying as a Navigator. He has served as Commanding Officer of the HM Submarines *Onslaught* and *Sceptre* and as Captain, Second Submarine Squadron (*Trafalgar* class SSGNs). Other appointments have included: Flotilla Operations Officer on the staff of the Flag Officer Submarines; responsibility for maritime arms control and increased military contacts with the former Warsaw Pact countries while serving in NATO at the Supreme Headquarters Allied Powers Europe; supervising the move of the *Upholder* class submarines to Devenport, and the Directorate of Command, Control and Information Systems in the Ministry of Defence. He is currently the Defence Adviser at the British High Commission in Australia.

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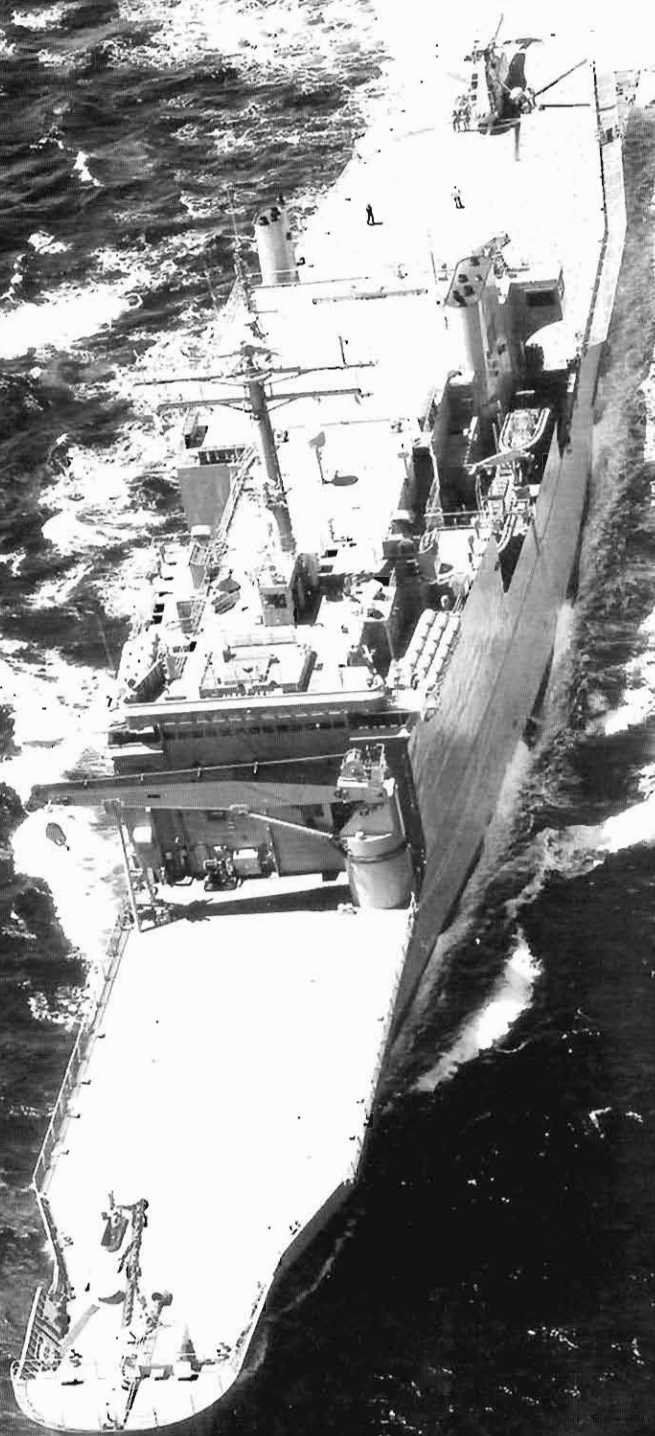
Sir Robert Walmsley, KCB, FREng is the Chief of Defence Procurement in the UK Ministry of Defence and the first Chief Executive of the Defence Procurement Agency. Prior to his current appointment Sir Robert served in the Royal Navy for 38 years retiring with the rank of Vice Admiral. An engineering specialist, he held a range of seagoing appointments mainly in submarines and his more recent appointments include: Director of Operational Requirements for the Navy; Assistant Chief of the Defence Staff for Communications and Information Systems; Chief Naval Engineer Officer and Director General Submarines in the Procurement Executive; Controller of the Navy; and Deputy Chief of Defence Procurement.

Dr Lee Willett was, until very recently, Leverhulme Research Fellow at the Centre for Security Studies at the University of Hull and was seconded to the Naval Staff Directorate in the Ministry of Defence as a Research Associate. In this capacity, he wrote widely on the future of the Royal Navy Submarine Service. Recent publications include: 'Tomahawk Diplomacy' in *Warships International Fleet Review* (Spring 2000); 'TLAM and British Strategic Thought' in *Undersea Warfare* (Spring 2000); "The Most Important Type of Warship in the World": the UK Strategic Defence Review and the Royal Navy Submarine Service; and 'Submarines in British Defence' in the spring edition of Australia's *Navy News*. He is also joint editor of a forthcoming Royal Navy volume titled *Dimensions of Sea Power: the Strategic Defence Review and Maritime Manoeuvre*. He continues to write widely on the future of the Royal Navy, and in March 2000 was appointed to the Military Science Program at the Royal United Services Institute for Defence Studies.

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Lieutenant Commander Horden Wiltshire, RAN joined the Royal Australian Navy in 1985 completing a degree in Bachelor of Engineering (Naval Architecture) (Hons) from the University of New South Wales in 1988. He qualified as a Seaman officer and later specialised in submarines. He has served as Torpedo Officer in HMAS *Ovens*, Operations Officer in HMAS *Collins* and

Executive Officer of HMAS *Farncomb*. He completed a Masters of Business Administration in 1993. In 1999 he successfully completed the Submarine Command Course (Perisher) in the Netherlands and is currently Commanding Officer of submarine *Sheean*.



Introduction

Vice Admiral David Shackleton, AO, RAN

This book originated from the Royal Australian Navy's Maritime War in the 21st Century conference which was an integral part of the inaugural Pacific 2000 international maritime exhibition held in Sydney in February 2000. Pacific 2000 was a dynamic exhibition which combined the world's latest maritime and naval thinking with the technologies that are intrinsic to enabling navies to do their business.

Technology presents navies with great opportunities to re-think how they operate. The linkage between naval doctrine and advanced technology is as profound now as it has ever been in our history.

Pacific 2000 was the first of its type in Australia, and provided the opportunity to showcase Australia's navy and industry. In a very obvious way, it acknowledged the ever-increasing importance of high-technology equipment in the maritime environment. It was also an opportunity to celebrate and further pursue the important interdependence of navy supporting industry, and of course industry supporting the navy.

Conferences and exhibitions such as Maritime War in the 21st Century and Pacific 2000 offer the opportunity to discuss the difficulties and options of keeping pace with technology and of exploiting what it offers with the limited resources that are available. They also provide an opportunity to work through some of the issues that make the navy such an important asset for a maritime nation such as Australia. They provide an understanding of what needs to be done and what navies can do to meet that demand. From that understanding sound decisions can be made affecting all of the important choices that will face us.

All maritime nations are dealing with circumstances that require them to make choices on their capabilities and levels of investment. Australia is no different. Australia's strategic circumstances are evolving, as are those of its partners, and they must be adapted to.

Modern Australia has come from the sea. Its settlers arrived by sea. Its major income earning commodities travel to their markets by sea. Australia is an island continent. So perhaps it is not so surprising that Australia has established

a level of maritime industry that is quite extraordinary when considered against the overall national backdrop. Industry builds the Navy's warships and submarines. They design, develop, install and maintain the complex sensors and combat systems that are so necessary to any navy. Industry does truly help the Navy move forward in an ever more intricate and demanding operational environment.

But the other dimension of maritime capability is the need to have highly professional mariners who can fully exploit the technology they have, and interact with the designers and builders so that the full range of synergies can indeed really work for a national benefit. An important role of the navy is to keep that equation clearly in the forefront of its thinking. It is a two-way arrangement that must be acknowledged and nurtured.

The real benefit of the Maritime War in the 21st Century conference and this book will be an enhanced understanding by all, individually and collectively, as to how this can be done better in the global oceans of the global village.

Part | 1

Keynote addresses

Stating the problem: facing the challenge

1

Rear Admiral Geoff Smith, AM, RAN

The problem for smaller navies can be summed up in one sentence. Maritime warfare is inherently technology sensitive and capital intensive. This creates an imperative: an imperative to *manage change*.

Smaller navies have a requirement to keep up with technology and exploit what it offers, but they must do this with very limited resources. This means that choices must be made, choices between particular capabilities, choices between maintaining forces at levels which are such that they represent *real* capability deployable at little or no notice, or at levels which are the minimum to allow a core of expertise on which to base expansion. It means choices between running on 'as is', or modernisation, or new construction. It means choices between procuring systems that are developed for and tailored to the exact specifications required—which means accepting 'parent navy' responsibilities and all that these imply—or acquiring other nations' systems which will rarely be exactly what is wanted. All of these are choices which involve not only navies or even defence forces and defence departments, but governments, the scientific community and industry—and that's only a start.

Significant naval effort represents a significant call on national resources and the more that one tries to be 'national' and 'self reliant', the more significant that call. However, such efforts do have the potential to create very considerable benefits for the nation in terms of industry and technology, if they are properly managed.

The choices have higher dimensions. Smaller nations have just as much of an imperative as larger countries to create and sustain a full range of capabilities. Asymmetric threats are most dangerous when they can be targeted at gaps in an order of battle. So it is essential to 'mix and match' to ensure that there are no obvious weaknesses and that one's combat forces are as *flexible* as possible. This means that individual services need to work hard at ensuring that they create the most versatile forces that they can.

But there is more to it than that. Smaller nations have an imperative towards *joint* operations, which is much stronger than large nations. This is not only because of the need to avoid duplication and waste—everyone understands this. It is because of the reality that the lack of *mass* in combat power must be

made up for by exploiting as many different capabilities as possible from as many different environments as possible.

The adversary's problem will be much more difficult for him to solve if he can be presented with as many different threats as possible, particularly if this allows coordination of his operations. To give a tactical example, it may ruin your entire day to face a threat at sea from submarines, or from surface ships, or from aircraft. It will certainly ruin it to have a torpedo inbound from one direction, a Harpoon missile fired by a surface ship from another, precision guided bombs from a strike aircraft from a third and a maritime patrol aircraft watching the affair and waiting to finish you off. This is only an example in the purely maritime arena. How will the average soldier feel to have a closely grouped salvo of precision guided naval shells falling on him when he is 50 kilometres inland?

The truth is that properly constructed *joint* capabilities and properly operated *joint* forces represent very much more than the sum of their individual parts and a very much more efficient disposition of resources than concentrating on one particular service—or, even more critically, one or two special capabilities. Additionally, this *joint* focus recognises the need which smaller nations have to maintain a level of capability for *independent* operations to support the national interest. But, there is also a need for *coalition* capabilities. Properly conceived and constructed *independent* capabilities should confer the capacity to contribute in an effective and credible way to working in an alliance or coalition. While only particular assets or capabilities may be selected to go into a coalition operation, if forces have any degree of capability in an independent sense, there will be something to offer.

There are two 'myths' that tend to resurface at intervals, particularly when naval warfare is discussed, that should be dispelled. The first is what may be called 'the myth of the all seeing eye'. A British statesman once complained of his Cabinet colleagues that they had been using maps that were too small with hands that were too big. Navies suffer from the same problem in relation to how operations are conducted at sea. The popular perception of those who don't understand the realities of the maritime environment is that a ship is big and that the ocean is small, which translates mentally to 'already located, already identified—and very vulnerable'. But what does a ship look like to those who are searching for it?

Figure 1.1 is a sound gram of a merchant ship—no radiated noise reduction systems or procedures and no attempt at concealing itself. This is the picture that a patrolling submarine or ship equipped with a towed array would have—or indeed a patrol aircraft listening to sonobuoys. Figure 1.2 is what the sound gram of a rain squall looks like. This is also what the sound gram of a noise-

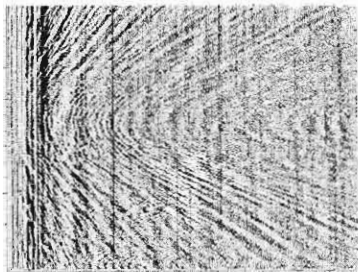


Table 1.1. Sound Gram of a merchant ship.

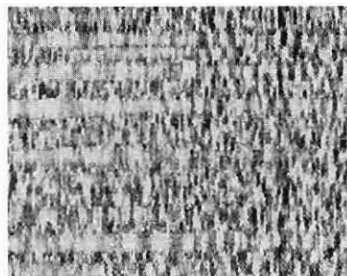


Table 1.2. Sound Gram of a rain squall.

quieted warship or submarine operating covertly would look like in these environmental conditions. Figure 1.3 is what a single surface ship looks like on radar. Figure 1.4 is what the picture looks like in a busy environment, with only other surface craft. There is no land and the weather is clearly perfect, so there is nothing to confuse the picture. And having identified it—which may well be able to be done with systems such as inverse synthetic aperture radar (ISAR)—make sure that you don't lose it, even if it is moving up to 600 nautical miles in one day.

So, in reality, the ship is not so big, and the ocean not so small. Of course, there are many other ways of locating, identifying and 'fingerprinting' combat ships, but few of them are simple and most rely upon the combat unit doing something—a theme which will be returned to later. All demand substantial resources and effort by an adversary.

The point is that there are very few 'all seeing eyes' available to most nations—and nothing about emergent technology changes that reality. So, in thinking about maritime warfare, it should be borne in mind that the environment is large, complex and difficult to master, and it will not stop being large, complex and difficult to master, despite what technology offers. ISAR has already been mentioned—a later chapter will discuss stealth as applied to ships. But it should also be borne in mind that this size, complexity and difficulty create real opportunities for utilising the maritime environment to deploy combat power.

The second myth is the confusion of platforms with capabilities. When looking at ships, aircraft or land vehicles there is a tendency to immediately associate a lot of things with them and this leads to a lot of very muddled thinking, particularly about navies—and, increasingly, about air forces. This is because the cost of warships is not in steel or propulsion—not to a great degree anyway—but in the systems chosen, or not chosen to fit to a particular platform.

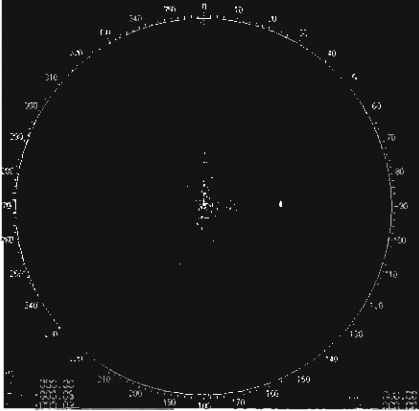


Table 1.3. Radar picture of a single ship.

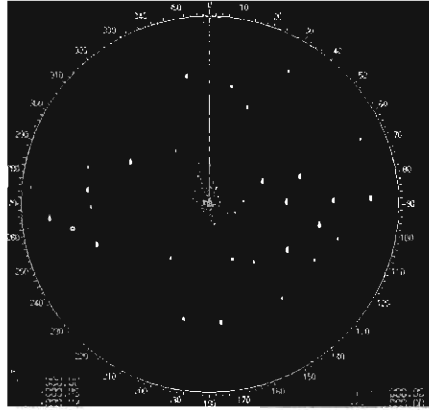


Table 1.4. Radar picture of multiple ships.

In the case of a modern frigate or destroyer with the range of weapons and sensors normally carried, the ship—that is the hull, engines and hotel systems—represents only about 20 per cent of the total cost. 80 per cent—*four fifths*—of the total cost goes in the combat data systems, communications, sensors and weapons. Applying stealth technology may change this relationship to some degree but it will not negate the basic point.

One of the most important developments of the new technology is the way that the linkages between combat capabilities and particular platforms are being weakened. A cruise missile, for example, can be delivered from an aircraft, a land site, a surface ship or a submarine—and that is probably only the beginning. So here is an important point. Platforms—of any kind—should be looked at for the attributes that they possess as *vehicles* in addition to the capabilities that can be incorporate into them as *combat systems*.

From a seaborne perspective, it should be remembered what the attributes of ships as *vehicles* are. What do ships provide, in other words, before starting to add the 80 per cent extra cost of systems? The attributes of ships as *vehicles* are:

- *Mobility.* Ships can carry more, further and faster than any other platform. One transport ship, for example, represents literally hundreds of heavy transport aircraft sorties. Equally, warships can carry *lots* of munitions—something that may prove crucially important when a small footprint landing force requires fire support ashore.
- *Readiness and speed of deployment.* As complete warfighting capabilities, naval forces can deploy into theatre and be operational faster than any



HMA Ships *Anzac* (right) and *Sydney*. Four fifths of the cost of a warship goes into the combat, communications, sensor and weapons systems.

other platforms. Aircraft may transit faster, but if they are going to be forward based there are significant time penalties to the establishment process. The same applies to land forces.

- *Flexibility.* Ships do not create a footprint in someone else's country and they do not raise the sort of sovereignty issues that basing anything overseas brings. They are difficult to find, more difficult to track and extremely difficult to predict. Battle readiness is something that can be reached,

sustained or relaxed at little or no notice and the state of that readiness is not something that can readily be discerned by the external observer.

- *Poise and persistence in that poise.* If situation is uncertain, if a government needs to place a marker, then naval forces can support themselves for long periods—practically indefinitely if they have access to underway replenishment.

All this adds up to the key theme of *versatility*.

Air and land force platforms have their own inherent—and vital—attributes, which won't be developed here. But the point stands and that is that navies and governments need to be very clear about what they can get from the platforms in a particular environment and what they *need* from those platforms. There is a need to be informed by this process before starting to focus more directly upon the combat systems themselves.

Next, briefly, there is network centric warfare (NCW). This is in grave danger of developing some myths of its own. NCW is a concept that has its origins in the long range over-the-horizon targeting and weapon delivery systems developed by the United States Navy in the Cold War and since perfected to an extraordinary degree. It has come to embrace the revolution in command, control, communications, computers and intelligence (C4I) that has become possible with advances in computers, networking and communications.

Its conceptual 'ideal' is one where three levels of networks: joint planning, joint data and joint composite tracking, are used to fuse sensors, combat data systems and planning organisations with their own kind. This is with the aim of achieving integrated linkages across all platforms that can result in high-speed automatic response and assignment of resources to need from the most appropriate platforms at the most appropriate time.

This, of course, represents just that—an ideal and one that is well beyond the resources of practically anyone but the United States. It is also not as easy or simple as it looks—or as some of the most enthusiastic advocates would appear to imply. Nevertheless, there are ideas associated with it that need to be considered.

The most important idea concerns what may be regarded as being the key concept of NCW for maritime warfare. This is the fused picture of *battlespace awareness* that can be generated and maintained. What having such a fused picture means is that individual units do not have to depend upon their own sensors either for an understanding of what is going on, or for the information required to fire their own weapons. This is a *vital* point.

It was noted earlier that ships can be located and identified when they are doing

something—and that something is usually radiating on radios, radars and sonars in order to develop a picture of what is going on. Well, if they have access to remote sources of information—other ships, aircraft, unmanned aerial vehicles, over the horizon radar—they may be able to remain covert and unlocated for long periods, but ready to move into action with little or no notice. In a tactical sense, for example, there must be real potential for the interaction of airborne early warning and control aircraft and air warfare ships acting as missile traps.

From all of this it should be clear that many of the ideas of NCW and the systems which are being brought into service as part of the whole package have the potential to increase the combat power of smaller forces in extraordinary ways. This doesn't mean to imply that small nations will be able to use NCW ideas to defeat super powers—what it does mean is that there is much potential for smaller nations in improving their capabilities for independent action. How?

If you add real time data fusing capabilities to the sensors of a small task group and then connect this task group up with the sensors of even a limited number of air platforms and remote sensors, you are achieving enormous improvements in the capacity of that task group to go in harm's way. Consider, too, that not only is there the potential for remote sensors in terms of big facilities such as the Jindalee Over the Horizon Radar Network, but assets such as unmanned aerial vehicles must introduce a whole new dimension for extending the task group's virtual horizon (without crew duty cycles!). These are the sort of concepts that need to be thought about.

This chapter has not attempted to give a comprehensive survey of what may be the future of medium and small navies in maritime combat. But it has tried to give a clear understanding of the reality of the position of medium and small navies. That reality is: small and medium navies must deal with *technological change* to retain *combat credibility*; and they must deal with that change from a base of limited resources.

This means that choices must be made—and they will be hard ones—but those choices must not be at the expense of *flexibility*, nor should they create weaknesses that allow adversaries easy options. The *joint* approach will give the maximum *combat power* and, if the proper choices are made, *emergent technology* does have real potential to give smaller navies more benefits than disadvantages.



Materiel challenges facing small and medium sized navies

2

Sir Robert Walmsley, KCB, FREng

As we move into the 21st Century, the materiel challenges facing small and medium navies are not insignificant. In an environment of reduced budgets and manpower, new technologies with increasing levels of complexity, and new operational challenges, small and medium navies have a difficult task in ensuring they achieve the right materiel choices. This chapter looks at some of the challenges and how they might be met using the experience of the United Kingdom (UK) as an example.

The situation in the UK

In the UK the Defence Procurement Agency (DPA) is responsible for the purchase of all new equipment for the armed forces, with a budget of £6 billion per year—around \$AUS15 billion—and 4,752 staff. And, working through the Defence staff, the Royal Navy (RN) is, in a very real sense, a customer of the DPA. Customer is a word that can be easily and carelessly overused inside government; so consider these two points. First, a customer is a person with money. Not to be confused with stakeholders such as employees, taxpayers or wider interests inside the Defence Ministry. Second, and this is why the distinction matters, is that when something has to be paid for, there is a desire to make do with less. Both propositions are fundamental to 'Smart Procurement', which shall be discussed later.

Like many defence forces the world over, the RN has been faced with a changing role following the end of the Cold War. The potential maritime threat has shifted from large-scale open-ocean warfare, with a strong anti-submarine emphasis, towards a wider and more geographically dispersed range of operations in littoral waters. Situations are likely to be more unexpected and complex, requiring a swift and flexible response.

Against this changing background, the UK's 1998 *Strategic Defence Review (SDR)* reached a number of conclusions impacting on the role and equipping of the RN. First, it concluded that the future of Britain's defence was in joint operations with maritime, ground and air forces operating effectively together. Nothing new for any island nation, of course. But the wider variety of military tasks carries with it a requirement for equipment that is inherently flexible, and both joint and allied operations call for far more than token interoperability.

The main impact of the SDR on the naval equipment program was:

- Confirmation of the importance of a modern destroyer and frigate force with the flexibility it affords (provided they have got a gun and a helicopter).
- A decision to order two new large aircraft carriers to serve as the base for joint service operations following the conclusion that the ability to deploy offensive air power is central to future operations. And the description of these ships is carefully worded: they are there to influence events ashore, not just to act as a base for aircraft whose principal role is to defend the fleet—usually with themselves as the highest value unit!
- A new future carrier borne aircraft for the new *Joint Force 2000* to replace current RN and Royal Air Force *Harriers*.
- The need for more sealift which has increased the number of new roll-on roll-off container ships from two to six. Ships which will be procured with private finance, with perhaps two for permanent use by the Ministry of Defence (MOD), two more on a very short tether and the final two at a sensibly long period of notice so that they can earn revenue for their owner.

Material challenges

Platform/Type	Vessel/System	In-Service Date
Ships	RoRo Container Ships	2000
	Amphibious Landing Ships	2002/3
	Type 45 Destroyer	2007
	Aircraft Carriers	2012
	Future Surface Combatant	2012
Submarines	<i>Astute</i> Nuclear Attack Submarine	2005
Aircraft	<i>Merlin</i> Anti-Submarine Helicopter	1999-2002
	Support, Amphibious & Battlefield Rotorcraft (SABR)	2008
	Future Carrier Borne Aircraft (FCBA)	2012
Missiles	Principal Anti-Air Missile System (PAAMS)	2007

Table 2.1. Current UK naval equipment procurement program

As Table 2.1 shows, the UK has a fairly substantial naval procurement program. And even this list doesn't convey the range of work on amphibious shipping and fleet tankers, all now under construction, or HMS *Vengeance*, accepted

into the RN in December and forming the final 15,000 tonnes of the UK's national underwater insurance policy. But, the RN's materiel challenges are not much different from those facing the other UK armed services or, indeed, the other navies of the world. If proof of the similarity in procurement challenges is needed, perhaps it will be a shock to discover that the UK has recently appointed an army Brigadier to lead the project team for our new Type 45 destroyer. That was because he had led two earlier procurement programs—involving a prime contract and an international missile project—and so could point to an impressive track record to justify 'best person for the job' status. Acquisition is a professional business.

So, what are the materiel challenges being faced? Firstly, the complexity of modern defence equipment programs which make them inherently risky—and much *more* risky than most readily appreciate or care to admit. The pace at which technology is evolving, particularly in the area of command, control, communications, computers and information (C4I) exacerbates this. Defence departments are too often overtaken by commercial advances which either leave them with obsolete equipment, or force them into costly get well programs rather than a planned, orderly, evolutionary growth of capability. Face up to reality, this is what always happens in practice anyway; more graphically, 'if we don't plan incremental acquisition, we'll get excremental acquisition'.

Second, as already mentioned, is the increasingly flexible role that our equipment is being asked to play. Much more built-in capability is needed to cover operations in a range of environments: equipment should *not* need modification before fulfilling a role in a perfectly predictable, perfectly realistic scenario. No ship should ever find its combat equipment compromised by a lack of cooling or electrical power.

Integration and interoperability are further challenges. The UK's two new aircraft carriers, for example, will be a joint asset operating both navy and air force aircraft, as well as helicopters from all three services. The design of the carriers will be largely dependent on the type of aircraft selected. And the carriers will want to use information from the joint digitized battlespace. The integration challenges on the carrier project can be read across to many other programs. The DPA is therefore creating a new post of 'Integration Authority' which will coordinate the procurement of a 'system of systems' within an overarching architecture. Curiously, it is the adoption of *really* integrated project teams, with their very focused—potentially stovepiped—commitment to delivering their responsibilities which has moved this Integration Authority from the desirable to the absolutely necessary. And that is only to cover integration at the national level. There is also a need to consider interoperability requirements



The Royal Navy's *Duke* class (Type 23) frigate HMS *Westminster*. In the past warships have been designed around a particular capability. Future designs will allow margins for future capabilities to be incorporated.

with partner nations whether outside or inside the North Atlantic Treaty Organisation alliance. And in this context and especially in Australia's region, tribute should be paid to the interoperability work of the five nations Combined Communications and Electronics Board. But the challenge of interoperability is enormous and, to be frank, is not something any of us is much good at. Standards—in the information technology field at least—can all too easily be overwhelmed by technical advance. And *nobody* knows how to decide who should pay to provide, and then maintain, interoperability between two systems under separate user authority.

The fifth challenge comes directly from defence suppliers: for everywhere industry is changing. Over capacity is leading to reduced numbers of companies. There is consolidation and restructuring on a global scale, which in turn leads to few, if any, nations having the capacity to meet all their own requirements. This is also reducing opportunities for competition. The centrality of competition to any sound procurement policy should be emphasised, not because competition is the way to ensure some Dickensian grinding down of the last element of cost, but because competition is the driving force behind new ways of doing things, because it incentivises innovation and investment in better ways of doing things.

And all this has to be stacked against the major pressures on defence resources. This could have been put first on the list but deliberately wasn't. Lack of resources has become far too frequent an explanation or even an excuse for not doing what is necessary. As with competition, a healthy squeeze on resources can be a great spur to finding better ways of doing things. That point aside, there is likely to be a broader range of candidate requirements and less money to spend as well as fewer people to manage future projects.

Smart Procurement

In the UK, these challenges are being met through an initiative called 'Smart Procurement', which aims to deliver equipment *faster, cheaper and better*. The initiative embraces a number of different policies. Some of the concepts of this initiative will now be discussed using current UK procurement programs to highlight the issues and to demonstrate some of the benefits that are hoped to be achieved.

Incremental acquisition/technology insertion

A warship, perhaps more than any other platform, has an almost unlimited range of potential capabilities. The challenge is in deciding on the initial capability required, based on the technology currently available and what is affordable; and then deciding what margins should be allowed for future capabilities to be added. In the past, the downward pressure on production costs led to the smallest possible ships designed around one particular capability. So for example the UK's need to get the *Sea Dart* missile system to sea led to the call for the smallest ship capable of taking *Sea Dart*. This resulted in the Type 42 destroyers, which have proved excellent in service but have proved very costly to maintain. Similarly, the Type 23 frigate designed to introduce the towed array passive sonar to the surface fleet and with an acquisition cost about 70 per cent of the ships it replaced. The Type 23 frigate was designed for a life of only around 18 years, because it was recognised that it would be

extremely difficult to update. As an aside, it should be emphasised that there is no law of nature that dictates the concept of a special, and especially high, level of defence inflation. Factory gate prices have been falling for a year and more, and defence must get the benefit. That too is smart procurement.

The lack of flexibility in tight ship designs is now exacerbated by the need for more responsive and flexible warships; and particularly by the requirement for constant upgrading to incorporate the latest C4I capabilities. Warships must therefore be designed from the start for technology insertion. Under Smart Procurement, incremental acquisition provides for equipment capability to be upgraded in a planned way, from the initial delivery of a specified baseline capability to the eventual achievement of a higher full capability.

The Type 45 destroyer is a prime example of building in flexibility from the outset. The ship is being built with a reduced limited initial operating capability for the first of class in order to be affordable, but with the ability for increased capabilities to be incorporated later. The combat system is genuinely capable of accepting planned enhancements in areas such as electronic warfare. Other equipment, such as surface-to-surface guided weapons can be added later. This is a requirement that has been subject to discussion for at least ten years, but it can certainly be added later and might even benefit by the use of anti-ship missiles from existing stocks. Whatever the reason, in the Type 45 there will be good margins of space, weight, power and services for future enhancements.

Trimaran

But what of innovation in ship design? Limited space within the traditional single hull ship has led to consideration of the trimaran configuration to accommodate operational payloads. In the trimaran, the central cross structure linking the three hulls provides a wider central space on both the upper deck and the main through deck, where the demands for technology insertion are likely to be most pronounced. And the trimaran also has better sea keeping properties, but these benefits are only useful if one is *absolutely* satisfied on its structural integrity *and* can understand the more mundane implications, such as berthing issues.

So the UK's Defence Evaluation and Research Agency (DERA) has ordered an 1,100-ton trimaran demonstrator, the RV *Triton*, as a major risk reduction contribution to informing the decision on the adoption of a trimaran configuration for future warships. Construction of Triton follows five years of intensive research by DERA into warship hull design. Sea trials will be conducted in collaboration with the United States (US), who have contributed the

comprehensive trials instrumentation system. The results will be assessed for application to the future surface combatant, the RN's next generation of frigates, which will be coming into service in around 2012.

Electric propulsion systems

As a propulsion innovation, the electric ship has many well-known advantages—so the UK is looking to exploit these benefits. However, there are a number of challenges involved in such a technology, principally in meeting the power density and signature requirements, and addressing system integration issues. Contractors are only likely to propose such a new system if they believe the risks are acceptable within the funding available. For that reason, the UK is embarking on an electric propulsion de-risking program, with a shore technology demonstrator as its main element. The results will be shared with contractors, who will be invited to observe the demonstrator working and make proposals for additional trials. Successful demonstration should allow contractors to propose electric propulsion without charging a significant risk premium. Note that it is planned to transfer the risk, while recognising that this must be reduced to a sensible level.

Challenges-involving industry

This is a broader lesson: the early involvement of industry is *crucial* if new, high technology, equipment is to be introduced on time and within cost. Too often, projects have overrun and overspent because of a lack of clear understanding within both MOD and industry over what is wanted, and what is feasible. A different, and better, relationship with industry is one of the key themes of Smart Procurement.

An example of this different relationship with industry is the program for the *Astute* attack submarines. A prime contract was let in March 1997 with GEC Marconi for the design, build and support of three vessels, with an option for a further two. The total cost for the first three of these 6,000 tonne submarines is in the order of £2 billion—with the batching process being a first for nuclear powered vessels in the UK. It is both energising industry and saving the government about 10 per cent by comparison with singleton orders.

The prime contract company is to deliver a complete package including 8 boat years of contractor logistic support and an availability, reliability and maintainability demonstration period. The contractor has been contracted to deliver performance, which gives him the freedom and incentive to deliver performance at minimum cost. MOD also has an incentive to help reduce the costs by sharing in any eventual savings—a process called 'gainsharing'. By

jointly sharing the risks and benefits of the program, the contractor will be incentivised to produce the equipment to time and cost—both acquisition and support, and MOD will get a better product at reduced cost. It's worth remembering that companies aren't in business to make ships; they're not in business to make aircraft; they *are* in business to make money. Understand *that*, and you have the key to their soul.

The closer relationship between MOD and industry is exemplified, under Smart Procurement, by the fact that the contractor will now become part of the MOD's integrated project team. When the first embryonic team for the Future Aircraft Carrier project was formed, it included participation from BAe, Marconi Electronic Systems, Lockheed Martin and Thomson CSF. These companies all undertake significant business activity in the UK; The view that globalisation means ownership is very hard to determine (unless it's by a government). What matters is where the work is done or, more crudely, where the wages are paid. In any event, these companies played a key role during the development of the functional requirements for the new vessels, which gave them an understanding of the requirement, the procurement strategy and the project ethos. The functional requirements were kept high level but well structured—to allow industry to propose a wide range of solutions.

Currently a competitive assessment phase is underway with two competing industrial teams, headed by Thomson CSF Naval Combat Systems, and BAe Systems. Once this competitive phase is complete, industry will become full members of the integrated project team. The key is to keep the relationship with industry close, while at the same time preserving competition as far as possible to achieve value for money.

Private finance initiative

A different type of relationship between MOD and contractor is demonstrated by the private finance initiative (PFI). To return to the *Astute* submarine, traditionally the DPA would have bought training equipment and located it at a base; and separately, the RN training authorities would deliver the training. Instead, under PFI, Industry has been invited to supply a comprehensive training service for *Astute*. Investment in hardware and facilities, training design and management, and the supply of the training service for up to 40 years, will be the responsibility of the selected bidder. As the UK has done with aircraft and helicopter training, the requirement has been expressed in terms of training delivered to submarine crews—and it is expected that industry will be innovative in finding solutions. And it does work. Since the contractors don't get paid until qualified students emerge from the facilities, they put up the buildings

double quick, adopt cost effective support and look hard for third party customers. It is so much better than the vulnerable intramural arrangements for delivering training capital facilities. For *Astute*, competitive invitations to negotiate were issued to three consortia in August 1999, and the contract is to be awarded by mid-2000. This procurement of a whole submarine training service may be a first in the submarine world.

PFI is now considered for every new requirement, and only when it has been demonstrated that it is unworkable, inappropriate or uneconomic will consideration be given to using defences' own capital funding resources. Most PFI contracts placed to date have been for simulation and training type activities,



HMS *Richmond* (left) and HMAS *Melbourne*. International collaboration is a potential solution to many of the challenges likely to confront future major projects.

but more recent examples are taking PFI closer to the front line, such as the roll-on roll-off ferries, and, *very excitingly*, the new future strategic tanker aircraft to replace the UK's existing air-to-air refuelling fleet of *Tristars* and VC10s.

Industrial challenges

Competition, which is a central policy in UK procurement, gives rise to a further challenge. Prompted by the need to compete globally, Europe's defence industry is streamlining. Examples of this have been seen over the last year with the merger of British Aerospace and Marconi Electronic Systems into BAE Systems; and the emergence of the new European Aeronautic, Defence & Space (EADS) company formed by Aerospatiale of France, DASA of Germany and CASA of Spain.

The reduction in the number of national defence companies poses particular problems in the naval arena. Nations tend to, or rather *do*, guard their shipbuilding industry zealously. Many still have government owned, or partly owned, dockyards. Although the UK privatised its shipyards in the 80s and its naval dockyards some 10 years later, like most countries the UK prefers to reserve shipbuilding and refitting for UK industry. But if national restructuring has left only one or two major warship builders, how is competition maintained without going overseas? One option is to appoint a prime contractor who is not necessarily the shipbuilder. The *Astute* submarine prime contract was won in competition by GEC-Marconi, who had no previous experience of submarine-building but who subcontracted the actual build. Thomson CSF is leading one of the consortia on the future aircraft carrier assessment phase; so the prime contractor does not necessarily have to be a shipyard owner, even though the shipbuilder activity will be conducted in the UK.

Commercial standards

The use of commercial, rather than naval-specific, standards is another area where it is hoped to drive down the costs of shipbuilding. Last year, MOD and Lloyd's Register, in consultation with UK shipbuilders, produced new rules for the design, construction and maintenance of naval ships. The rules are the same as those for commercial shipping, with additions to cover military-specific aspects such as magazines, flight decks, and specialised damage limitation requirements. This greater use of commercial standards and techniques in naval shipbuilding is expected to result in savings in excess of millions of pounds every year for the UK.

It is estimated that the use of civil standards on the UK's new helicopter landing ship, *HMS Ocean* has resulted in a saving on production costs of up to

40 per cent. That, combined with competition, is why such an excellent ship was acquired for less than £200 million.

The new rules will also strengthen the UK shipbuilding industry. For example, naval dockyards will benefit through having to work to only one set of standards and procedures for both traditional naval customers and any new civilian clients. And DPA staff won't be kept busy answering questions on the interpretation of standards—especially when they are in conflict! Australia has been an active participant in the work.

International collaboration/cooperation

A potential solution to the financial challenges is international collaboration. Whereas the *Anzac* frigate has been delivered with just this in mind, the tri-nation *Horizon* frigate is a prime example of the pitfalls. In April last year, France, Italy and the UK called a halt to this long attempt to collaborate in Europe on naval shipbuilding. Now the UK has a national program for its Type 45 destroyer, while France and Italy are working on a bilateral program.

Horizon primarily failed for three reasons: the lack of proper agreement on the requirement and specification; the lack of full and open communication with industry at an early stage; and the lack of a credible industrial structure. This last point is more important than it sounds. Complex joint ventures potentially leave companies liable for risks which they probably don't understand and certainly won't have the opportunity to manage. Find an unnecessary layer of structures and find how to reduce the price by 10 per cent! These are lessons for the future, and Smart Procurement embodies them. This is not to say, however, that the UK hasn't had some naval successes in collaboration—for example, with France and Italy on the superb weapon system for the Type 45 and with the US on the WR21 gas turbine engine collaboration.

Elimination of major refits

Discussion has so far concentrated on challenges facing procurement. Stepping into the area of defence logistics, briefly, a major new initiative is the elimination of major refits. In the past, navies have been too ready to take navies out of service for long periods in order to carry out refits that reinsure vessels to their 'as built' condition. Indeed, there was no other specification than 'as built' so that's really why it's quoted. And it's also partly because a large number of ships are needed to keep a small number operationally available. In the UK, emphasis will be on undertaking the minimum work consistent with the necessary safety and operational capability of the ship. Consideration is also being given to replacing rigid maintenance schedules, which

equipment running time or set calendar intervals, with a new technique that decides on maintenance on the basis of probability and impact of a range of failures. All this exemplifies the UK's strong commitment to treating projects on a through life basis.

Conclusion

The challenges described are *not* unique to UK. All countries are facing the same problems of falling resources, new technologies and new operational challenges. The UK is not alone in experiencing slippage and cost overruns in its projects but that simply underlines how much there is to learn from each other. Smart Procurement won't solve all the problems at a stroke, but it will help to improve on past performance, and there are always better ways of doing business.

Materiel challenges | 3 for a smaller navy

Commodore Andries Hummel, RNLN

For a small navy with ambitions to operate on an equal footing with the major North Atlantic Treaty Organisation navies, it is quite a challenge to have its materiel up to standard and to include in the design the growth potential and flexibility to keep it there. So far the Royal Netherlands Navy (RNLN) has managed to design, develop and build state of the art materiel within budget and schedule. This chapter explains the RNLN's design philosophy and how this will lead to the delivery of the required materiel.

This chapter will look briefly at the organisation of the RNLN and the way it runs major projects, before looking in detail at the design philosophy it employs on major projects. The focus here is on research and development (R&D) in general and the design and development of combat systems in particular.

As a result of a recent Defence White Paper in The Netherlands the RNLN will be comprised of 12,000 military personnel (including 3,000 marines) and 4,000 civilians. The RNLN's main assets are 14 frigates, four submarines, two afloat support ships, two landing ships, 10 maritime patrol aircraft, 21 helicopters and 12 mine countermeasures vessels. The Chief of Naval Operations is responsible and accountable for the RNLN and has four directorates to support him, these being: naval staff, personnel, finance and materiel. There are three operational elements: the Netherlands Fleet, the Caribbean Fleet and the Marine Corps.

The Materiel Directorate, headed by the Chief of Naval Materiel, has three departments: engineering, projects and procurement. The project department is responsible for all major projects. A small project team comprised of about five people runs each project. The project manager is responsible for the three project elements: product, time and money. For the product element the project manager relies heavily on the engineering department for engineering and product expertise. The engineering department is divided into four sections. R&D, including product developments that are related to a major project, is initiated and managed by the engineering department.

A major ship project is managed in two parts: a single contract for the platform will go to a shipyard, while multiple contracts are awarded for the various components that go to make up the combat system. The selected shipyard

assumes full responsibility for the platform, while the RNLN has responsibility for the design, development and integration of the combat system. The overall responsibility for the total ship, including the integration between platform and combat system is also borne by the RNLN.

This might sound quite challenging. However, the knowledge is available; and is required anyway in order to be able to specify requirements and to have meaningful discussions with industry, or in other words to be a smart buyer. Coupled with the experience the RNLN has in this process, this makes the RNLN happy to bear the responsibilities indicated. In fact it has been found that this has been a reason why the RNLN has been able to retain its top quality people rather than losing them to industry.

In the field of R&D there is the national Netherlands Organisation for Applied Scientific Research defence laboratories for applied research. Funding is partly via a central defence budget and partly via navy budgets for specific R&D programs. For technology and product development the RNLN is using a mechanism through which the Ministries of Defence and Economic Affairs and the industry where the development is taking place, each pay one third of the total development cost. The national defence laboratories are very often participating in those developments as well, both to provide and to gain knowledge. Recent developments undertaken through this arrangement are:

- a medium range 3D volume search radar: SMART-S;
- a medium range infrared scanner: IRSCAN;
- a feasibility study for a phased array radar: EXPAR; and
- a long range 3D volume search radar: SMART-L.

The trend in development programs in The Netherlands is towards international cooperation, primarily to make those developments affordable. In this way national defence and industrial research can be complemented with international activities. Furthermore, the upfront and production costs are reduced and maximum interoperability with international partners is maintained.

A very good example in this regard is the RNLN's new air defence and command frigate (ADCF), where international cooperation is found in several areas, ranging from the APAR multi-function radar partnership with Canada and Germany, to the development of the *Evolved Sea Sparrow Missile* where Australia among others is partnered. For missile systems there is a very close cooperation occurring with the United States (US), the missiles used by the RNLN being identical to those used by the US. The type of cooperation chosen is based on flexibility, with cooperation occurring in those areas where it is beneficial for

all parties. Another area of cooperative research currently being undertaken with Germany and the US is a concept validation program to bring a ballistic missile defence capability onboard. A recent feasibility study has already shown that the anti-air warfare system of the ADCF has the inherent capability for theatre ballistic missile defence.

Turning to the issue of combat system design: all designs required by the RNLN are undertaken in house by its Naval Software Centre in conjunction with the other sections of the engineering department of the materiel directorate. This software centre developed the current combat management system software in use in the RNLN. Over the past 30 years the complexity of combat systems designed by the RNLN has increased by roughly a factor of four each decade. As an aside, the complexity is measured via the function point analysis method. The ADCF is the project currently under development and it is showing the same increase in complexity.

This increase in complexity is only one of the challenges that has to be met. Specification of the combat management system is also a real challenge. This includes the description of the various operational procedures and processes, including the human machine interface. In short this is a description of the in-depth knowledge required to effectively and efficiently manage a combat information centre (CIC) onboard a frigate under diverse conditions and to enable optimal decision making with the smallest feasible crew.

In the commercial world the speed of development for computers, memory, displays and supporting software is enormous. In the military world it is important not to be left behind. A challenge is how to benefit from the rapid commercial-of-the-shelf (COTS) developments and still maintain military requirements. The challenge is how to provide state of the art equipment whilst not interfering with the production planning of the ship and combat management system. The in-service support of tailor made software for combat systems is, as a side effect of the ongoing developments in the COTS world, also something of great concern. In fact, the moment the software is put to service it is already legacy software. Again a challenge is how to avoid the legacy-related problems.

Last but certainly not least is how to maintain maximum flexibility and growth potential to keep up with the evolving threat, which is one of the driving factors in design complexity. Basically system design is the process of analysing the required system capabilities and distributing them over the different entities in the system: hardware, software and manual operations. The component hardware can in itself be a complex system and include its own software. For

example it could be a multi-function radar, or even a complete anti-air warfare system. It is important to know which functionality is covered by which subsystem. This is either a given when the subsystem is bought off-the-shelf, or can be chosen if it is a development managed by the navy. Whether the required functionality will be covered by hardware, software or a human being is a design decision depending on many complex factors such as the required reaction time, allowable operator load, available operator skill, required redundancy, etc.

A software module can be seen as containing three types of components. Two are interface components: the user cooperation component (UCC) and the hardware or subsystem cooperation component (SCC). The UCC is the software that transforms the combat system outputs into relevant information for the operators (via the screen, or sound) and transfers operator inputs into commands for the combat system (buttons, pointing devices, voice commands). The SCC is the software that transfers combat system in- and outputs to and from a specific subsystem (a sensor or a weapon system). The third type is the component that purely performs the required functionality, for example the calculation of the expected time of arrival, or the sonar detection range. This compositional design component (CDC) is therefore independent from both the organisation of the CIC and the chosen subsystem.

Traditional software development follows the so-called waterfall model that consists of a number of subsequent development phases. In phase one, the analysis phase, the required functionality is laid down in detail: the so-called requirements capture. For this step either the specification has to provide enough detail without ambiguities, or operational experts have to clarify their needs. The next phase is design in which the software system is designed in detail using the outputs of the analysis phase. The last phase is the programming, where the results of the detailed design will be translated into a programming language that will then be converted to computer code. The necessary total effort required is a function of the complexity of the software system combined with the sum of the analysis, design, and programming phases.

An increase in complexity not only leads to an increase in the required effort, but also to an increase in the number of defects, errors or so-called bugs. An increase in complexity should therefore be coupled to an increase in the quality of the software development process in order to decrease the defect density. The effort necessary to correct those defects becomes quite dramatic the later a defect is discovered in the development process. Indeed, there is a logarithmic relationship between time and cost of repair.

The simple conclusion is to reduce or remove the design and programming phases and to use the analysis process in a formal way to capture the requirements and then write the software. In the RNLN the requirements capture is done at its software centre. Several small teams of two to four people, consisting of experienced CIC officers together with information specialists, work in parallel to perform this task. They use a computer assisted software engineering tool to lay down the numerous requirements in a formal way in a model. Such a model can be simulated in real time to check whether what is laid down is what is really meant.

The models are then directly translated into software code by a model compiler. This means that for the application components of the combat management system of the new ADCF nobody is writing software. This has resulted in a significant reduction in effort for the development of the combat system for the ACDF as compared to the effort required for development of the combat system for the M-Frigate which used more traditional development methods.

The model compilers are made by the top programmers and are used many, many times, so they mature quickly. In this way not only the efficiency is improved, but also the quality of the software. The 'back end' of the model compiler is adapted for the selected computer and operating system. This means that a change of computers somewhere during the lifecycle only implies a change in the 'back end' of the compiler. The same functional models are then translated in software code for the new hardware. In-service support of the software does not take place at software level, but via the functional models. As the software itself is not an issue anymore, legacy software is avoided.

The software modules are built in accordance with an architecture that supports an incremental development of the system. It allows partial filling with modules and therefore supports partial functionality of the system. This means that from the first development cycle onwards there is a combat management system available that can be used, although of course with only limited functionality. This can be compared with building a wall: at the end of the process the wall will be at the required height. During the building process, whereby layer after layer is added, there is already a wall present at any time.

The functional models, and therefore the software modules, can be reused in other programs and projects. They are application independent and can be used wherever the same software architecture concept is used. UCC's and SCC's can be adapted to fit the specific requirements and choices. In this way a library for future use is evolving.

The architecture concept used by the RNLN has an incredible flexibility and an inherent growth potential. More or faster computers can easily be added. Where in the past the software was the delaying factor in a modification, in this concept it is the hardware that will form the bottleneck.

COTS is used for the computers, the memory and for the displays not only for development and operational training, but also onboard the ADCF itself. The use of COTS onboard is made possible by installing this equipment in what could be called 'incubator cabinets', the so-called PROTEC cabinets. Outside they withstand the hostile military environment including the requirements for shock, vibration, temperature and humidity, while inside the far more benign standards for civil equipment are maintained. By using COTS equipment in PROTEC cabinets the full advantages of COTS can be exploited. The equipment for the ship will only be chosen at the very last moment; easy installation onboard the ship in the already installed PROTEC cabinets makes this possible. Exchanging the COTS content later on is possible in the same easy way.

The design philosophy used by the RNLN results in naval materiel that is state of the art. Through navy to navy contacts and by importing relevant information and systems into the overall system design, interoperability with the major navies is assured. Changes can easily be implemented. Changes will always take place during the lifetime of a ship and can be caused by a requirement for improved functionality, a change in views on CIC management, and/or because additional functionality needs to be added (such as, for example, cooperative engagement capability or ballistic missile defence). Apart from all that, this design philosophy also leads to affordable materiel.

The RNLN's design philosophy based on a modular and flexible system design with an inherent growth potential and using functional models instead of software code provides an excellent concept for international cooperation.

Part | 2

An all round look:
the problems faced by
medium and small navies

Smaller navies: an endangered species?

4

Captain Gary Collier, MBE, RNZN

This chapter considers the future of maritime warfare from the perspective of a smaller navy. Such a navy could be defined as having about 5,000 people or less, operates frigates or smaller vessels including submarines, and has reasonably modern technology but not necessarily at the cutting edge. Such a definition would include the navies of Belgium, Brunei, Ireland, Norway, New Zealand and Singapore amongst others. Where appropriate New Zealand and the Royal New Zealand Navy (RNZN) will be used as examples in looking at the issues being faced.

Smaller navies may not however, have the resources, or have chosen not to allocate the resources necessary, to maintain a bluewater Navy with the capacity to establish sea control on the open ocean. Conversely some smaller navies may have no need to maintain a bluewater capability given their geographic location or operating environment. It therefore makes sense for smaller navies to operate with others to achieve a common objective in coalition type operations, a trend which is likely to continue.

But for any navy, let alone the smaller ones, participation in coalitions is not a free ride and the costs of taking part are rising. Also, as the cost of modern equipment increases in a climate of reducing defence budgets, have we already commenced the voyage that takes us to the day when 'smaller navies are an endangered species!' The RNZN feel that this may already be occurring.

New Zealand/Singapore comparison

In New Zealand some people suggest that the RNZN should be, or could be, like the Republic of Singapore Navy. Singapore is a good example of a smaller navy that has no need for a bluewater capability because of the benign sea states in its operating areas, at least compared with New Zealand. Singapore is also a fine example of the fact that a smaller navy is not necessarily a weak navy. It is balanced and well equipped, with modern systems, new ships and an active procurement program to provide capabilities that are well suited for and tailored to the geographic and political environment in which it operates.

So how does New Zealand compare? It is an isolated island nation with a coastline of about 3,000 nautical miles and an expansive exclusive economic zone (EEZ) measuring some 1.2 million square miles. Its EEZ, the 5th largest in

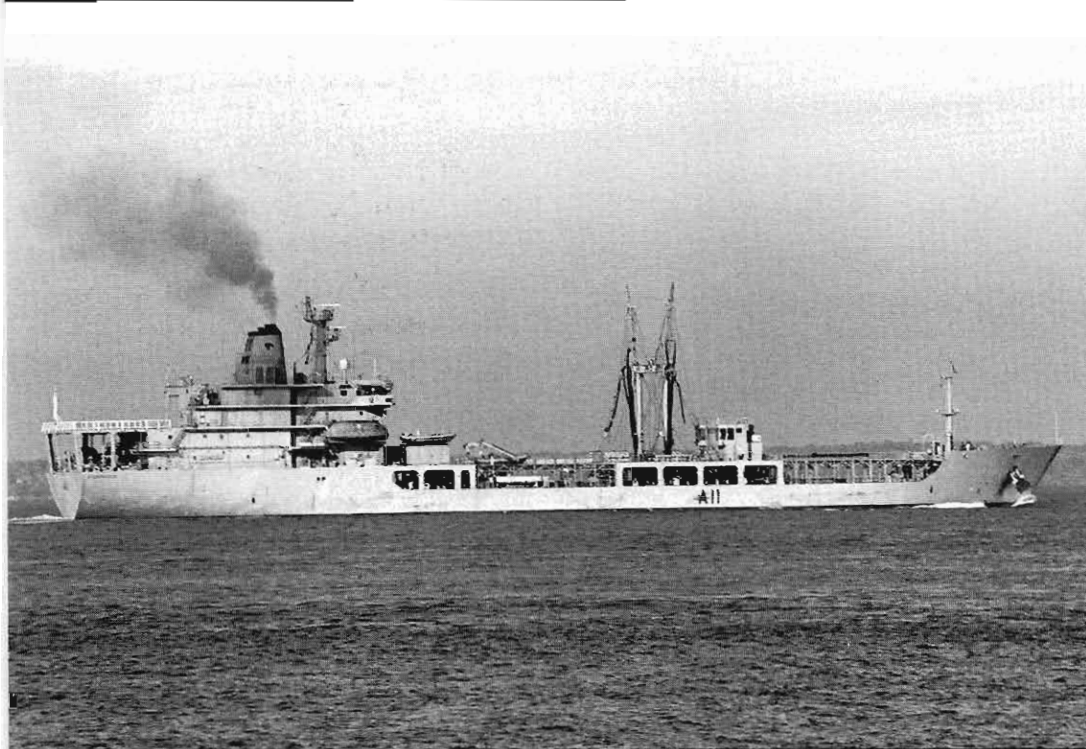
the world, is mostly in deep water. Its maritime environment is as diverse as it is large. It extends from the balmy tropics of the Pacific, where tropical cyclones can quickly and frequently ruin this rather idyllic postcard picture, to the freezing gale tossed Southern Oceans where conditions are as harsh as anywhere in the world. Distances are great. New Zealand's nearest neighbors include Australia 1,200 nautical miles to the west, Fiji is 1,100 miles to the north while Chile is 6,500 miles to the east. So the maritime environment around the two nations is not comparable. New Zealand has a vast sea area, fewer neighbours and no overlapping or contested claims in its EEZ and, should things go wrong, the physical distance involved means there is at least a greater warning time than is available to most nations. Finally, New Zealand is similar in size to the United Kingdom and Japan but with a population of only 3.8 million. It is therefore apparent that a lack of human resources will not allow it to establish a navy of a quantity sufficient to be considered a naval power. So, like other smaller navies, it is imperative that New Zealand promote and participate fully in coalitions and similar arrangements such as the Five Power Defence Arrangements.

Challenges confronting the smaller navy

The smaller blue water navy is threatened by such interrelated issues as multi-national peacekeeping activities, by technology advancement, budgetary constraints and the necessity for interoperability. But the individual geographic, social and political environments of each country will also affect the future of smaller navies. What are some of the specific issues within these headings?

Peacekeeping

The so-called 'outbreak of peace' does not necessarily mean that New Zealand lives in a peaceful or stable environment. Recent and ongoing events in the region are proof enough of this. Consequently defence forces have now adopted more of a peacekeeping focus in their operational activities and this is certainly the case in New Zealand. But defence forces must always equip and train as they mean to fight, since the lead-time to acquire new capability is long. And, as has been discovered in Cambodia, Bosnia, Bougainville and now East Timor, forces deployed on peacekeeping operations should have first class equipment. HMNZS Canterbury had her 28th birthday while operating off East Timor—she had no breakdowns, but the engineers put in long hours to achieve that. However, her current capability is such that she would not be able to operate in a more challenging environment and this is the consequence of operating ships or equipment beyond their use by date. It is through the process of training as it is intended to fight; that defence forces develop the core skill



The New Zealand replenishment tanker HMNZS *Endeavour*. Replenishment at sea is vital for any maritime force particularly in light of the vast maritime jurisdictions that can be claimed under the 1982 United Nations Law of the Sea Convention.

sets essential to successfully undertake peacekeeping tasks and other United Nations missions. Again East Timor underlined that to New Zealand policy makers, without the existing balanced force, New Zealand could not have contributed as much as it did to the INTERFET (International Force in East Timor) operation. The bottom line is that you cannot keep or enforce peace without a well equipped, well trained, disciplined and combat capable armed force.

Technology

Re-equipping and upgrading programs demand the use of ever-better technology. Modern navies are dominated by technology to the point where virtually all elements are either governed by or linked to it. While the effects of technology

are widespread, each nation must approach the question of how best to use technological advances. This in turn impacts on doctrine because technological change can alter the way in which a navy uses force and can effect its force structure. As an example, take the case of the United States Navy (USN) proposed 'Street Fighter' or 'Guerrilla Warfare' ship for littoral warfare and battlespace management. The concept calls for stealthy vessels ranging from 400 to 2,000-tonnes. Capable of 60 knots, fitted with a flight deck for helicopter or unmanned aerial vehicles, equipped with an advanced gun and point defence missile system. The larger variant will be fitted with a 48-cell vertical launching system for standard and land attack missiles. It has been suggested in defence articles, that these vessels will bolster fleet numbers at an affordable level. Note the term 'affordable'. Perhaps this was the answer to a small navy's prayer! While no doubt a great idea for littoral warfare, is the technology truly affordable? For the USN perhaps, but then their definition of 'affordable' is different to that used by most other navies!

In the New Zealand context, the level of resources necessary to maintain the same degree of technological edge would be inconsistent with fiscal reality. The New Zealand Defence Force does, therefore, seek to procure or retain weapons, sensor systems and platforms that involve proven, rather than leading edge technologies. By virtue of the need for proven systems, it could be said that new equipment is dated on introduction. The point is that smaller navies cannot afford the risks inherent with unproven technology. Indeed to pursue such a path would effectively place a force on the bleeding, not leading edge of technology!

Budgetary Constraints

The next significant factor in the sustainability of any navy is financial resources. As a result of the changed security environment, many Western democracies, including New Zealand, have reduced defence spending given popular demands for more funding for education, health and social welfare—the so-called peace dividend. By way of example the official post-election brief for the recently elected New Zealand Government shows a clear downward trend in actual levels of New Zealand's defence expenditure since 1991. The annual defence budget has dropped in current dollar terms from NZ\$1.7 billion to NZ\$1.4 billion today. As a percentage of gross domestic product, it has fallen from 1.6 per cent to 1.1 per cent over the same period.

While the political priorities can be appreciated, for a maritime nation there must be a balance. The impact on New Zealand's 'smaller navy' is obviously the difficulty experienced in achieving and maintaining a sound technological

level within such tight fiscal constraints. As observed by the Chief of Staff of the Royal Norwegian Navy¹ at the *SMi Conference on Littoral Warfare* in London last year '...the development of advanced high-tech weapon systems and their increasing life cycle costs could drastically reduce the number of units affordable for any nation. It is a paradox that weapons systems are becoming steadily more expensive while technology is becoming cheaper.' And that is certainly New Zealand's experience.

Interoperability

But the need to at least keep pace with technology and the requirement for multi-national operations leads to the next interrelated challenge confronting the smaller navy, that of interoperability. Navies now operate in an era where units of diverse countries are expected to pull their weight, to be able to effectively operate with all participants and be able to defend themselves. But, as already mentioned, the technology needed for interoperability is not cheap. If services cannot inter-operate then the day will come, and perhaps it's already here, when smaller navies will not be invited to participate especially if their units would be a burden to the force.

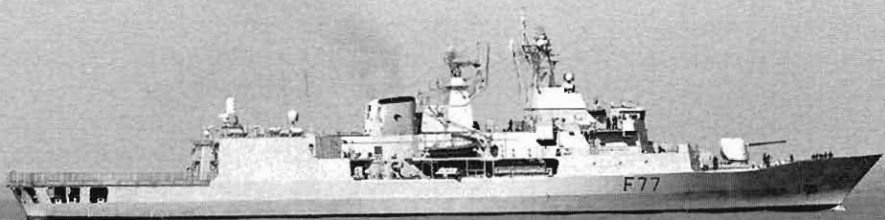
So where will that leave the smaller navy? It seems that if smaller navies are unable to operate with others they are destined to become a coast guard-type force. While this may suit the purely national defence requirements, smaller navies would be unable to promote regional stability through regional engagement let alone participate in United Nations missions further afield. It might appear that this situation is well known. Admiral Jay L. Johnson, USN, Chief of Naval Operations, is reported as saying that to field forces in a coalition the USN recognises areas for improvement. They include the requirement to create a common technical standard, which permits USN forces to work together and communicate across affordable secure coalition networks at sea. Secondly, despite fiscal constraints limiting all nations navies, the USN has a commitment to frequently train together in the operational environment to achieve a common level of knowledge and experience.² This clearly recognises the importance the USN places on having smaller navies participate in regional coalition operations and the USN's efforts to ensure that coalition operations will continue to embrace smaller navies.

The New Zealand Situation

But what has been the experience of smaller navies? In New Zealand's case, the navy has diminished in size. During World War II New Zealand manned and operated cruisers, corvettes and minesweepers—all together over 60

commissioned combatants. Today New Zealand has two new *Anzac* class frigates and one ageing *Leander*. Meanwhile a naval combat force study currently underway³ is attempting to identify the way ahead in a time of political change and inherent uncertainty for Defence, in an environment of reducing budgets and overwhelming public ambivalence to defence matters. The aim of the current review is to identify the preferred option for the size and shape of New Zealand's future naval combat force, taking into account the need to replace *Canterbury* by 2005. The review process also considers New Zealand's maritime environment and responsibilities—which under the United Nations Law of the Sea Convention are growing—as well as assessing the impact of the maritime factor in defence commitments.

For example, New Zealand's maritime environment is, as referred to earlier, totally different from that in the South China Sea. Hence the very capable force structure of Singapore's Navy would not be suitable as the basis for a future RNZN naval combat force. Singapore does not have a vast EEZ to monitor and its environment demands skills and equipment optimised for littoral operations. New Zealand on the other hand is surrounded by vast expanses of open ocean. This has a direct bearing on the type and size of ship that can be



New Zealand's *Anzac* class frigate HMNZS *Te Kaha*. Smaller navies face many difficulties, not the least of which is achieving and maintaining a sound technological level within tight fiscal constraints.

safely and effectively operated in New Zealand's area of interest. Many small ships will not work for New Zealand given the operating environment and the prevailing weather conditions in the EEZ and the distances that have to be covered in the region.

The pressures that are brought to bear by shrinking defence budgets given other spending priorities have already been highlighted. New Zealand will also, like other countries in the region, have an ongoing requirement to undertake peace support operations such as East Timor and Bougainville. In New Zealand, like many nations, the public perception is that Peacekeeping is solely the preserve of the army. It is easy for television to show troops patrolling, repairing damaged buildings and helping rebuild the infrastructure. Equally it is all too easy for the public to forget the operational ship over the horizon on picket duty or escorting the ships in the supply chain to support the ground force. Air elements too are essential in supporting those on the ground that must of course continue to be fully supported by air and sea until safely withdrawn. In short, peace support operations, like warfighting, is a joint and invariably a combined activity with clearly a role for maritime forces including those of smaller navies.

Options

So what options might be open to smaller navies should the cost of maintaining their combat capability exceed the funding available i.e. the non-combat options? If budgets continue to reduce or defence forces are forced to salami slice capability perhaps the smaller navies of the future will need to focus on lesser but specialist capabilities such as mine countermeasures, hydrography or logistic support or optimise for local and EEZ operations only. It may be that these 'niche' capabilities are affordable to the extent that they exceed the national requirements and could, therefore, be made available to fill the gaps in the force structure of other partners. There is of course a catch or two, not the least of which is the sovereignty issue and the difficulty for a smaller 'provider' to change the capability to suit the larger partner.

On the other hand, if present levels of combat capabilities are to be retained then other options may need to include:

- affordable new technology;
- lesser capable ships that can be upgraded as the need arises;
- cost-effective alternatives such as arming ship-borne helicopters with missiles rather than the more expensive ship launched weapons, albeit resulting in a reduced offensive capability;
- treaty arrangements with allies to minimise costs of infrastructure, training and even the sharing of personnel;

- combine forces such as the Belgium/Netherlands example and in New Zealand's case, it has already been suggested in New Zealand that the New Zealand Defence Force be subsumed within the Australian Defence Force; and finally,
- establish a permanent regional navy.

Conclusion

It is clear that peace support activities and coalition operations will increase and maritime forces will continue to play a central role in both. President Wahid of Indonesia has predicted that 'the 21st Century would be a naval century, an era in which naval and maritime power became an even more critical element of National Power and prestige'. Similarly, this from the USN Chief of Naval Operations, '...coalition warfare and its inherent requirements for interoperability across the technical, operational and political spectra will characterise naval warfare in this millennium'. He goes on to say '...regional expertise and unique capabilities partners bring to a coalition will help ensure success'.⁴

As we then enter a naval 21st century, the cost of maintaining a combat viable capability continues to increase. Thus, the risk to the smaller navy is that they may not be able to afford to keep pace with the technology required to operate with others. This could lead to the situation where smaller navies could neither contribute to regional stability nor undertake peace support operations. Based on this scenario, perhaps the 'international' role of the smaller navy is at risk. However, on the positive side, it can be seen from statements such as those made by the USN Chief of Naval Operations, smaller navies indeed play an essential role in, and are a welcome contributor to, coalition operations. In addition, access to affordable technology is recognised by the USN as is the need for frequent exposure to training opportunities. If this laudable aim is achieved, then the smaller navy does not need to reduce capability or revert to a coast guard role. In which case the smaller navy is here to stay and, providing it is appropriately funded, will continue to provide its government with a range of options with which to mind its maritime business.

Notes

- 1 Rear Admiral Hans Kristian Svensholt, Royal Norwegian Navy, *Naval Forces*, 2/99, p. 12.
- 2 *Janes Navy International*, vol. 105, no. 1, January/February 2000, p. 32.
- 3 This naval combat force study has since been put on hold pending a Defence Assessment to be undertaken during the second half of 2000.
- 4 *Janes Navy International*, vol. 105, no. 1, January/February 2000, p. 32.

Fighting the maritime war in the 21st century: War? What War?

5

Joon Num Mak

The majority of Southeast Asian countries face four categories of threats or pressures:

- lateral resource pressures;
- external threats;
- low level non-traditional threats (piracy, drugs, illegal migration); and
- domestic threats.

Much of the literature on Southeast Asian security in general, and maritime security in particular, have focused on the first three categories. Very often, lateral resource pressures, external maritime threats, and non-traditional threats have been conflated. This is because maritime security for Association of South East Asian Nations (ASEAN) navies have primarily been about asserting sovereignty and securing maritime resources, very often in disputed maritime zones.¹ In this respect, the Spratlys disputes have often been cited as one, if not the most important, of the reasons why navies in the region embarked on their modernisation/expansion programs over the last decade. Inevitably, China, and Chinese naval capability, is brought into the picture. China is regarded as not only the most powerful, but also the most recalcitrant, of the Spratlys disputants.² This chapter argues, however, that the majority of the Southeast Asian nations, with two possible exceptions, are not planning seriously to fight any conventional war, including maritime war.

Indeed, if we look at the history of ASEAN, and ASEAN experience, we see that ASEAN relied on diplomatic and institutional instruments to manage the external security environment. The recourse to arms was, and still is, considered a final and desperate option. War is recognised as expensive and detrimental to economic development considered essential for regime stability and perpetuation by most of the Southeast Asian states. In terms of defence, the ASEAN core of Southeast Asia (with the exception of Singapore) has always been inward looking. Consequently, the region on the whole has not developed any significant external defence capability. Instead, Southeast Asia has relied on the presence of the United States (US) to provide a stable regional balance. This situation is likely to remain unchanged. The region's primary contribution to regional security is its institutions-based approach. Southeast Asia has

used various domestic and regional institutions (the best examples of the latter being ASEAN, and the ASEAN Regional Forum (ARF)) to manage domestic, intra-regional and extra-regional security. This deliberate, non-military approach to external security was because it allowed Southeast Asia to devote scarce resources to economic development.

All Southeast Asian naval forces are small and medium-sized navies in terms of both assets versus responsibilities, and in absolute numbers. Small and medium-sized navies are generally those forces incapable of projecting power worldwide. More specifically, small navies are those fleets that are incapable of projecting decisive force into open seas and which 'do not possess the operational nuclear submarines, aircraft carriers or cruisers, or large amphibious vessels necessary for worldwide operations'.³

The greatest challenge facing Southeast Asian navies generally are domestic political pressures and priorities. As mentioned before, most Southeast Asian states place a rather low premium on external defence in general, including naval warfighting. Effectively, this means that navies are regarded as constabulary forces more than anything else, and they are forced to either plan to fight a maritime war with limited and or unsuitable assets, or without national strategic and doctrinal guidelines. The singular exception is that of Singapore. This study therefore focuses on two proximate navies, the Republic of Singapore Navy (RSN) and the Royal Malaysian Navy (RMN) to illustrate on the one hand, the general approach to maritime warfighting in Southeast Asia, and the uniquely logical maritime strategy of Singapore, on the other.

This chapter also locates the development of the two navies within the framework of national security priorities and threat perceptions. Southeast Asian naval force development can only be properly understood within the overall context of each country's security strategy, since domestic political and security priorities often override external threat considerations in the region. ASEAN's approach to security, in particular, is thus fundamental to understanding Southeast Asian maritime defence. Instead of looking to external threats to explain ASEAN's defence modernisation, this chapter argues that Southeast Asia has, on the contrary, remained inwardly or domestically focused even after the Cold War. Most ASEAN states interpret defence in the wider sense of the term to include non-military threats to stability, with domestic security being paramount in most cases.

The force development approaches taken by the RSN and RMN provide not only interesting contrasts, but illustrate how different geostrategic situations, threat perceptions and differing national and domestic priorities impact on military force structures. This comparative study also helps to explain why it is necessary

to look within the 'black box' of the state to fully understand how domestic security priorities and political objectives affect external defence policy, strategy and force development in Southeast Asia. Singapore and Malaysia are not only geographically close, but as former British colonies, both their navies also share common historical and doctrinal roots. It is interesting therefore that while the armed forces of both countries include deterrence and forward defence as key missions in their defence strategies, the achievements and orientations of their navies markedly differ.

Singapore, with its survivalist mentality engendered by unique geostrategic and historical circumstances, sees itself as strategically vulnerable. It therefore equates external defence with national survival. Malaysia, on the other hand, is more sanguine and relaxed about its external security environment. Officially, defence planning is based on a 'no-threat' scenario for the short, and even medium, term. Geography, too, played a major role in the different evolutionary paths of the Malaysian and Singapore navies. Malaysia's large exclusive economic zone (EEZ) area dictated to a large measure, the size and constabulary orientation of the RMN. In contrast, Singapore's position as a small island state meant that any defence strategy, to be realistic, had to be based on forward defence. In addition, the corporatist-bureaucratic structure of Singapore has helped to ensure a degree of regime legitimacy and stability, thus allowing the Republic to be more outwardly focused with regard to defence.⁴ Malaysia, on the other hand, is still greatly concerned about regime legitimation, regime perpetuation and domestic order. Security therefore still remains largely internalised, with domestic security being given priority over external defence.

The end result of all these domestic forces is that the RSN has developed in an orderly manner into a navy with significant combat capability. The circumstances affecting the RMN's development, however, has tilted it towards the constabulary role, and its combat capability still remains questionable. The chapter concludes by reiterating the need to understand overall national security priorities and domestic considerations in any analysis of Southeast Asian naval forces.

The ASEAN security paradigm

Despite initial fears of a US drawdown and the rise of a new regional hegemon in the form of China, the majority of Southeast Asian states (with the exception of Singapore) never addressed the external dimension of defence seriously. This was because Southeast Asians perceived quite shortly after the end of the Cold War, that US strategic, political and economic interests, plus the vested interests of the US Navy itself, still made the Asia-Pacific an area of vital interest for the US.⁵ Second, China until today has not developed significant



The People's Republic of China *Luhu* class destroyer *Qingdao*. China is developing a significant blue water capability.

blue water power projection capability. Moreover, countries like Malaysia are convinced that China is becoming an increasingly responsible international player. Overall, the outlook for Southeast Asia can be said to be generally positive.⁶

Third, and most important, domestic threats to Southeast Asian regimes are still considered to be a greater, and more real, danger than the somewhat remote possibility of external aggression. This is because as post-colonial states (Thailand excepted), Southeast Asian states have been preoccupied with state-building, internal consolidation and regime survival. In this sense, the majority of ASEAN members are still 'weak' states.⁷ Economic development, freedom

from external interference in their domestic affairs, and the preservation of domestic stability are regarded as equally, if not more, important for national survival than military power. Building on Mohammed Ayoob's concept of Third World security, it can be argued that political survival constitutes the heart of the ASEAN security paradigm. Threats can be economic, environmental or even military in origin. Whatever their origins, threats enter into a state's security calculations only *if* they take on a political dimension and threaten state boundaries, state institutions or the survival of the regime.⁸ Seen in this light, there are no significant external military threats to state and regime survival which would drive any ASEAN member to focus on building up a real external defence capability. Instead, threats and challenges to ASEAN regimes tend to be domestic and today, increasingly non-military. As such, it remains unsurprising that armies are still the senior service in nearly all the ASEAN armed forces. Apart from their unquestionably major role in quelling various insurgencies between the 1960s and 1970s, armies are also the primary instrument of legal violence used for regime maintenance in Southeast Asia. Hence, their position as the senior service (and all that implies in terms of resource allocation) will most likely remain unchanged.

Comprehensive security & national resilience

While a common ASEAN external defence doctrine remains a myth, the old ASEAN members do share elements of a common security doctrine based on the concept of 'non-interference' and 'comprehensive security'. The latter concept emphasises the importance of internal stability and economic growth as the first line of defence for a nation, i.e. it stresses the non-military components of security. ASEAN developed the concept of national and regional resilience to deal specifically with the problem of maintaining domestic, and moving outward, regional stability. 'National resilience' entered the ASEAN lexicon by way of the Indonesian concept of *ketahanan*, which is to be distinguished from *pertahanan*. *Pertahanan* means defence, whereas *ketahanan* connotes the ability to 'withstand' or 'endure', i.e. resilience. 'National resilience' therefore involved strengthening the people and nation, so that the latter could withstand all manner of domestic and international pressures. *Ketahanan* was therefore *not* about armed might, but involved a comprehensive socio-economic approach to enhance internal security through development.⁹ Domestic stability would eventually result in regional resilience, or what Michael Leifer has described as 'addressing security through a presumed synergy between national and regional resilience'.¹⁰ Thus *dirigisme* economic growth became a key goal of the ASEAN members. For instance, Indonesian Foreign Minister Ali Alatas credited Asia-Pacific peace and security to 'the tremendous economic activity in the region'.¹¹

Southeast Asian external security fundamentally essentially hinges on the Northeast Asian security environment, and is premised on a continued US presence. This is because Northeast Asia is the locus of military power in the Asia-Pacific, while Southeast Asia is a military lightweight. Because of the relative stability of the Asia-Pacific power balance during and after the Cold War, Southeast Asia found it unnecessary to expend scarce resources on external defence. As Malaysian Defence Minister Syed Hamid bin Syed Jaafar Albar put it, '...we could not think about external defence before looking at our internal situation'.¹² Economics before defence, and domestic before external stability, sums up the general regional approach to security.¹³ The result, overall, is that the region has tended to rely on the security umbrella which the US continues to provide. As a consequence, Southeast Asia remains highly permeable to the defence dynamics of Northeast Asia.

ASEAN defence modernisation

Despite the high profile defence modernisation of the 1980s and 1990s, Southeast Asia did not really address the issue of external defence seriously because of the relatively benign external security environment. It has been argued that the defence acquisitions of the ASEAN members in the late 1980s and early 1990s were driven by the end of the Cold War; a generally more stable and benign internal security situation with the end of domestic insurgencies in Thailand, Malaysia, and the Philippines; and the region's own rapid economic growth of the last decade, which provided the funds for the arms acquisitions. Finally, it was often seen as a hedge against a resurgent and powerful China.¹⁴ With hindsight, however, the response of the individual ASEAN countries to strategic uncertainty was paradoxically too much, and at the same time, too little. It was too much with regard to intra-regional challenges, because the ASEAN conflict management process, the 'ASEAN way', was still effective in managing intra-ASEAN tensions.¹⁵ As a response to external threats, it was too little because no ASEAN member then, or now, could afford to arms race with China.

Various commentators have argued that the South China Sea maritime disputes are one primary cause of Southeast Asia's renewed maritime consciousness in the post-Cold War world.¹⁶ However, it is important to bear in mind the fact that while the Spratlys dispute is of vital importance to China from the standpoint of national prestige, strategy and as a potential food and economic resource, it is not regime-threatening for any ASEAN member.¹⁷ One suspects that in the final analysis, the Spratlys provided perhaps one of the best reasons or excuses for the ASEAN navies to justify their requests for a larger share of defence budgets. On the whole, ASEAN defence modernisation, with the

outstanding exception of Singapore, had little to do with the development of a real external defence capability.¹⁸ This is reflected in the fact that most of the ASEAN members have *not* developed strategic doctrines to underpin the development and employment of their armed forces in conventional defence.¹⁹ Neither did most of them purchase equipment that is optimal for the Southeast Asian defence environment.²⁰ In fact, the defence acquisitions of the ASEAN members over the past decade and a half had been somewhat haphazard, with platforms bought in penny packets, or 'demonstrator lots', with little attention paid to the 'changes in military culture that are required to handle different concepts of warfare'.²¹

Thus, it can be argued that regional elites had concluded early on that they could not realistically afford a purely military approach to managing the external security environment.²² Thus, the ASEAN members individually and collectively, continued their attempts to manage potential conflicts—especially with China—through diplomacy and by enlarging the ASEAN institutional approach by establishing the ASEAN Regional Forum (ARF) in 1994.²³ Overall, the conventional defence forces of the ASEAN members had very limited roles to play in maintaining regional stability. Naval forces, for instance, are considered useful for handling low-level contingencies and constabulary tasks, such as maritime enforcement, control of illegal migration, and to show 'presence' in disputed maritime zones. In this sense, the ASEAN members did increase their expenditure on conventional armaments in the last 15 years up to the start of the 1997 financial crisis.

Regime security

However, the primary role of most Southeast Asian armed forces is the maintenance of internal security. The expansion of the Indonesian armed forces in the absence of any clear external threats, for example, was attributed to the fear of the Suharto regime that the population increases and social changes that go along with economic development would 'create a crisis of expectations which will threaten the regime and the integrity of the country'.²⁴ Defence modernisation therefore had more to do with domestic security, patrimony and regime survival than acquiring any significant capacity to deal with external threats. Malaysia's Mahathir Mohamad had made it clear in 1984, three years after he became Prime Minister, that: 'Malaysia's first line of defence is not its military capability. The first line of defence lies in its national resilience...'²⁵

Similarly, despite the dispute with China over Mischief Reef in 1995, the Armed Forces of the Philippines have not been able to persuade Congress to support a long-term modernisation program. Many Filipino Congressmen, even today, feel that the Philippines does not face any serious external threat.²⁶

When the ASEAN members were hit by the economic downturn of late 1997, military programs were virtually the first national projects to be sacrificed by Malaysia, Indonesia and Thailand.²⁷ This is illustrative of the fact that hi-tech hardware is still not considered to be essential in the 'defence' of these countries. Nevertheless, there is a limit to how deep defence cuts can go, since it can affect the loyalty of the political-military elite.²⁸ Singapore is the sole ASEAN exception in that it takes external security threats seriously. Hence, it is the only country with a clear defence doctrine backed up with a logical arms acquisitions policy. Significantly, Singapore made it clear that its defence acquisitions program would not be trimmed despite the regional economic crisis.

Given this context, the acquisition of military technology, industrial know-how, offsets and even weapons systems were seen as important inputs for a country's industrialisation program and its economic progress. For some neo-patrimonial regimes, weapons acquisitions were also a significant source of additional funds to sustain the patronage network.²⁹ Hence, in the absence of clear external threats, weapon systems were chosen not for their potential contribution to defence, but for the funds they could inject into the patronage network of the ruler. Equally important, defence modernisation also maintained the prestige of the military in the region, thus keeping them satisfied. Since the military played key roles in regime maintenance in Southeast Asia, this was a crucial factor behind the defence modernisation. The financial and economic crisis of 1997 is bound to reinforce the defence introspection of the ASEAN members in the medium term.³⁰ This is because armed forces development in many of these countries is directly dependent on economic growth.³¹

This exposition of ASEAN security is important because it helps to explain why the members of the grouping, in overall terms, have not paid serious attention to building up the warfighting capability of its navies, and why some acquisitions appear quite inexplicable. Thus, while there has always existed this tension between the warfighting and constabulary roles within ASEAN navies, the overall strategic situation has always made the constabulary role for Southeast Asian navies more immediately relevant. With the sole exception of the RSN, policing, presence and safeguarding the offshore estate are the primary missions of the majority of the ASEAN navies.

The Republic of Singapore Navy (RSN)

Forward defence

Singapore's doctrine and strategy have been shaped by three primary considerations. The first is the island Republic's lack of size, strategic depth, and its limited natural and human resources. The second was its enforced and acrimonious exit from the Federation of Malaysia in 1965 after just two years of a stormy 'marriage'. The third is the near-total identification of the ruling PAP with Singapore's own survival. In 1965, Singapore found itself to be the smallest nation in Southeast Asia, with a total land area of a little more than 600 square kilometres. It has no EEZ, and no hinterland to speak of, and it still



The *Victory* class corvette *RSS Valiant*. The Republic of Singapore Navy is set to become Southeast Asia's most potent maritime force despite its relatively small size.

depends on Malaysia for much of its supply of fresh water. In addition, nearly all of Singapore's food is imported. Given these circumstances, the Republic's first Prime Minister, Lee Kuan Yew, deliberately fostered a siege mentality to mobilise and unite the populace to ensure the Republic's strategic and economic survival.

Right from the start, Singapore adopted a clear external defence doctrine based on the pre-emptive strike. Singapore's external defence doctrine and strategy was dictated by the fact that it is a small island state, surrounded by relatively large and powerful neighbours. This sense of vulnerability, whilst somewhat diminished today, is still an important factor in Singapore's strategic calculations. The Republic's priority has therefore been to deter or defeat potential external threats, be it the Soviet Union or to prevent itself from being crushed as 'a Chinese nut between an Indonesian-Malaysian Malay nutcracker'.³² This strategy has undergone little change since the Republic's independence. It is still intended to send a clear signal of Singapore's determination to respond swiftly and decisively against any foreign threats to its perceived vital national interests.³³ Thus pre-emptive strike-using offensive counter-air operations and the seizure of territory-is still central to Singapore defence strategy.³⁴

Three distinct phases of defence development of the Singapore Armed Forces (SAF) can be identified. The first was a concentration on land forces in the 1960s and early 1970s to secure the island's immediate ramparts. Phase two involved the building up of the air force from the 1970s till 1985. With limited territorial seas, the RSN initially only had a coastal defence role to play and was virtually reduced to the status of a junior service. In the early 1980s, the then Defence Minister (presently Prime Minister) Goh Chok Thong remarked that '...so far as the navy is concerned, one again has to take into account one's resources. I would have a modern aircraft instead of a modern ship.'³⁵

It was only after Singapore had built up its air and land forces and was certain that they were capable of deterring potential external enemies that the SAF began to concentrate on the navy in the mid-1980s. Thus, while the RSN took a somewhat back seat during the formative years of the SAF, the accent has changed today. After securing its ramparts, Singapore was prepared to give more attention and resources to maritime defence and surveillance, but surveillance in a very different context from the rest of ASEAN.

SLOC protection

Instead of the protection of maritime resources, Singapore is concentrating on building up a capability to keep its maritime links with the rest of the world open, i.e. sea lines of communications (SLOC) defence. The decision to

concentrate on SLOC protection was made in the early 1980s and the Singapore Navy's mission was refocused and its strategy redefined with this objective in mind. The decision involved giving the RSN the capability to 'go out and fight in the open sea'.²⁶ The RSN has consistently reiterated the importance of SLOC protection as a justification for force modernisation. It points out at every opportunity that seaborne trade accounts for 90 per cent of Singapore's trade, with the value of the country's imports and exports amounting to over three times its gross domestic product.²⁷ This trade dependence is in turn dependent on the safety and freedom of access of Singapore's sealanes. Furthermore, these sealanes are critical conduits for nearly all of the Republic's daily food and energy requirements. Therefore, any threat to sealanes is regarded as a threat to Singapore's survival itself.

This trade dependency argument aside, the RSN's SLOC protection strategy is entirely in line with Singapore's forward defence doctrine. The RSN's focus on a SLOC strategy is also a result of the fact that it does not have to worry about protecting the offshore estate, simply because Singapore does not have an EEZ. Thus, the RSN can afford to pay minimal attention to the constabulary role and concentrate all its resources on SLOC protection and forward defence. The RSN's mission is therefore straightforward, which is to protect Singapore's interests at sea by ensuring the security of the Singapore Strait and the nation's sea lines of communications, extending westward through the Malacca Strait to the Indian Ocean, northwards in the South China Sea up to Indo-China, and southward towards the Indonesia and Australasia.²⁸

Towards a balanced force

The RSN sees a 'balanced capability' to carry out the entire range of required missions as the heart of its SLOC protection strategy, and indeed, of the navy's doctrine itself. It must be able to counter hostile warships, submarines, sea-mines and aircraft. Thus in the 1980s, it launched a modernisation program to acquire new multi-dimensional capabilities, including anti-submarine warfare (ASW), anti-air defence and mine countermeasures (MCM), while at the same time upgrading existing assets. The six *Victory* class missile corvettes (MCV), ordered in the 1988, constituted the heart of the modernisation program. At the same time, it was also decided to introduce ASW capable mine countermeasures vessels (MCMV), with variable depth sonar and armed with acoustic homing torpedoes. These four *Bedok (Landsort)* class MCVs, ordered in 1991, helped to close the ASW gap for the RSN, enabling it to protect Singapore's SLOCs against both surface and sub-surface threats. At the same time, the RSN's more than a decade old missile gunboats (MGBs) were refitted with the long-range *Harpoon* missile to complement the existing *Gabriel* missiles;

and an electronic warfare suite added. The command, control and communications systems were upgraded to enhance compatibility with the MCVs, and the *Mistral* surface-to-air missile system installed to enable the MGBs to operate with and augment the MCVs in the task of SLOC protection. Force integration and interoperability within the RSN, and with the rest of the SAF, was one key objective of the 1980s modernisation program. This stress on force integration was again re-emphasised in the force development plans in the 1990s.

In 1990, eight F-5Es were reconfigured for the maritime reconnaissance role when F-16s became available for frontline defence while an 'indeterminate number' of other aircraft were re-equipped and armed with anti-shipping missiles and allocated to the maritime strike role.³⁹ In addition, orders were placed for six Fokker-50 maritime surveillance aircraft. These have all become fully operational. SLOC defence strategy, however, essentially requires small navies to acquire multi-dimensional capability, including submarines. It was therefore entirely logical for Singapore to acquire submarines to make its SLOC defence strategy complete. Thus, in 1997, the Singapore Defence Ministry announced that it would acquire three more *Sjoormen* (A12) class submarines from Kockums, in addition to the one already leased for 'training purposes' in 1995. Submarines are recognised as great force multipliers and will fit in very well with Singapore's SLOC protection strategy, both directly, and to hone the ASW capability of the RSN's surface vessels. Thus, the basic foundations of Singapore's SLOC defence strategy would appear to be complete by this year when the *Sjoormens* enter service.

Fleet command & coastal command

The RSN is today divided into two principal flotillas under two commands. The 1st Flotilla, under Fleet Command, is the principal strike arm, and carries the burden of SLOC protection. It comprises the six *Victory* class corvettes, and the six refurbished missile gun boats of the *Sea Wolf* class, and six locally built *Fearless* class patrol vessels (PV) configured for the ASW role. Coastal Command is charged with safeguarding the Republic's territorial waters with the 2nd Flotilla. The latter includes six *Fearless* class PVs optimised for the ASW role, 12 inshore patrol boats, the four *Bedok* class MCMVs, and four *Vosper* type coastal patrol craft. In addition, Singapore renamed its marine police the Police Coast Guard (PCG) in the early 1990s. The PCG is equipped with the RSN's older and smaller coastal patrol craft. The 3rd Flotilla is the RSN's amphibious component. It comprises five old ex-*County* class LSTs (two active, three in reserve) and various fast transport craft. The 3rd Flotilla supports the SAF in general, as well as the RSN. Four new locally built *Endurance* class tank landing

ships (LST), the first of which was launched in March 1998, are replacing the *County* class LSTs. The RSN's modernisation program for the 1990s has involved a very large degree of indigenisation, including the 12 *Fearless* class PVs and the *Endurance* class LSTs. There are also hints that the RSN is planning to acquire a new class of up to eight ocean-going corvettes.

On balance, it can be seen that the RSN has been single-minded in its mission planning and priority-setting. For Singapore, the 1980s was the time when it could afford to concentrate on SLOC defence. Its air defences, including counter-air capability, was by then probably the most sophisticated in the region whereas its maritime capability was still relatively under-developed. Secondly, any spending on new maritime capability would probably go unremarked in the general ASEAN build-up. In essence, the SAF has always emphasised the need for very close cooperation between all three services in the defence of Singapore. 'Integrated warfare' can therefore be described as the strategic philosophy of the RSN, and indeed of the entire SAF. In this sense, Singapore is probably the only Southeast Asian navy that is on the way to possessing comprehensive maritime power—surface, sub-surface and air. Perhaps the only shortcoming of the RSN is the fact that because of geographic constraints, all its bases are too closely located together. Another criticism would be that the navy is still essentially very short-legged, with RSN personnel regarding 'over 72 hours at sea to be a long deployment'.⁴⁰ Nevertheless, these caveats aside, the RSN is set to become Southeast Asia's most potent maritime force, despite its relatively small size, if it carries on with its systematic force development and its emphasis on force integration. It is however, unlikely to emphasise horizontal expansion, because of manpower constraints. Most likely, it will focus on qualitative improvements in the fleet, support and training infrastructure, and on force multipliers.

The Royal Malaysian Navy (RMN)

Security priorities

'...national security is inseparable from political stability, economic success and social harmony. Without these, all the guns in the world cannot prevent a country from being overcome by its enemies...'⁴¹ These words of Malaysian Prime Minister Mahathir Mohamad in 1986 clearly states Malaysia's attitude to defence. Indeed, Malaysia has a clear ranking of security priorities. The most important is regime security, followed by domestic or internal security, and then by state or external security. Domestic security is often couched in terms of regime legitimisation and maintenance by the ruling elite. Regime legitimisation in Malaysia has largely taken the form of performance legitimacy (that is, delivering the economic goods, and law and order, to the populace to ensure a

stable and satisfied society) since the 1980s. As Prime Minister Mahathir Mohamad remarked in 1986: 'We think that the contentment of the people is a major factor in determining security...'⁴²

This was more explicitly stated in 1995 by the then Defence Minister, Najib Tun Abdul Razak: 'Today, leadership has experienced a paradigm shift whereby *the traditional legitimacy of leadership, though still important, is replaced by performance legitimacy [emphasis added]*...This then is a sure sign of the maturity of society...'⁴³

In 1984, the then Deputy Prime Minister Musa Hitam delivered a seminal paper on the Malaysian Doctrine of Comprehensive Security to the Harvard



Malaysia's offshore patrol vessel KD *Marikh* was one of a number of vessels acquired by the Royal Malaysian Navy during the mid-1980's to enhance its capability to patrol its EEZ.

Club of Singapore. The paper pointed out that Malaysia faced an array of threats, including economic, political, psychological and military threats, and therefore needed to respond comprehensively. The aim of the three-pronged strategy was to ensure:

- a secure Southeast Asia;
- a strong and effective ASEAN community; and
- a 'Malaysia (that) is sound, secure and strong within'.

In addition, Malaysia also has a declaratory National Defence Policy (NDP) formulated in 1986. The three tenets of the NDP are:⁴⁴

- self-reliance,
- regional cooperation, and
- external assistance.

The NDP reflects a strong foreign policy orientation. Self-reliance covers not only the Armed Forces, but includes the entire nation. Self-reliance is based on two premises. The first is that Malaysia must be capable of acting independently in all matters involving domestic security. The second is that the country must be able to protect its 'territorial integrity and security interests within the immediate vicinity from low and medium level external threats'. The 'immediate vicinity' is defined as the land territories, territorial waters, airspace, the EEZ, the Straits of Malacca and its approaches, the Straits of Singapore and the sea and air lines of communication connecting Peninsular Malaysia and Sabah and Sarawak.⁴⁵

National defence policy

A declaratory defence policy is one thing, but operationalising the policy can be something else. The Malaysian Armed Forces (MAF) has attempted to operationalise the NDP by evolving a strategy based on:

- deterrence,
- forward defence, and
- total defence.

The first two concepts can be interpreted in terms of acquiring adequate conventional warfare capability, i.e. acquiring the capability to deter the use of 'force or coercion against us', while forward defence entails the 'ability to protect our interests in the immediate vicinity of our national boundaries, and within the region to support our neighbours in time of need'.⁴⁶ The notion of forward defence has been referred to more often by the RMN than the other two Services.⁴⁷ MAF doctrine was re-defined after the 1985–1986 economic

crisis from being threat-based to one which focused on the defence of national interests, or rather, geo-strategic interests of the 'immediate vicinity'.

RMN missions

In contrast to Singapore, Malaysia's maritime area covers more than 450,000 square kilometres. The missions of the RMN are normative, and in essence are representational of the declaratory missions and roles of most ASEAN navies.

The primary mission is to defend the country's national interests, territorial integrity, national sovereignty, and to ensure the security of Malaysian nationals and properties in time of war. Peacetime missions include:

- Training for war.
- The protection of Malaysian nationals, resources and territory.
- Undertaking hydrographic surveys.
- Assisting civil agencies in maritime law enforcement, search and rescue, and disaster-relief operations.
- Supporting Malaysia's foreign policy.
- EEZ law enforcement.
- Support for army and air force operations.

Former RMN chief Shariff Ishak noted in a public lecture that the sea is vital for Malaysia because of:⁴⁸

- Mercantile trade, as over 90 per cent of the country's exports and imports are transported by sea.
- Fisheries, which is important to the national economy and subsistence.
- The exploitation of hydrocarbons. Presently, more than a third of Malaysia's gross national product (GNP) is derived from offshore gas and oil exports.

The RMN started off by being a constabulary force, largely involved with border patrols against communist insurgents, and fisheries protection. Its first major purchase following Malaysian independence was a fleet of the 50-metre Vosper Thornycroft PV, armed with just a single 40mm Bofors. It was only in the 1960s and 1970s that the RMN began to purchase limited numbers of combatants, including missile-armed fast strike craft and a few frigates/corvettes.

An independent service

Despite being a junior service, the RMN, unlike the Royal Malaysian Air Force (RMAF), was able to escape complete domination by the Malaysian Army and

maintain a measure of strategic independence for three reasons.⁴⁹ The first was the creation of the Federation of Malaysia itself in 1963, when Malaya became Malaysia with the incorporation of the British territories of North Borneo and Sarawak. This created a nation that was divided by about 500 nautical miles of sea which automatically gave the RMN a vital SLOC mission. The second development was the official release of Malaysia's 1979 *Peta Baru* (New Map) showing the country's continental shelf boundaries, and hence its inferred EEZ area. This official incorporation of a vast new offshore estate, including rich deposits of offshore gas and oil, gave the RMN (like all of the regional navies except that of Singapore) a whole new area of responsibility to surveil and protect. The final factor was the economic slowdown of 1985. During the late 1970s, the MAF had embarked on a very ambitious program, known by the Malay acronym PERISTA (or Armed Forces Special Expansion Program) to equip and turn the MAF into a conventional force as rapidly as possible to block a possible Vietnamese thrust across Thailand and down the Malay Peninsula.

The 1985 economic downturn, however, derailed PERISTA, and all acquisitions, largely meant for the army and air force, were frozen. This pause gave the government time to review the overall strategic situation and with it, the MAF's PERISTA program. By this time, Vietnam's failure to completely control Cambodia made Malaysia realise that fears of a Vietnamese attack across Thailand and down the Malay Peninsula were totally unfounded. What made the threat even less likely to materialise was the fact that the Soviet Union was economically overstretched and could not afford to underwrite any Vietnamese adventurism. This resulted in a strategic re-assessment by the Malaysian Government. It was therefore decided that henceforth, defence planning and the development of the MAF should not be threat-specific, but should give the MAF a general deterrence posture. In effect, this meant that the MAF

...shifted the basis for planning force-level requirements from a threat focus to the defence of national interests, which were defined in terms of the core-area (the territory of Malaysia); the immediate vicinity (which includes the Straits of Malacca, Straits of Singapore, the line of communication between Peninsular Malaysia and Sabah/Sarawak, the South China Sea, and the Andaman Islands); and the neighbouring countries.⁵⁰

Constabulary bias

This gave the RMN *de facto* the prime responsibility of defending Malaysia's core economic interests because the economic and 'national interests' of Malaysia

were in more ways than one, tied up with the nation's maritime interests. Malaysia was one ASEAN nation that showed an early appreciation for its potential offshore wealth, and in fact was already pumping oil from the South China Sea even before the 1982 Law of the Sea Convention (LOSC).⁵¹ Therefore in the absence of any land-based threat in the early 1990s, and with the funds to pay for it, Malaysia accepted, in the words of Prime Minister Mahathir Mohamad: 'the need to defend our seas and territories with all our strength we are capable of'.⁵²

With the departure of the US Navy from Subic Bay, coupled with more assertive Chinese action in the Spratlys area of the South China Sea, maritime defence was given priority for the first time.⁵³ Moreover, the disputes in the Spratlys, to which Malaysia was party, seemed to emphasise the relevance of maritime forces. The switch from counter-insurgency warfare to maritime defence was explicitly spelt out by the then Chief of Armed Forces, General Hashim Mohamed Ali, in 1989 when he highlighted the 'importance of the air force and navy'.⁵⁴ This situation was, however, relatively short-lived. The army was able to come up with new missions, such as peacekeeping and rapid deployment, that effectively ended the RMN's challenge to it as the premier service.

When the Malaysian economy rapidly picked up again after 1986, it was decided that the MAF's stalled modernisation program should be reactivated. A memorandum of understanding (MOU) was reached with the United Kingdom (UK) in 1988 under which the MAF would explore the possibilities of acquiring up to £1 billion worth of hardware from British defence industry independent of the Fifth Malaysia Plan (1986–1990). It was decided that the largest share of this special defence budget should go to the navy and the air force.⁵⁵ In terms of actual allocation, the bulk went to the RMAF. The navy expected great things from the MoU. It wanted submarines above all else to implement its strategy of forward defence and deterrence, but the British had not been producing or operating conventional submarines for quite some time. After toying with the idea of purchasing two ex-Royal Navy boats (one *Oberon* class boat and one *Porpoise* class), the RMN called off the deal because of the lack of an after-sales package.⁵⁶ The navy therefore attempted to turn to other sources, and was on the verge of obtaining two ex-Swedish Navy *Draken* class boats and two new Kockums boats from Sweden when the deal fell through in May 1991 because of limited funds.⁵⁷ The RMN was finally forced to settle for two UK built *Yarrow* frigates, with a £400 million contract signed in March 1992, as well as six ex-Royal Navy *Wasp* helicopters for its air wing.

At this time the principle was established that the main roles of the RMAF's new fighters would be 'air defence and *defence of the maritime regime* [*emphasis*

added].⁵⁸ In 1993, it was announced that Malaysia would purchase 18 MiG-29s for the air defence role, and eight McDonnell Douglas F/A-18Ds, presumably for maritime strike.⁵⁹ In addition, the RMAF took delivery of four King Air B200Ts for the maritime patrol role in May 1994.

On the horns of a dilemma

The RMN has managed to chart an independent course by exploiting the niche that the creation of the Malaysian Federation and the 1982 LOSC gave it. These two events made it necessary for Malaysia to have forces capable of protecting Malaysia's maritime resources and safeguarding the nation's maritime interests. It has often been argued that Malaysia's multiple maritime disputes with all its neighbours has automatically given the RMN a prime warfighting role. For instance, Malaysia is involved in the Spratlys dispute with the People's Republic of China, Chinese Taipei, the Philippines and Vietnam. Kuala Lumpur also disputes the delineation of the maritime boundary off northwestern Peninsular Malaysia with Thailand. Malaysia and Indonesia have made rival claims to the islands of Sipadan and Ligatan off the southwestern Sabah coast. With Singapore, the dispute is over *Pulau Batu Putih* (Horsburg Lighthouse) in the Malacca Straits. However, Malaysia's South China Sea claims are in the far south of the Spratlys group, out of the area of greatest tension. At the same time, it is difficult to envisage the RMN engaging even in undeclared hostilities with any of its neighbours over any maritime dispute. 'Presence' is all-important, rather than actual combat capability.

The presence of RMN ships in areas of dispute can be conceived as the will of the government to state their [*sic*] claim and that force may be used to uphold it. *What matters is not so much the actual military significance but how it is construed by would be adversaries [emphasis added].*⁶⁰

The writer then defined military threats as 'intrusions into Malaysian waters by foreign warships and government vessels especially in the disputed areas'. Significantly, he added that the presence of these vessels had not resulted in any skirmishes or use of force thus far.⁶¹

Although various maritime agencies, such as the Marine Police and Department of Fisheries, are also tasked with constabulary roles, their assets are quite limited when compared with that of the RMN. The area of operations of the Marine Police, for instance, is confined to Malaysian territorial waters. In the absence of a Malaysian coast guard, this meant in effect that the RMN had to shoulder the constabulary as well as warfighting roles. Given the scarcity of resources, the RMN had to decide on which role to give priority to.



The RMN also acquired the *Katsuri* (Type FS 1500) class during the mid-1980s.
Shown here is *KD Lekir*.

The RMN in fact, attempted to do both, maintaining a sizeable fleet of the Vosper *Kedah* class PVs for the constabulary role, and at the same time maintaining a small core of combatants.⁶² As such, in peacetime, the RMN theoretically places equal emphasis on the three roles of warfighting, naval diplomacy and policing. The navy in fact has 'no qualms' about the policing role and 'in fact it makes good sense as the country can ill afford another service, for example a Coastguard'.⁶³ Prior to the 1979 *Peta Baru*, the RMN was essentially a coastal defence force with four *Combattante* class missile-armed fast attack craft (FAC(M)), with four more *Spica* class FAC(M)s added in the late 1970s. Malaysia's new EEZ meant that the RMN needed longer-legged assets,

as well as a more balanced force. The early to mid-1980s saw the RMN acquire new capabilities for EEZ presence. The most significant of these were four *Lerici* class MCMVs acquired from Italy, a multi-purpose combat support ship from South Korea, two offshore patrol vessels (OPV) of South Korean origins, and two FS1500 type corvettes from Germany. A naval air wing was established in the late 1980s with the purchase of six ex-Royal Navy *Wasp* ASW helicopters.

1990s modernisation

In the 1990s the RMN, like virtually all its ASEAN neighbours, embarked on a modernisation and expansion program. Two frigates, to be armed with the *Sea Wolf* surface-to-air missile, were ordered from Yarrow as part of the MoU with the UK. In addition, Malaysia purchased all four *Fincantieri* built corvettes ordered originally by Iraq, but impounded in Italy following the 1981 Gulf War. All four corvettes have been refurbished.

Today, the RMN fleet appears fairly formidable on paper, with eight FAC(M)s, four frigates, six corvettes, and two more frigates awaiting delivery. In contrast to the RSN, however, it is argued that while the RMN obviously has a tactical doctrine, its development has been hampered by the absence of a clear, long-term strategic doctrine, and by the fact that it has to undertake a multiplicity of tasks. Indeed, acquisitions have been somewhat *ad hoc*, with emphasis placed more on hulls/platforms rather than developing an integrated capability. This is reflected in the various types of communication equipment fitted, the many sources of suppliers of hulls and electronics, the outdated combat systems, and a very minimal ASW and anti-air capability. Thus, one suspects that this emphasis on hulls, rather than combat capability and total fleet integration, is the result of a somewhat unique procurement procedure. The result is that the RMN, unlike the RSN, has yet to become a completely integrated force. Interoperability is a problem, and lack of equipment commonality must certainly exacerbate maintenance and spares problems.⁶⁴ This is not such a handicap if one follows Malaysia's official line that there will be no conflict in the region for at least the next decade, and that presence, as a constabulary force, is therefore more important at the moment than any real warfighting capability. The emphasis on upgrading the surface capability of the RMN by acquiring larger, longer-legged vessels suitable for long-range patrols is also seen in the decision to purchase from Italy the four *Fincantieri* built missile corvettes. The Malaysian-Italian agreement for the corvettes, signed in Kuala Lumpur in October 1995, caught many observers by surprise, not least the RMN itself. This acquisition at least brought a degree of commonality, rationalisation and combat capability to the fleet. Nevertheless, these four Italian corvettes never

figured in the original acquisition plans of the RMN. Another indication of the RMN's attempts at rationalisation includes the communications upgrading program.

It must be emphasised that the RMN is a professional force, and it is attempting to address the dilemma of a lack of integration by attempting to rationalise its ship life extension programs for the FAC(M)s and FS1500s. At the same time, the much-publicised and long drawn-out new generation patrol vessel (NGPV) program for 27 vessels also reflects the navy's attempts to acquire a multi-role warship that will be capable of performing the constabulary role and the warfighting task efficiently. As such, the NGPV grew from the requirement for a basic OPV to that of a corvette or frigate-type ship, fitted for but not with, a variety of sensors and weapons.⁶⁵ Present RMN chief Vice-Admiral Abu Bakar bin Abdul Jamal, described the NGPV or PV as a 'self-defence system' capable of operating either alone or as part of a surface, sub-surface and aerial force. A fully outfitted PV would, in fact, be as capable as most modern frigates.⁶⁶ This attempt by the RMN to acquire potentially combat-capable ships under the guise of patrol vessels is perhaps an indication of the RMN's attempt to get back to what it considers to be its primary role. The NGPV project has been awarded in principle to the German Naval Group consortium, in partnership with the Malaysian Dockyard Sdn Bhd. An initial batch of six vessels has been ordered.

In terms of operational doctrine, the RMN did attempt to be Malaysia's first line of defence, a role outlined by former navy chief Vice-Admiral Abdul Wahab Nawi in his development plan for the navy to the year 2010.⁶⁷ The RMN's 'forward defence' strategy envisaged the use of submarines to interdict any adversary before they can penetrate Malaysia's EEZ.⁶⁸ However, the submarine plan is almost a decade old, and the navy's failure thus far to acquire submarines is a reflection of the dilemma facing the RMN. It has to balance its resource protection role against its warfighting role, primarily because Malaysia cannot afford both. Up to this point, it would seem that the RMN is being forced to give greater weightage to its resource protection role. This is because Malaysia's maritime sector is seen to have great potential, and there are real problems and low-level threats in Malaysia's sea areas to be addressed. These threats include illegal foreign fishing, illegal migration, the need to secure and protect gas and oil fields located in Malaysia's EEZ and boundary problems with all of Malaysia's maritime neighbours.⁶⁹

This 'coast guard' emphasis has arguably prevented the RMN from developing into a dedicated warfighting navy. This of course is not a situation peculiar to the RMN.⁷⁰ Some navies in fact, are quite happy with the resource protection

role because it ensures funding at a time when cutbacks are the order of the day. As a constabulary force, the RMN's importance is primarily economic, while its combat value is arguably secondary. The Malaysian Government has made it clear that it cannot afford to pay equal emphasis to both the constabulary and warfighting roles. Former Malaysian Defence Minister Datuk Syed Hamid Albar, commenting on the issue of submarines for the RMN, said that while the navy had 'a large platform of responsibility...we still have to look at whether the government can afford them'.⁷¹ While acknowledging the strategic need to purchase submarines, that would most likely happen only after the navy had 'completed our development for the surface ships...'.⁷² It is therefore very clear that the RMN, whether it wants to or not, will be concentrating on the resource protection role in the near future. This is reflected in the Malaysian Government's decision to go ahead with the NGPV project, while the submarine program has been put on hold. Things might change, however. The RMN has unofficially made it known recently that it is prepared to give up its older patrol vessels to the proposed Malaysian maritime enforcement agency (coast guard), therefore implying that it is prepared to give up its constabulary role. This could result in a more focused and more combat-oriented RMN in the future.

Conclusion

It is interesting to compare the two entirely different approaches to force development by the Singapore and Malaysian navies. Both navies share similar strategic objectives, i.e. forward defence and long-distance interdiction of enemy forces. However, the actual results achieved have been somewhat different. This is largely because Singapore, as a city-state set within what it considers to be a less than friendly environment, has made deterrence a cornerstone of its survivalist credo. To this end, it has set aside six per cent of its GNP annually to be spent on defence. The island's lack of strategic depth, no EEZ, extremely limited territorial waters and dependence on trade and imported food supplies makes Singapore strategically vulnerable. At the same time, these constraints have also made defence planning and strategic priorities quite obvious and straightforward. Singapore cannot be defended on the island itself. Any potential enemy must be neutralised before they can reach the island. Thus, forward defence and SLOC protection holds real meaning for the Republic. As a consequence, Singapore has been extremely focused and logical in its force development and acquisitions. Land forces will advance to establish a forward ring of defence, while the air force and navy have the task of neutralising enemy forces out to a range of approximately 200 nautical miles, and even beyond. Singapore does not have to worry about resource protection, except

to ensure the safe and orderly transit of ships in the Strait of Singapore and the adjacent Malacca Straits. Thus it has been able to concentrate on building up a truly combat-capable warfighting navy.

The RMN's missions, however, are more complex and varied. With more than 450,000 square kilometres of maritime area to surveil and rich fisheries and hydrocarbon resources to protect, and with multiple conflicting maritime claims to enforce, the relatively small Malaysian navy is, in truth, very overstretched. The Malaysian Government, quite unlike its southern counterpart, does not believe that external conflicts will take place in the region in the medium term. In addition, the Mahathir Government has always been more concerned about regime security and legitimation than external military defence. As such, the RMN is not exactly on top of the priority list with regard to budgetary allocations. Neither does the navy have the final say in equipment choices.⁷³

All these have contributed to a situation where the RMN is caught between two stools—its constabulary duties and its warfighting role. The end result is that it has acquired vessels from various disparate sources, systems integration is far from satisfactory, and while it has a fairly impressive number of hulls, combat capability has been compromised by various factors, among them the need to acquire enough hulls for the constabulary role.

This brief study of the Malaysian and Singapore navies attempts to illustrate the impact of domestic politics and security perceptions on defence developments in Southeast Asia. While only two navies are dealt with here, preliminary research indicates that the same applies to most of the ASEAN navies, including those of Thailand, the Philippines and Indonesia. Thus, there is always the danger of drawing false conclusions by studying Southeast Asian navies in isolation of the many variables that affect defence and defence policies in the region. Suggestions for maritime cooperation must therefore be framed within the context of national interests and issues, rather than dealt with normatively as 'natural' confidence-building measures, or as the realist answer to balancing potential hegemons. Southeast Asian maritime cooperation, on balance, will succeed only with non-controversial, 'soft' security issues such as anti-piracy patrols and fisheries control. Cooperation to balance countries like China, for instance, is highly unlikely because national interests and perceptions vary widely from state to state in the region with regard to China and its intentions. Thus, when it comes to fighting a maritime war in the 21st century, many Southeast Asian navies may well reply: 'War? What war?'

Notes

- 1 See for example M.L.F. Spencer, 'Australia's Contribution to Peace in South East Asia: A Maritime Strategy', *Journal of the Australian Navy Institute*, January/March 1998, pp. 9-11.
- 2 Felix K. Chang, 'Beyond the Unipolar Moment: China's Reach in the South China Sea', *Orbis*, 40 (3), Summer 1996, p. 354; Nilanthi Samaranayake, 'Oil and Politics in East Asia', *Online Journal of Peace and Conflict Resolution* 1.2, May 1998.
- 3 Joseph R. Morgan, *Porpoises Among the Whales: Small Navies in Asia and the Pacific*, East-West Center Special Reports, no. 2, March 1994, p. 3.
- 4 J.N. Mak, 'The ASEAN Dilemma: Internal/regime Security Versus External Defence', in *Asian Defence Doctrines*, Institute of Defence and Strategic Analysis (IDSA) and Copenhagen Peace Research Institute (COPRI), (forthcoming).
- 5 It has been noted, for instance, that Southeast Asia is 'fortunate' because the transparency of US foreign policy gives clear indications of US intentions and concerns, and that the US clearly remains committed to maintaining a (military) presence in the region. Lieutenant Commander Mike McArthur, 'Maritime Tensions in the South China Sea: What Interests Are Driving These Disputes?', *Journal of the Australian Naval Institute*, August/October 1996, p. 41.
- 6 Sam Bateman, 'ASEAN's Tiger Navies: Catching Up or Building Up?', *Jane's Navy International*, April 1997, p. 18.
- 7 The majority of ASEAN members place a premium on regime security rather than domestic/national security. 'State' here is defined as a 'structure of domination and coordination, including a coercive apparatus and the means to administer society and extract resources from it'. In this definition, a state does not require political legitimation. A 'nation-state' is a political community whose territorial and juridical boundaries coincide with the boundaries of the nation. 'Regime' is the organisation at the centre of political power, and it determines who has access to that political power. 'Government' is defined as the actual exercise of political power within the framework of the regime. The government would therefore include all those people and institutions, including the military and bureaucracy, that are in control of state power. See Muthiah Alagappa (ed), *Political Legitimacy in Southeast Asia*, Stanford University Press, Stanford, 1995, pp. 26-27.
- 8 Mohammed Ayoob, *The Third World Security Predicament: State making, Regional Conflict, and the International System*, Lynne Rienner Publishers, Inc, Boulder, Colorado, 1995, pp. 9, 16. Mohammed Ayoob argues that insecurity is the 'defining characteristic of Third World states'. This is the direct result of their late entry into the international system of states, and hence, their late attempts at state-making rather than nation-building. Thus, these Third World states, including the majority of the ASEAN members, are beset by the problems of:
 - Lack of internal cohesion.
 - Lack of unconditional legitimacy.

- Easy susceptibility to internal and inter-state conflicts.
 - Easy permeability by external actors.
- 9 See Donald K. Emmerson, 'Indonesia, Malaysia, Singapore: A Regional Security Core?', in *Southeast Asian Security in the New Millennium*, eds Richard J. Ellings & Sheldon W. Simon, M.E. Sharpe, New York, 1996, pp. 37-39. In this sense, the multi-dimensional threats to the ASEAN members called for a comprehensive response (political, military, economic, and socio-cultural). National resilience was therefore both a condition, and a tool to achieve comprehensive security. See also Muthiah Alagappa, 'Comprehensive Security: Interpretations In ASEAN Countries', in *Asian Security Issues Regional And Global*, eds Robert A. Scalapino, et al, Institute of East Asian Studies, University of California, Berkeley, 1988; Donald E. Weatherbee, 'ASEAN: Patterns of National And Regional Resilience', in *Asian-Pacific Security: Emerging Challenges and Responses*, eds Young Whan Kihl and Lawrence E. Grinter, Archives Publishers, New Delhi, 1987.
 - 10 Michael Leifer, *The ASEAN Regional Forum*, Adelphi Paper 302, Oxford University Press, Oxford, 1996, p. 15.
 - 11 S. Thanasegaran, 'ASEAN Moves Closer on Tackling Security Issues', *Asian Defence and Diplomacy*, Oct. 1997, p. 51.
 - 12 Hans Werner Steinhoff, 'In a Totally Open World Economy You Will Never Have 'Fair' Competition; Malaysian Defence Minister Speaks out', *Naval Forces*, June 1997, p. 8.
 - 13 That the region has no real conventional defence capability today is therefore not surprising. Indonesia, for instance, has essentially relied on a guerrilla-war-in-depth strategy to stop external attacks. Malaysia, the Philippines and Thailand all, to varying degrees, depended on a system of implicit and explicit defence arrangements for their external defence. The singular exception is Singapore, with a clearly enunciated defence doctrine with a very distinct external focus.
 - 14 Andrew Mack & Pauline Kerr, 'The Evolving Security Discourse in the Asia-Pacific', *The Washington Quarterly*, Winter 1995, p. 131.
 - 15 *ibid.*, pp. 134-135.
 - 16 Lieutenant Commander Mike McArthur, 'Maritime Tensions in the South China Sea: What interests are driving these Disputes?' *Journal of the Australian Naval Institute*, August/October, 1996, pp. 39-40.
 - 17 It has been argued, for instance, that the sea will be the answer to China's food and energy shortages, expected by the year 2020. Apart from living and non-living resources from the East and South China Seas, sea lines of communication will become increasingly vital for China's trade. See John Downing, 'Maritime Ambition: China's Naval Modernisation', *Jane's Navy International*, May 1998, p. 12.
 - 18 See Mak, 'The ASEAN Dilemma: Internal/regime Security versus External Defence'.
 - 19 Doctrine may be defined as the 'fundamental principles by which the military forces

guide their actions in support of objectives. It is authoritative but requires judgment in application'. *Multinational Maritime Operations*, Department of the Navy, Naval Doctrine Command, Norfolk, VA, September 1996. In the ASEAN context, doctrine is ideational and extends to more than the military. It is a set of beliefs which informs the way strategy is drawn up and subsequently implemented.

- 20 Up to very recently, acquisitions invariably drove doctrine in the ASEAN core countries. Thus, many ASEAN armed forces blithely list their roles to cover the whole spectrum of missions from preserving national sovereignty, protection of maritime resources, deterrence, meeting new security challenges, countering aggression, terrorism and insurgencies, and helping to maintain public order. How this is to be achieved, or whether it involves a strategy of forward or close defence, and what kinds of roles each service should play within an overall strategy, remains largely unclear. Singapore, of course, is the exception. The primacy of air power as the first line of defence in an overall strategy of all-round forward defence (at sea and on land) is clearly enunciated by the Singapore Armed Forces.
- 21 Paul Dibb, 'Defence Force Modernisation in Asia: Towards 2000 and Beyond', *Contemporary Southeast Asia*, vol. 18, no. 4, March 1997, p. 357.
- 22 Kusuma Snitwongse, 'ASEAN's Security Cooperation: Searching for a Regional Order', *The Pacific Review*, vol. 8, no. 3, 1995, p. 525.
- 23 ASEAN diplomats often acknowledge that the ARF was primarily set up as a means to get China involved in a multilateral security forum.
- 24 Bob Lowry, 'Indonesia's Defence Policy Matrix', in *The Evolving Pacific Power Structure*, ed. Derek da Cunha, Institute of Southeast Asian Studies, Singapore, 1996, p. 97.
- 25 Keynote address to the Global Community Forum Malaysia 1984, Kuala Lumpur, December 3, 1984.
- 26 Ian James Storey, 'Creeping Assertiveness: China, the Philippines and the South China Sea Dispute', *Contemporary Southeast Asia*, vol. 21, no. 1, April 1999, p. 104.
- 27 When the Association's members were hit by the economic downturn, virtually the first thing they did were to freeze or cut back on their defence programs. See Jeffrey Bartholet, 'No Funds, No Guns: East Asia's Great Weapons Bazaar Goes Broke', *Newsweek*, June 22, 1998, pp. 22-23.
- 28 Stephen Haggard and Robert R. Kaufman, 'The Political Economy of Democratic Transitions', *Comparative Politics*, April 1997, p. 268.
- 29 The ruler of a patrimonial state does not have complete coercive power to enforce the acceptance of his rule. He is therefore forced to win the allegiance and loyalty of key sections of the political-military elite by satisfying their aspirations, usually through the disbursement of largesse. Authority is maintained through this network of personal patronage, rather than through ideology or law. At the same time, the ruler must ensure that he, and only he, has continued access to resources to maintain the patronage network. As networks grow, so does the need for more resources.

Politics thus become an intra-elite struggle as factions fight to gain dominant influence with the ruler and gain the rewards of office. This system is sustainable so long as the masses are politically quiescent, and rivalries between elite factions are contained so that infighting does not undermine the regime itself. Today's neo-patrimonial states are increasingly challenged by modernisation and economic change which has created new social groups and classes with different political interests. Neo-liberal economic development, in particular, will inevitably undermine the monopoly of the ruler to distribute rewards and largesse in return for political loyalty. Hence neo-patrimonial states tend to adopt the neo-mercantilist model of development which ensures that states still have substantial control over the allocation of economic resources. See Harold Crouch, 'Patrimonialism and Military Rule in Indonesia', *World Politics*, 31 (1), 1978, pp. 571-572; Richard Snyder, 'Explaining Transitions from Neopatrimonial Dictatorships', *Comparative Politics*, Vol. 24 (4), July 1992, p. 379. For a readable explanation of the basic tenets of neo-mercantilism, see James Fallows, *Looking at the Sun*, Vintage Books, New York, 1995, pp. 177-240.

- 30 For example, Defence Minister Syed Hamid said Malaysia plans to establish a 'credible defence force' only within a period of 15 to 25 years. Hans Werner Steinhoff, 'In a Totally Open World Economy You Will Never Have "Fair"', p. 8.
- 31 Philippines President Joseph Estrada also made it clear that the Philippines would have to continue relying on the US for its external defence because of an economic slowdown. 'Estrada: Philippines Must Rely on US for Defence', *New Straits Times*, Friday, Aug. 21, 1998, p. 19.
- 32 Dewi Fortuna Anwar, *The Rise In Arms Purchases: Its Significance And Impacts On South East Asian Political Stability*, paper presented at the Peningkatan Pembelian Senjata, ZOPFAN Dan Stabilitas Politik Di Asia Tenggara conference, Centre For Strategic And International Studies, Jakarta, April 13, 1993, p. 18.
- 33 Time Huxley & David Boey, 'Singapore's Army—boosting capabilities', *Jane's Intelligence Review*, April, 1996, p. 174.
- 34 *ibid.*
- 35 Goh Chok Thong, 'Security and Defence', *Issues Facing Singapore in the Eighties: Talks By Ministers At The National University of Singapore 1981/82*, Information Division, Ministry of Culture, Singapore (undated), p. 167.
- 36 Peter H.L. Lim, *Navy: The Vital Force*, Republic of Singapore Navy, Singapore, 1992, p. 41.
- 37 'Top Brass Interview: Singapore's Chief of Navy Rear Admiral Richard Lim', *Asian Defence Journal*, June 1997, p. 14.
- 38 Richard Scott, 'Fleet Review: Safeguarding the Seaward Lifeline', *Jane's Navy International*, July/August 1997, p. 27.
- 39 Derek Da Cunha, 'Major Asian Powers And the Development of the Singaporean and

- Malaysian Armed Forces', *Contemporary Southeast Asia*, vol. 13, no. 1, June 1991, p. 63.
- 40 Mark Farrer, 'An Instant Capability? Singapore Buys a Submarine Squadron', *Asia-Pacific Defence Reporter*, February-March 1998, p. 8.
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64 David Foxwell, 'Fleet Review: Downturn Ties Up RMN Ambitions', *Jane's Navy International*, April 1998, p. 46.

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Mid-sized navies in the Asia-Pacific region, 2000–2025: the case of the Canadian, South Korean and Japanese navies

6

Dr James Boutillier

The Maritime War in the 21st Century conference was convened to examine the environments in which small and medium sized navies would likely operate in the Asia-Pacific region in the first quarter of the twenty-first century. Forward-looking exercises of this sort are essential but invariably fraught with difficulties. All too frequently, they fail to take into account the reactions of neighbouring defence establishments, the unpredictable nature of technological change, and the distorting effect of major socio-political phenomena like the collapse of the Soviet Union or the Asian economic crisis. There are, nevertheless, some general observations that can be made that will help establish the context in which those navies are likely to function in the future. The object of this chapter is to do that with particular reference to the Canadian Navy and, to a lesser extent, the South Korean Navy and the Japanese Maritime Self Defence Force (JMSDF).

While an analysis of what constitutes a mid-sized navy is somewhat outside the scope of this chapter, it is worth reflecting on this issue momentarily. The Royal Australian Navy (RAN), for example, is widely recognised as a mid-sized or middle power navy. However, developing a coherent typology to describe the attributes of such a navy is difficult. Is ‘power’ the operational word? Does the character of the navy derive from the characteristics of the host nation? Or does ‘mid’ locate the navy within the global spectrum of navies? Are mid-power navies necessarily blue water navies? Is ‘size’ the operational word in the sense that it relates to the overall size of the fleet or, by indirection, to the size of the ships in that fleet? Certainly, by South Pacific standards, the RAN is a great power navy. By Indonesian standards—if we were to count hulls alone—the RAN is a small navy. But what do we do with qualitative factors since the RAN is qualitatively superior to any Southeast Asian navy large or small?

And how do we deal with divided fleets? The Canadian Navy is a mid-sized navy by almost any standard. But its west coast component (that is to say the

roughly 45 per cent of the overall fleet stationed at Esquimalt on the British Columbian coast) is numerically a small navy but—arguably—a mid-sized ‘navy’ qualitatively. For the purposes of this chapter a mid-sized navy will be defined broadly as one with a significant proportion of mid-sized surface combatants—destroyers and frigates—and the capability, if not necessarily the tradition, of blue water deployments. The question of submarines constitutes another problematic variable since all the navies in question have submarines though these vessels are not the hallmarks of mid-sized navies.

What of the future in the Asia-Pacific region? To begin with, there will probably be increasing levels of naval activity throughout the region in the next 25 years for the following reasons. First, Asia-Pacific militaries—or more specifically armies—are literally and figuratively returning to their barracks. The disappearance of the army from South Korean (1987), Thai (1992), and Indonesian politics (2000) appears to be a phenomenon related to at least three factors: the transition from the post-colonial state-building phase to mature independence; the continued spread of democratic institutions; and the desire on the part of regional militaries, impressed or traumatised by the Gulf War (1990-91) and Kosovo (1999), to reduce their numbers, modernise their equipment, and professionalise their forces.

This means, secondly, that the littoral states of East Asia (land-locked Laos and Mongolia are irrelevant for the purposes of this discussion) are more likely to focus their defence budgets on maritime assets—for surveillance and defence. They will do so not only for the reasons enumerated above but because of a third factor, the likelihood of increased competition at sea. That competition will reflect and be driven by the increased allocation of defence resources to the maritime realm. It will also result from greater and greater competition for marine resources—renewable and non-renewable.

Demographic pressures will lie at the heart of this competition. During the next 25 years the vast majority of global population growth will occur in the developing world. In fact, over the period 2010 to 2025 ninety-eight per cent of that growth will be in the Third World. This means that 50 to 60 million people per year will be added, conservatively, to the Asia-Pacific region. This will occur at a time when the region will probably surpass the ocean’s sustainable yield in terms of fish. Currently, roughly 95 million tons of fish are removed from the world’s oceans every year. The sustainable threshold has been estimated at 100 million tons. National fleets are already ranging farther and farther afield in search of fish. The Thais, for example, have brokered arrangements to fish off the Seychelles in the Western Indian Ocean. Increasing levels of marine pollution in the enclosed seas along the Asian coast and the catastrophic

decline of some salmonid stocks off the west coast of Canada are warning signs of an oceanic ecosystem in a state of siege. These are not trifles. Roughly 75 per cent of the direct protein intake for 500 million people in Southeast Asia derives from the sea. All the indicators suggest that the competition for renewable marine resources will become more intense over the next quarter century; a situation certain to translate into increased levels of naval and coast guard activity.

The fourth reason why there will be an increase in activity is the fact that jurisdictional ambiguity remains persistent in Asian seas. In some instances this ambiguity works to the advantage of claimants in the sense that it keeps boundaries fluid at a time when the location of ocean bottom resources remains unclear. In other instances the ambiguity fuels tensions. There are over 70 outstanding maritime disputes in the region: disputes over islands, sea lanes, and national waters. The search for increasingly scarce and highly mobile fish stocks such as tuna is likely to exacerbate this situation still further.

In addition, (and fifthly) the resumption of economic well-being in Asia will accelerate the demand for energy in Asia. That demand will translate into increased competition for oil and gas from disputed off-shore fields (though the very existence of commercial sources of oil remains the subject of debate in places like the South China Sea). Furthermore, that demand will compound the importance of the sea lanes of communication that run from Singapore to Northeast Asia. Tanker traffic in particular and merchant traffic in general seem certain to grow as the economies of Asia recover their vitality, populations grow, and trade liberalisation encourages global commerce.

In short, almost everything seems to point in the direction of more activity at sea in the next quarter century. More naval activity, more competition for maritime resources, more merchant shipping and more maritime related concerns (fish, boundaries, oil and islands).

This suggests that the demands on mid-sized navies are likely to grow rather than decrease. There may very well be calls for standing naval forces in the region (although the fact that some nations have coast guards and others do not tends to complicate the picture in terms of divisions of labour, etc). The announcement in early 2000 that the Japanese Government was considering dispatching its Maritime Safety Agency (coast guard) vessels to the South China Sea to form part of a multinational maritime force to combat piracy should be seen as a straw in the wind; not only an indicator of a significant change in outlook on the part of the Japanese (who have been remarkably chary about participating in regional security outside the confines of the United States (US)–Japan Security Treaty) but also because it marks a



The replenishment ships HMAS *Success* (left) and HMCS *Protecteur* off East Timor in 1999.

willingness on the part of the Southeast Asian nations to move beyond bilateral naval relations to multinational ones (the Five Power Defence Agreement being a notable exception to this rule).

While piracy is a clear and present danger, amply justifying collaborative naval efforts, there are other areas that command or may command the attention of regional mid-sized navies. Captain Kasumine Akimoto of the JMSDF has been active in articulating maritime peacekeeping doctrines and the multinational naval intervention in East Timor in 1999 illustrated the flexibility and mobility of naval vessels that make them ideal for peacekeeping operations in the Pacific. A further, small-scale example of this flexibility was the utilisation of HMAS *Tobruk* as 'neutral ground' on which the warring factions in the Solomon Islands could meet for discussions in July 2000.

Search and rescue (SAR) operations are another area in which the regional navies will find themselves engaged directly and indirectly. Not only is search and rescue an urgent and continuous concern in the maritime realm (the Pacific component of the Canadian Navy, known as Maritime Forces Pacific, handles roughly 7000 cases per year) but SAR has proven to be a valuable, non-contentious activity for confidence building among those navies. It will come as no surprise, therefore, that the first genuine navy-to-navy contact between the JMSDF and the South Korean Navy (ROK(N)) centred around a SAR exercise (SAREX) in the Straits of Tsushima in 1999. Indeed SAREXs are standard building blocks in the elaboration of navy-to-navy relations. If regional navies are obliged to work together in the future to combat piracy, undertake peacekeeping operations, or address marine disasters (like the sinking of the Russian submarine *Kursk*), SAREXs will constitute useful and anodyne points of departure.

Similarly, greater naval activity in the Pacific will place a premium on the development of incidents at sea regimes. The 1972 US–Russian agreement was revisited recently in the US–Chinese Navy (PLA(N)) accord and in an expanding series of talks in Southeast Asia. The willingness of regional navies—large and small—to enter into these discussions suggests not only a recognition of the dangers associated with unregulated encounters at sea but a willingness to break with the past and embrace the idea of multinational naval cooperation. Lee Kuan Yew’s ‘pull together or sink together’ comments with respect to the need for Southeast Asian nations to cooperate in the defence realm are apropos in this regard.

What the Southeast Asian nations worry about are China’s long time maritime ambitions. The Chinese, themselves, have broken with the past and begun to focus more and more intently on their oceanic approaches. They are, in someways, in a situation analogous to the one in the Soviet Union in the early 1960s when the Soviet Navy became subject to the visionary and energetic leadership of Admiral Sergei Gorshkov. The Chinese vision is unabashedly Mahanian. Great nations have great navies and great navies, in turn, contribute to national greatness. Long the sick man of Asia, China has arisen and the PLA(N) is considered its national due. That said, China is still a desperately poor country with huge internal problems. But what concerns many China-watchers is the fact that a definable pattern of activity has emerged over the past 20 years which suggests that Beijing is committed to developing a navy sufficiently large by 2025 that it will be able to exercise sea denial—at the very least—in the approaches to Asia.

The Chinese are well aware of the fact that their navy is old-fashioned and that it will be a long time before they can contemplate engaging the United

States Navy (USN) at sea. But they are determined to address their shortcomings in a systematic way, creating a fleet-in-being which will give the USN, and the other major regional navy, the JMSDF, pause for reflection. As seaborne American missiles acquire greater and greater ranges the Chinese will push their sea frontier farther and farther eastward in an effort to match those ranges.

The Chinese Army and Navy appear destined to rely heavily on land, sea, and sub-sea missile systems. Rather than embark on an aircraft carrier program, the Chinese are more likely to place their reliance on ship-killing missiles for most of the period under review. While their missile arsenal is still modest it is growing steadily and the acquisition of two 7,900-ton *Sovremenny* destroyers from Russia (with the possibility of two to four more to follow) has given the PLA(N) access to big, supersonic missiles designed to kill US carriers.

The Americans, of course, are well aware of this challenge (in many cases overstating it as they did with the Soviet naval threat in the past). They are also cognisant of the fact that they have allowed their own navy to deteriorate in terms of the number of aircraft carriers, mid-level surface combatants and attack submarines. Prior to his retirement, Admiral Archie Clemins, the US Commander-in-Chief Pacific, made an impassioned plea for increases in all three areas; arguing for a return to 15 carriers vice 12; an increase in the number of nuclear attack submarines (SSN) from 50 to 68; and an increase in the number of destroyer/cruiser hulls from 116 to 138.

Quite apart from the question of fleet size, there is the larger question of fleet allocations. It is a curious feature of the post-Cold War era that almost all of the short to mid-term crises have been in the Euro-Atlantic world: Haiti, Bosnia, Somalia, the Arabian Gulf and Kosovo (the transit of Taiwanese waters by two US carriers in 1996 being an important exception). Thus the Atlanticist inclination long fostered by the North Atlantic Treaty Organisation was maintained. In fact, Pacific Ocean operating areas were frequently denuded of major USN assets in order to meet the geo-strategic requirements of the Mediterranean and the Middle East. More recently, however, discussions of an indigenous European security community, developments on the Korean peninsula, and the much heralded 'rise' of China have tended to shift the Pentagon's focus toward the Asia-Pacific region. A deployment of assets from the Atlantic to the Pacific will, no doubt, be gradual (and may be difficult to discern if the USN adds significantly to its overall inventory of ships), but if it occurs it will create a more active operating environment for mid-sized navies like the RAN and the Canadian Navy.

Conversely, if for some reason it does not occur, it will also mean a more active operating environment. While, at first glance, this may seem a paradoxical

proposition, a dearth of US ships will no doubt result in requests from Washington for mid-sized navies to contribute hulls to operations such as the United Nations' interdiction operation in the Arabian Gulf. Thus, the RAN and the Canadian Navies (the JMSDF and ROK(N) are more problematic cases for the moment but will probably not be by 2020) could find themselves, early in the 21st century, under the same sort of 'imperial' pressure to contribute to fleet operations that the Australian and Canadian Governments were under on the eve of World War I.

The Canadian Navy is in good shape for the moment. It took delivery of 24 brand new ships during the 1990s. 12 of them were 4,800-ton *Halifax* class frigates. These ships were conceived in the 1970s, built in the 1980s, and delivered in the 1990s. Thus, the Canadian Navy found itself the unexpected beneficiary of state-of-the-art fighting ships in the post-Cold War era. It is unlikely that any Canadian Government today would be able to see its way clear to constructing a comparable array of sophisticated warships in 'peace time'.

At the same time the navy took delivery of twelve 970-ton maritime coastal defence vessels (MCDV). These smart little ships are intended to provide training platforms for naval reservists and liberate the navy's frigates and destroyers from inshore sovereignty and fisheries patrols. Furthermore, the MCDVs are intended to provide the navy with mine-hunting capability.

However, the other side of the story is that critical elements of the Canadian Navy are becoming outdated. The navy has four *Iroquois* class destroyers, vessels marginally bigger than the frigates and fitted out as command and control vessels as well as anti-air platforms. Despite extensive refits, they are elderly ships by naval standards. The same is true of the supply and replenishment ships (AOR). These ships—one on each coast, the Atlantic and the Pacific—are almost 30 years old and the navy is moving to replace them in the near-term.

Canada's naval profile will also be changing in 2001 with the entry into service of 'new' *Victoria* class (ex-British *Upholder* class) submarines. The navy operated so-called O-boats (British built submarines) from the mid-1960s to the beginning of the 21st century and is in the process of replacing them now with more sophisticated hulls. The numbers remain the same—four. The long term distribution of the hulls remains to be confirmed but the size and complexity of the oceanic environment in the Pacific argues in favour of two boats being stationed on Canada's west coast.

Conventional anti-submarine warfare (ASW) capable submarines (SSK) promise to be important constituents in the regional naval balance. Indeed, it could be

argued that *Collins* and *Victoria* class boats will have a disproportionate value in the context of collaborative endeavours with the USN. Upwards of 70 new submarines are likely to make their appearance in the Asia-Pacific region in the next 25 years. These are above and beyond the large number of old-fashioned submarines in the PLA(N)'s current inventory. The presence of this number of submarines in an age which is dedicated doctrinally to littoral warfare suggests that the USN will place a premium on being able to gain combat experience by operating with Australian, Canadian, Japanese and South Korean SSKs. It is also interesting to note that American concerns about the correlation of naval forces seems to be underscored by the decision to relocate some of the USN's fleet of SSNs from Pearl Harbor to Guam in order to be closer to the Asian shore.

During the 1990s the Canadian Navy articulated an Asia-Pacific policy which was reflected in three major developments. First, the navy repositioned east coast assets to the west coast. Whereas, traditionally, 70 per cent of the Canadian Navy had been located in Halifax (with hard operational responsibilities related to ASW and convoy escorting) and the balance had been based in Esquimalt (dedicated largely to training), the post-Cold War decade saw the proportions shift to a 55/45 ratio. Second, Maritime Forces Pacific developed a rolling five-year deployment program in which frigates, destroyers and/or the AOR, HMCS *Protecteur*, deployed to Northeast Asia on even years and Southeast Asia on odd years. These deployments were designed to develop navy-to-navy relations, enhance trade, and buttress Canada's diplomatic activities. Third, the navy became more actively engaged in large scale exercises like *RIMPAC* (Rim of the Pacific) and *Tandem Thrust* and it inaugurated the process whereby one of its west coast frigates was integrated on an annual basis into the USN's carrier battle or surface action groups operating in the Arabian Gulf. Not only did this integration demonstrate Canada's commitment to supporting the United Nations and the navy's commitment to working with the USN but it enabled west coast ships to hone their operational skills. In addition, it gave those vessels an opportunity to experience the latest developments in the communications realm. This is an issue of singular importance, particularly in view of the fact that one of the greatest challenges for mid-sized navies over the next 25 years will be keeping up with the USN in terms of cyberwarfare.

A host of questions surround the cyberwarfare phenomenon. To what degree will the USN (let alone the other three services in the United States) be able to communicate seamlessly between and among elements by 2025? Will the USN 'step short' so that it does not inadvertently disenfranchise its mid-sized naval colleagues in the realm of cyberwar? What choices will have to be made by mid-sized Asia-Pacific navies if they wish to remain abreast of the USN technologically? What price will the mid-sized navies pay if they do not remain

abreast; not only in terms of dealing with the USN in coalition settings (remembering, of course, that mid-sized navies do not operate on their own to any significant degree) but in terms of combating cyber attacks by other Pacific navies? And will mid-sized navies have to resign themselves to being excluded from an array of naval operations by virtue of a lack of interoperability?

There is, of course, a related concern. Even if there are high levels of technical interoperability how much information will the USN be prepared to share with its mid-sized partners? Similarly, will the mid-sized navies themselves remain congruent technologically and will they be prepared to share critical information in an oceanic environment that is likely to be more demanding rather than less.



Japanese Maritime Self Defence Force *Kongou* class AEGIS destroyer JDS *Myoukou*.
As well as air defence of the fleet the *Kongou* class ships contribute to the air
defence of mainland Japan.

These technological issues are only a few of the challenges confronting the Canadian Navy. Its sea-going helicopter fleet is increasingly shopworn and old fashioned. Although new maritime helicopters have been authorised their introduction to the fleet will be slow and upwards of half the period under review will have elapsed before all of the replacement machines are integrated into fleet operations. There are also concerns regarding maritime air capability as the number of long-range patrol aircraft declines and the remainder grow more elderly.

Maritime patrol aircraft (MPA) are, in many ways, forgotten constituents of mid-sized navies. And yet they are invaluable assets enabling fleet commanders to surveil huge areas of ocean in an efficient and systematic manner. Maritime surveillance is likely to become more and more important in the future. The spate of illegal migrant ships that fetched up on Canada's west coast recently (and comparable numbers arriving on the western flanks of Australia in 1999) has highlighted, once again, the importance of long-range maritime surveillance. At the same time drift net fishing, whaling (contrary to quotas), drug smuggling, hostile intelligence gathering, piracy, and accidents at sea suggest that mid-sized navies cannot afford to let their MPA capability decline. It is, of course, axiomatic, that the MPA issue is not exclusively a naval matter since MPA's (and indeed most naval assets) perform a variety of functions in support of other government departments. Thus, the maintenance of naval and maritime air capabilities should be seen as a national rather than a mere naval concern.

The Canadian Navy must also ensure that its AOR replacements are shepherded through the budgetary wars and brought to timely completion. The dispatch of HMCS *Protecteur* to East Timor in 1999 and the imbroglio in August 2000 involving the merchant ship GTS *Katie*, which was repatriating one tenth of the Canadian Army's equipment from southeastern Europe, (and which had to be boarded on the high seas by the Canadian Navy) underscored in an unambiguous way the importance of having commodious, multi-purpose heavy-lift ships to support Canadian military operations abroad.

Statistically, at least, there seems every reason to believe that mid-sized navies like the Canadian Navy will find themselves providing transportation to 'war' zones over the next 25 years. East Timor appears to have brought that message home to the RAN and the acquisition of modest lift capability by the JMSDF, in the form of the 7,900-ton *Osumi*, seems to be part of the same realisation.

The other critical problem facing navies like the Canadian Navy is determining what the operating environment will be like by 2025. By that time the *Halifax* class frigates will be either in need of replacement or will have been replaced. What will the new generation of ships be able to do? If anti-air warfare

dominated naval thinking in the 1990s—largely at the expense of Cold War ASW capabilities not to mention anti-mine warfare—will ASW make a comeback in view of the number of submarines scheduled to be operating in the Asia-Pacific region? Will mid-sized navies move away from ‘multi-purpose’ capability (itself an expression of tactical uncertainties) toward specialised roles within a maritime environment dominated by the USN? Will the reunification of the Koreas (thought to be 20 years away) trigger a withdrawal of American forces from Northeast Asia? Would this mean fewer opportunities to work with the USN and, per-force, a greater requirement to work with navies like the ROK(N) and JMSDF? Or conversely, will the continued rise of Chinese sea power (so far as one can make linear extrapolations) mean that the USN will be even more closely engaged on the Asian shore and mid-sized navies will be expected to play a more specialised role within that context?

The Japanese have a profound interest in these scenarios. They have a large, modern, and professional non-nuclear navy which has benefited operationally from its close association with the USN over the years. Much is made of the fact that with the collapse of the Russian armed forces Japan’s defence budget is the second largest in the world. But costs are extremely high in Japan and render state-to-state comparisons misleading at best and irrelevant at worst. Hamstrung by economic and political uncertainty, successive Japanese Governments failed to develop more visionary agendas for the JMSDF during the 1990s. Instead, the Japanese Navy remained securely within the confines of its relationship with the USN. However, toward the end of the decade the government did begin to exploit the navy’s inherent mobility and flexibility, using it as a tool for enhancing relations between Japan and South Korea. Mutual ship visits and a SAREX were a part of this rapprochement process.

At the same time the JMSDF saw action at sea, opening fire for the first time in its history on North Korean vessels in the Sea of Japan. The North Koreans had long been suspected of engaging in bizarre inter-state behaviour; behaviour that included using vessels to land kidnapping parties on the shores of Japan. Gunfire was only part of the sea change that occurred at this time. Shaken by the flight of a North Korean, three-stage *Taepo Dong* missile over Honshu in late August 1998, the Japanese agreed to join the Americans in developing a sea-based theatre missile defence system. This system is likely to be carried on board Japanese *Kongou* class Aegis cruisers, thereby obviating the need to establish contentious missile batteries ashore.

Another recent development has been the increase in tensions between the Japanese and the Chinese over incursions into Japanese waters by Chinese intelligence gathering ships. This problem is not likely to go away as the

PLA(N) deploys more frequently and farther afield. Indeed, during the period 1997 to 2000 the PLA(N) visited Australia, New Zealand, East Africa, Southeast Asia, North America and South America. These deployments constitute an uncharacteristic operational profile and are indicative of a navy that is intent on telegraphing its aspirations to the world in a more and more assertive way.

This can only be a source of concern to Tokyo in the long haul. Japan sees itself as living in a tough neighbourhood. It has either occupied and/or waged war with the Russians, Koreans, Chinese and Taiwanese not to mention the nations of Southeast Asia. Equally troublesome—if not more so—is the fact that China, Russia and probably North Korea are nuclear powers. What will Japan's prospects be if Russia succeeds in rising, phoenix-like? What will be the correlation of forces in Northeast Asia if the US withdraws from the Korean peninsula (and even Japan!) over the next quarter century?

All this suggests that despite the passivity and caution that have characterised JMSDF operations over the years, Japan has every reason to maintain its high-end, mid-sized navy. Unlike Canada and Australia, however, it is better positioned technologically in terms of its shipbuilding industry and its electronics capacity to ensure that JMSDF vessels remain modern and that it keeps up to date with the revolution in military affairs at sea.

The ROK(N) is less fortunate. While South Korea is bounded by the sea its' focus is on the land. By an accident of history the Korean peninsula is the last preserve of the Cold War and the absurdly misnamed Demilitarised Zone dividing North and South Korea is the setting for the globe's greatest military confrontation. It is hardly surprising, therefore, that 90 per cent of the personnel in the Ministry of National Defence in Seoul represent the army rather than the navy or the airforce. Ironically, the North Koreans have probably been the greatest inadvertent promoters of the ROK(N). Pyongyang has repeatedly utilised its aging submarine force (including midget submarines ideal for special operations) to put agents ashore in South Korea. This infiltration program has been marked by some celebrated failures. In one case a *Yugo* class submarine from North Korea ran aground on the north-east coast of South Korea. The commandos carried on board made their way ashore, executed the naval crew, and fled into the rugged countryside. This incident gave rise to probably the largest military manhunt in South Korean history involving tens of thousands of personnel combing the landscape in the autumn of 1996. Subsequently, an even smaller North Korean submarine found itself snared in fishing nets off the South Korean coast, and ROK(N) vessels sank two North Korean gunboats in a running battle off the west coast of the peninsula near the disputed maritime boundary.



South Korea's *Ulsan* class frigate *Chung Nam*. The ROK(N) has embarked on an ambitious program to build the KDX class destroyer.

These episodes have provided useful and timely ammunition for the ROK(N) in its campaign to develop its maritime power. Like the Japanese, the South Koreans have a very well developed shipbuilding and electronics industry but they have far less experience in building complex warships. Undaunted, however, and looking forward to the day when a united Korea will need a blue-water navy to patrol its vital ocean approaches, the ROK(N) has embarked on an ambitious building program—the KDX or Korean Destroyer Program. Currently, there are three generations of ships, KDX1 through 3; each one bigger and more sophisticated. Where the South Koreans will face real challenges will be in the integration of a catholic array of international components in a single hull. The other challenge will be gaining access to the latest Western missilery. Even if they do they will be years away from operating confidently and effectively in a deep ocean context.

What remains unclear is the relationship between geopolitics and naval ambitions. Presumably, if the peninsula is reunited in the future the overwhelming demand for army personnel and equipment will be dramatically reduced. Does this mean that there will be a corresponding transfer of funds within the republic's declining defence budget to the navy? Is it possible that the new nation of 70 million might declare itself non-aligned; leaning neither to China nor to the West? What will be the role of the national navy in either of these scenarios?

Whatever the case, there is a small and influential cadre of navalists in South Korea eager to see the ROK(N) transformed into a full-blown seagoing navy. It will be interesting to see whether decades of animus will be set aside over the next quarter century and the ROK(N) and JMSDF come together to work more closely. At least, they have a USN 'culture' in common and they may find common cause in the face of the PLA(N) and a revitalised Russian Navy.

What can we conclude from all of this? First, that the oceanic environment in the Asia-Pacific region is likely to become more demanding over the next 25 years. Following the Asian economic crisis regional mid-sized navies will resume their growth and operations tempo. Jurisdictional disputes and competition for diminishing stocks of renewable resources will ensure that the maritime scene continues to engage regional navies and foreign ministries. Furthermore, the growth of the PLA(N) will alter the naval correlation of forces significantly and may create Cold War conditions at sea.

Second, the mid-sized navies under review—the Canadian, Japanese, and South Korean navies—will be faced with the predictable challenges of remaining modern (replacing hulls, ensuring aerial support, etc) and of remaining interoperable with the USN. This will be no small undertaking and the question of interoperability will be compounded by the problem of information access. These are not new problems but they are likely to become more profound problems.

Third, confronted by a volatile technological and military landscape, the mid-sized navies will have to decide what their top priorities are. Are they to specialise in anti-air warfare or anti-submarine warfare? Are they to be multi-purpose? And so forth. Once again, these are choices that many navies have had to make of late. What is worrisome is that the rate of change is accelerating. Thus, the room for error is growing smaller. That said, the mid-sized navies in question will probably cleave to multi-purpose configurations.

Another aspect of the question of roles is the degree to which mid-sized Asia-Pacific navies will be drawn into East Timor-style operations in the future. Will

there be requirements for amphibious operations; operations across a beach rather than across a jetty? For the moment, the former seems unlikely but there is hardly such a thing as ‘unlikely’ in military planning.

Fourth, what will be the interplay between geostrategic and naval developments, particularly with regard to the South Korean (or Korean in a post-unification setting) and Japanese navies? What those navies find themselves doing in the year 2025 will be determined, in large part, by the USN’s regional posture. The same is true, to a lesser extent, for the Canadian Navy. Operations with the USN are likely to remain a top priority as they have been for the past 50 years.

Whereas a number of the chapters in this book address the technological changes likely to affect mid-sized navies in the Asia-Pacific region, the object of this chapter has been to examine the larger security context in which the Canadian Navy and, to a lesser degree, the South Korean and Japanese navies are likely to function in the next 25 years. Predictably, such an exercise raises more questions than it answers. The biggest challenges will be political rather than technical. Will the political decision-makers in the countries under review understand seapower sufficiently well to ensure that their respective navies are able to meet the challenges of national and international security in an increasingly dynamic Asia-Pacific maritime environment?

Part | 3

Using the air from the sea

Dr Eric Grove

This chapter discusses organic air capabilities and their application in medium sized navies. However, before proceeding it is necessary to define organic air and medium navies. Organic air power can be defined as air assets that are actually carried in ships (this does not include cruise missiles in submarines, which are discussed in another chapter). These assets can be fixed or rotary winged and the vessels that carry them either optimised for the task or have a more general capability of which the aviation component is a part, eg. a frigate or supply ship. All this is fairly straightforward. Defining medium navy however is more difficult. With personnel strengths of 40-50,000 and a range of capabilities including nuclear attack and ballistic missile submarines, as well as aircraft carriers and a major amphibious squadron, the navies of the United Kingdom and France qualify in a special 'upper second class' category of fleets. Arguably this category also includes the Russians and the Peoples Republic of China. It then begins to blur as the nuclear powered submarines disappear. India, Japan and Italy all have navies with the same number of personnel as the British and the French and all have carrier type ships. It is perhaps best to put these at the top end of our 'lower second class' category which can then be brought down via Spain and the Republic of China to navies with strengths of about 10,000 and significant fleets of major surface combatants and submarines. Australia comes out about the middle of this group to which the rest of this chapter will primarily refer.

It is part of the definition of such a medium navy that it has at least some organic aircraft. Virtually all truly modern major surface combatants have at least one helicopter as part of their weapons suite; it is a key asset both for anti-submarine warfare (ASW) and countering fast attack and similar surface craft. In the latter role missile firing helicopters have decisively called the bluff of the missile boat that had its brief moment of glory from 1967 to 1991. In the ASW role the active dipping sonar helicopter is even more useful than before with an increased emphasis on the conventional submarine threat in littoral waters. It seems strange now that the original specification for the new Royal Navy (RN) helicopter, the *Merlin*, did not include such a capability. The users are extremely impressed with the performance of the AQS-960 dipping sonar that was added to supplement the sonobuoys of the original. Even the

largest ASW helicopter can be embarked in a frigate designed for the purpose, while the supply ship also lends itself as a platform for such aircraft.

Helicopters are also vital components of amphibious capability in an era of ship to objective manoeuvre (STOM). It is this that has brought even the Japanese Maritime Self Defence Force to procure flat-top ships and helicopters and, of course, helicopters form an important part of the capability of HMA Ships *Kanimbla* and *Manoora*.

There seems to be broad consensus that the helicopter is a natural organic component of fleets. Not so the ship based fixed wing aircraft. Indeed rarely has there been such controversy surrounding a military capability. The prophets of 'air power' (ie. *land based* air power) have almost always tended to argue that ship based aircraft are unnecessary and expensive luxuries, especially when navies have been competing for scarce resources of funding and industrial capacity. Land based aircraft, these siren voices have argued, could carry out all necessary fighting functions over and from the sea as well as over the land. Moreover aspersions have been persistently cast on both the cost-effectiveness and the vulnerability of aircraft carriers. These arguments have had some success, especially both in Australia and the United Kingdom (UK) where existing carrier capabilities were abandoned, happily in the UK case not terminally.

In the 'upper second class' navies the tide has happily turned. Most operate at least one fixed wing aircraft carrier in either the conventional take off and landing (CTOL) mode with catapult and arrestor gear, short take off but arrested recovery (STOBAR) mode with ski-jump and wires or short take off and vertical landing (STOV/L). Most seem agreed that the Chinese Peoples Liberation Army (Navy) plans to acquire a carrier of some type (probably a STOBAR ship) in the not too distant future and that helicopter carrying training ship/transport *Shichang* is but a preliminary step. Both European members of this group are either commissioning or planning new ships, larger than their predecessors.

Some 'lower second class' navies also possess fixed wing carriers. The former British light fleet carrier is still not quite extinct in the shape of the Brazilian *Minas Gerais* with her recently updated A-4 *Skyhawk* air group and the last of the line, the Indian *Viraat*, with her *Sea Harriers*. *Harrier* type aircraft also equip the Spanish *Principe De Asturias*, the Italian *Giuseppe Garibaldi*, and the Thai *Chakri Naruebet* (although she has reportedly not been to sea or operated aircraft much for some time. Indeed, the status of the Thai navy in this category is questionable in all but numbers of personnel. It does not operate submarines and has only four surface combatants fully fitted for helicopters.) Most of the above navies expect to expand their carrier forces. India plans another ship,

probably the former Russian *Admiral Gorshkov*, converted to STOBAR. Brazil has plans for a replacement carrier in the 35-40,000 ton category and Italy plans to replace the 9,500 ton helicopter cruiser *Vittorio Veneto*, that seemed to promise the brave new world of such ships in the 1960s, with a fully fledged 22,500 ton through deck carrier-assault ship planned to commission about 2007 to carry a mixed helicopter/*Harrier* air group.

What do these nations get for their investment? Captain Waite, Chief Staff Officer (Operations and Capability) to the RN's Flag Officer Naval Aviation, put it well at a recent conference in London.² 'A carrier is not just a mobile airfield you simply move into a location and fly from. It has inherent mobility, which if used intelligently and in concert with a surge profile to deliver offensive air operations, provides the force commander with a powerful asset.' Land based air is not always available, Captain Waite continued:

...and you do not have to be far from the fighter bases to make such provision very asset intensive, dependant upon weather at fixed bases, and therefore unreliable. The advantages of carriers include the fact that cloud bases are usually higher over sea than over airfields; you never have a cross wind and you can manoeuvre your carrier to areas of good weather, in particular running before weather fronts then sprinting back through them to clear air on the windward side, thus minimising lost flying time. Finally if the weather is bad, it is also bad for offensive operations against you. The situation where you have no organic fighter capability; the weather over you is gin clear, but the airfield providing your fighter cover is socked out is a very uncomfortable one. The only way you can guarantee fighter cover at sea is to have it with you.

And, he might have added, as shown in the Adriatic, the only way to guarantee air cover for forces ashore well within normal combat ranges of land based assets is to have a mobile platform that can avoid morning fog.

Too often the argument between ship and shore based air is put in either/or terms but this dangerously oversimplifies the situation. In many situations a mix of sea and shore based assets provides maximum flexibility to joint forces. A paper presented ten years ago would not have used the Adriatic as a proving scenario for carrier based aviation but British experience in 1993-4 did much to make the case for improved carrier capability in the *Strategic Defence Review* of 1997-8. In 1994 only seven *Sea Harriers* in *Ark Royal* were providing not only a capability to fill in weather created gaps in the Allied air operations covering the United Nations (UN) Protection Force (UNPROFOR) ashore but also reassurance to the Major led British Government that there was a national asset capable of providing air support to British forces with no allied or UN

'strings' attached. This was a condition for the deployment of British ground forces in a highly uncertain situation. *Ark Royal* was always kept in a separate national UK task group; her aircraft only chopped to the North Atlantic Treaty Organisation (NATO) when they left the flight deck on agreed NATO *Deny Flight* offensive counter air or exercise close support missions. Purely national operations were a contingent possibility in certain circumstances.³

This example is stressed it demonstrates the utility of a small carrier with a small number of aircraft of limited capability supporting peace support operations in a politically confused and uncertain situation ashore where a country was breaking up. It does not require much imagination to transfer such a scenario to this region.

This is not to say that small is necessarily beautiful in carrier design. As in many things, to quote the *Renault* advertisement, 'size matters'. Bigger ships can operate more aircraft more economically. They are also less vulnerable as the increased chance of being found or hit is negligible compared to the proportionally diminished damage caused by any hit. Moreover larger ships need not be proportionately more expensive as, to quote a phrase common in the UK at the moment, 'steel is cheap and air is free'. On the other hand, the bigger the ship the more psychologically and politically difficult it may be for supporters to convince sceptical defence establishments and cabinets that they are not suffering from delusions of grandeur. Even in Britain the RN's carriers had to masquerade as 'through deck cruisers' until the first entered service and all three were safely laid down. As Brazil demonstrates, one does not have to be an upper second class navy to be in the market for a vessel in the 30-40,000 ton bracket but smaller ships of half the size can still be useful and, in some circumstances, vital. They are certainly better than nothing.

Even quite small carriers can put up impressive sortie rates. In the Gulf in early 1998 in the crisis over UNSCOM inspections, HMS *Invincible* with her joint air group of 16 aircraft, eight *Sea Harrier* FA2s and eight *Harrier* GR7s, was able to put two packages of eight aircraft over Iraq in each 24-hour period. *Invincible*, operating up-threat and closest to Iraq of all the carriers engaged, was providing up to a third of the mission packages in which her aircraft flew. As her Commanding Officer reported the Americans were most impressed at the sustained rate at which *Invincible* flew her aircraft.⁴

As mentioned above the tactic of 'surging' can also be used to optimise the capabilities of a limited number of aircraft. As Captain Waite vividly explains:

...gains in surge peaks should more or less make up for losses in the troughs when repair and maintenance can be carried out....surge activity

is most effective for offensive and power projection operations, the object here being to align the peaks of your activity with the key events in the overall campaign plan. The concentration of force in time and space: another principle of war and a real battle winner if you get it right.⁵

The reason *Invincible* was operating her aircraft in the Gulf was the unwillingness of most of the locals to give host nation support for the armed coercion of Iraq. The provision of land bases for shorter ranged aircraft cannot be taken for granted. Even if they are generally supportive of a mission politically, nations might be unwilling to allow their airfields to be used for strike missions



The *Invincible* class aircraft carrier HMS *Illustrious*. In many cases the safest place to be is on a mobile base at sea.

against a neighbour. The threat of terrorism might be a consideration. More acceptable might be the operation of less visible support aircraft, notably tankers, in synergy with more combatant sea based air assets.

Aircraft based ashore on fixed airfields are vulnerable to a wide range of threats, conventional and unconventional. In many circumstances the safest place to be is on a mobile base at sea. A lot of myth surrounds the supposed vulnerability of aircraft carriers. Aircraft carriers are not especially vulnerable things, certainly they are not vulnerable platforms compared to other types of warship—including submarines. Neither are they vulnerable compared to aircraft. Although carriers have been heavily engaged on operations since, 1945, the last carrier of any nation to be sunk was the Japanese *Amagi*, by air attack at Kure on 24 July that year. Her sister *Unryu* had succumbed to submarine torpedoes in December 1944. By this time Japanese home waters had become a pretty hostile environment. In these circumstances it is perhaps of significance that three major Japanese carriers, *Hosho* (the first), *Junyo* and *Katsuragi* survived the war to be used as repatriation transports. Moreover the giant *Shinano*, lost to four submarine torpedoes because of execrable damage control in November 1944 took no less than seven hours to sink.

The Americans did not lose a large carrier after the *Hornet* in October 1942, less than a year into a fierce four-year conflict. Only one of the nine smaller *Independence* class carriers was sunk, at the Battle of Leyte Gulf in October 1944 and none of the seventeen *Essex* class fleet carriers commissioned before the end of World War II was lost although most were heavily engaged and some badly damaged. Inevitably, the small escort carriers (CVE) proved more prone to loss with six sunk to various causes but that was out of a total of over 75 commissioned before the war's end. Some of these CVEs took major *Kamikaze* hits and survived. Inevitably it was the smallest ships of the *Casablanca* class (11,000 tons) that proved most vulnerable, all but one of those lost coming from this group. US carriers have led active operational lives since 1945 but none has been sunk since the CVE *Bismarck Sea* took a large twin engined bomber *Kamikaze* on the after elevator off Iwo Jima on 21 February 1945.⁶

Carriers are robust because they can defend themselves in three dimensions and form the core fighting capability of any group of which they are a part. Although it is often argued that a carrier's escorts are only there to protect the larger ship this should not be over-stated. Rather the entire group forms an integrated fighting unit in which the vessels provide mutual support. Surface ships without carriers are probably more vulnerable than carriers without surface ships. In relatively benign environments carriers can operate alone, without close escort, as British carriers usually did in the Adriatic in 1993-4. Moreover

a carrier's fighters are not merely defensive armament protecting the ship. They are an anti-air warfare capability that can be strategically offensive even if operationally defensive, as the Japanese found to their cost at the Battle of the Philippine Sea and as the Soviet Naval Air Force might have found out if the Cold War had gone hot in the 1980s.

As with all weapons platforms and systems the way they are operated has much to do with a carrier's vulnerability. The carrier has one fundamental advantage over a fixed airfield; as a mobile platform it is very hard to find. Captain Waite yet again puts it well:

The very nature of the sea may provide the bulk of your force protection for you, but only if you use it wisely and well. Unless you have to, do not operate very close inshore in a static location, where enemy reconnaissance cannot be denied. Ships over the horizon, properly handled are difficult targets both to locate and hit. Anyone trying to prevent you achieving your objectives will need an 'at sea warfighting capability' of some sophistication. The further over the horizon you are, the less predictable your movements, and the less time you spend in any one location, the more sophisticated that capability must be. It may be that this is virtually all you need do to create a near benign environment from the less sophisticated air and surface threat.⁷

Even if there is some danger of attack the carrier's mobility can be turned to advantage. Captain Waite once more:

Don't be there when that attack happens. Manoeuvre your carrier group within the battlespace so you are forward attacking the enemy during the peaks of your cycle and well back out of range during your troughs. Move in, punch hard, move out; conduct your maintenance and repairs, then re-appear again at a time and place of your choosing and where least expected, to hit him again. The timing of this cycle should be such as only to be forward and therefore vulnerable within the reconnaissance/decision/action cycle of the enemy. Unless he has a sophisticated and well-practised war at sea capability, this is a very difficult tactic for him to counter.⁸

The emphasis above on the level of capability needed to counter a properly handled carrier group is noteworthy. It might be doubted whether many nations in the Asia-Pacific region have the required combination of assets for effective anti-carrier warfare. Indeed luring weaker forces into the attempt at anti-carrier warfare might be a fruitful means of destroying them.

Carriers therefore offer secure mobility for their aircraft. Small to medium sized carriers generally operate one type of fighter attack aircraft. Currently

these are *Harrier* derivatives in STOV/L ships, and variants of more conventional aircraft in France's *Charles De Gaulle* and Russia's *Kuznetsov*. It is currently expected that the *Harrier* replacement in both Britain and with the United States (US) Marine Corps (who operate STOV/L fighters off their flat-topped assault ships) will be a STOV/L variant of the Joint Strike Fighter. This is likely but far from certain for a number of reasons, not least the funding squeeze in the US caused by the existing F-22 and F/A-18 E/F programs. Ski-jumps and the high thrust to weight ratio of contemporary fighters makes STOBAR operations a practical half way house between STOV/L and the CTOL operations that more or less dictate nuclear power, at least if steam catapults are used. A STOBAR carrier might not need to be too large if size was a problem. Its aircraft could not be identical to land based variants of the same type but the cost of modification might not be too much (navalising the European Fighter Aircraft (EFA) for STOBAR is currently estimated as less than five per cent of total cost per aircraft).

The trend, in any case is to maximum commonality of aircraft in joint air wings. The British have formed Joint Force 2000, a mixed force of RN *Sea Harriers* and Royal Air Force *Harrier* GR-7s, both of which will be replaced—if all goes according to plan—by the same joint strike fighter. Indeed there is nothing to stop the entire fixed wing component of the air wing being part of the air force if that prevents the latter service taking refuge in Trenchardian ideology to kill the program. There are some potential disadvantages in this, notably the lack of naval officers with fixed wing aviation experience but secondment of naval officers to carrier squadrons might solve this. However, no-one should need reminded of the defects normally attributed a similar system in the UK in the period 1918–39 but this period is still to be satisfactorily analysed historically for the lessons to be properly learned. Certainly the problems such as those the Royal Australian Navy faced in obtaining aircraft from the Royal Australian Air Force in the inter-war period and chronicled effectively by David Stevens are to be avoided at all costs.⁹ It is to be hoped that the UK's experience with Joint Force 2000 can be turned to good account in vindicating the idea of air force units treating a carrier as any other airfield. Navies and air forces must, if at all possible, shed their cultural prejudices—which are not all on one side—in the national interest. Organic maritime air power is potentially too useful and important to be sacrificed on the altar of service theology.

Any small carrier needs organic airborne early warning capability to operate its aircraft effectively. This can be provided on non-catapult ships by helicopter and the latest aircraft have both data links and overland search capability. Further improvements are planned with a possible V-22 derivative allowing a

pressurised cabin for higher altitudes beyond 10,000 feet. As with STOVL or even STOBAR capable fighters the expanding carrier market makes relatively cheap 'off the shelf' procurement a possibility for the lower second class navy.

In conclusion, should Australia have organic maritime air power beyond her existing helicopters? The answer is an unequivocal 'yes'. As her national anthem reminds her Australia is surrounded by sea which is her primary mode of access to the region. A mobile, self-contained air base that can move in this medium would give Australia's air power greater flexibility and deployability. Given the regional threat environment such a floating base might well offer the greatest possible security for the deployed aircraft. The latter could be mixed and matched according to the mission required and they could come from whichever service was deemed most appropriate as is done with helicopters today. The growing fashion for maritime aviation will provide a number of assets that can be obtained off the shelf at relatively limited cost, perhaps even a second hand ship capable of being given service life extension refits (the *Invincibles* spring to mind). A through deck ski jump ship added to Australia's existing amphibious transports would provide an expeditionary whole that is definitely greater than the sum of its individual parts. A carrier type vessel would also enhance significantly the utility of the frigate and destroyer force that might have to be reduced a little in numbers over time to provide personnel for the extra ship.

East Timor may be only the first of a number of conflicts of Indonesian succession into which Australia cannot help but be drawn. The lessons of the Balkans are that carrier based air can be almost indispensable for peace support operations in such circumstances giving a range of contingent options to support—or evacuate—forces deployed ashore. A carrier type ship also gives opportunities to make contributions of greater political and military significance to coalition expeditionary operations in support of common Western interests throughout the Asia-Pacific. It will soon be fifty years since HMAS *Sydney* made her vital contribution to the war in Korea. It would be an excellent way of marking the anniversary to make at least a commitment to the resurrection of a capability that it is surprising Australia has gone so long without.

Notes

- 1 The author uses the academic grading concept of first class, upper second class, lower second class and third class, as a means of grouping navies.
- 2 Captain Christopher Waite, 'Air Warfare—A Royal Navy Perspective' paper presented at an SMI Conference, *Naval Force Protection*, 19 January 2000.
- 3 E. Grove, 'Navies in Peacekeeping and Enforcement: The British Experience in the

- Adriatic Sea', *International Peacekeeping*, Winter 1994; E. Grove, *The Ark Royal Years*, privately published as the ship's decommissioning book in 1994.
- 4 Captain James Burnell-Nugent, 'HMS Invincible and Operation Bolton—A Modern Capability For A Modern Crisis', *RUSI Journal*, August 1998.
 - 5 Captain Christopher Waite , 'Air Warfare—A Royal Navy Perspective'.
 - 6 Historical details from *Conway's All The Worlds Fighting Ships 1922-46*, Conway's, London, 1980; and K. Poolman, *Allied Escort Carriers of World War Two In Action*, Blandford, London and Sydney, 1988
 - 7 Captain Christopher Waite , 'Air Warfare—A Royal Navy Perspective'.
 - 8 Captain Christopher Waite , 'Air Warfare—A Royal Navy Perspective'.
 - 9 D. Stevens, 'Australian Maritime Aviation: A Strategic and Historical Context' in ed. D. Stevens, *Prospects for Maritime Aviation in the Twenty First Century*, RAN Maritime Studies Program, Canberra, 1999, pp 4-5.

Land attack missiles for medium navies

8

Dr Lee Willett

Our first priority is to increase the ADF's combat capabilities. The purpose of military forces is to deliver effective combat-power on the battlefield, wherever that might be...We will increase combat elements and combat capability in the ADF through carefully redirecting resources...

Hon. Ian McLachlan (former Minister for Defence)¹

The words of the former Minister for Defence have continuing resonance today for Australia and its discussions of acquiring a sea-launched, land attack cruise missile capability. The Australian debate here has focused largely on the *Tomahawk* land attack missile (TLAM). Yet if Australia and other navies in the Asia-Pacific region are to develop land-attack programs, such programs must be needed—rather than just desired—and must be affordable. As an embryonic debate develops in Australia on enlarging its security perspective—from the defence of what is known as the inner arc to an active participation in joint and combined regional operations—Australia must develop clarity in understanding of the reasons behind any change in strategic outlook. More specifically, although TLAM might be made available by the United States (US) to some navies, its purchase must fill a capability gap, a strategic niche. The question for Australia, as for any navy, first must be 'why', before 'what'.

The post-Cold War world is as unstable as the pre-World War world. Yet all that can be predicted about the future is its unpredictability. Throughout history, the flexibility provided by naval forces has proved most capable in tackling such unknown challenges. Naval presence and influence are widely accepted tools of diplomacy and 'almost uniquely they have enabled political objectives to be attained without recourse to force of arms'.² Their flexibility enables the imposition of appropriate political and military footprints.³ Maritime forces, or forces based at sea, with their ability to influence events in both blue water and littoral scenarios, are a key military factor in the Asia-Pacific rim (RIMPAC), the largest maritime theatre in the world. Through presence, reach, forward deployment, mobility, flexibility, readiness, sustainability, diplomacy, sovereignty and firepower, forces based at sea present governments with balanced and wide-ranging political choices.

This chapter addresses the following issues. What is a 'medium navy'? Are land attack weapons a viable option for medium navies? What cruise missile options are available? Can cruise missiles contribute effectively to joint and combined operations? In what role would medium navies use such weapons—deterrence or war fighting? How many rounds (and of what types) are most appropriate for such needs? Is there a cut off point for force size below which cruise missiles are not a sensible proposition? What are the associated costs? What is the US and British experience of TLAM?

Cruise missiles and medium navies

The United States Navy (USN) defines a cruise missile as an 'armed, unmanned, self-propelled, guided missile sustained in flight by aerodynamic lift over most of its range'.⁴ Defining what is a 'medium' navy is not so straightforward. Much literature exists on a subject that amounts to a discussion of a 'global naval hierarchy'.⁵

First, should 'medium' navies be defined by geostrategic parameters? In terms of RIMPAC, India, Japan, China, Canada and Australia possess the 'ability to project force into the adjoining basin'.⁶ Moreover, is a regional medium navy also a medium navy on a global scale. Or can a medium global navy be a major local navy? Paul Dibb defined Australia as 'being perceived as being by far the largest power' in the South Pacific.⁷ Eric Grove develops this point, arguing that the geostrategic nature of the region means that regional actors such as Australia and New Zealand have importance and reach measured in thousands of miles.⁸ From the Australian perspective, Grove notes that:

A world where superpower rivalry has had the edge taken off it by a new and more substantial era of détente, and where other naval powers...are becoming more active, also allows other states to play a more leading role in the local naval balance. They may indeed be able to assert a local naval leadership. Such a state is Australia.⁹

This role has potentially greater significance given that RIMPAC is arguably not a single strategic system, but is made up of several regions.¹⁰ Moreover, this role will become increasingly relevant with the rise of several new regional maritime powers, namely—as Commodore Sam Bateman stated—'China, Japan, India, South Korea, Taiwan, and in the longer term, Indonesia and possibly other ASEAN [Association of South East Asian Nations]...countries'. Bateman adds that there 'is little reason to doubt that the area's maritime power will grow broadly in line with its economic power'.¹¹ With this in mind, perhaps there is a link between medium naval capabilities and gross domestic product?

Second, should 'medium' be defined by capability? Does the deployment of aircraft carriers, major amphibious units and nuclear-powered submarines or

nuclear-capable weapons give a navy 'medium' status? Britain, France and Russia fit into a rank of what might be defined as a 'first class navy'; a standing supported by a strategic triad of aircraft carriers, nuclear submarines and amphibious forces. In the long term, perhaps China, India and Japan can aspire to this status. Both China and India actively are pursuing aircraft carrier, nuclear-powered submarine and nuclear weapons programs. Japan continues to deploy some of the world's most sophisticated naval weaponry.

In terms of capability, perhaps an over-the-horizon, land attack cruise missile capability is equally as important in an era of power projection into littoral areas as the possession of carriers, nuclear submarines and amphibious platforms. As early as 1988, USN Vice Admiral Henry Mustin argued that the 'power projection capability represented by U.S. SLCMs [submarine launched cruise missiles] is as important to our naval strength as were earlier developments of the aircraft carrier and nuclear submarines'.¹² There are strong arguments that today's strategic environment is dominated by, among other things, 'the primacy of precision munitions, principally those delivered by missiles'.¹³ Improvements in anti-ballistic missile defences (and the topicality of this particular technology) suggest that cruise missiles might be a cheaper, more practical and strategically more enduring option. China and India are both developing indigenous cruise missile capabilities.¹⁴ Research suggests that the Australian, Canadian, Dutch, French, Israeli and Japanese navies have all expressed to the United States (US) particular interest in procuring TLAM itself.¹⁵

This definition combines both geography and capability. Yet both definitions and rankings should be evolutionary. Perhaps as good a definition as any is provided by Rear Admiral Richard Hill, who argues that a medium maritime power is any navy which has the capability to exercise some autonomy in its use of the sea.¹⁶ These points indicate that 'medium' navies should be defined by capability, but also by geography because of the reach provided by forces based at sea.

Cruise missiles have significant potential impact here. They are a force multiplier of significant magnitude for a medium navy. The acquisition of a long-range land attack cruise missile capability would improve immeasurably the status of a medium force like the Royal Australian Navy (RAN), particularly if its cruise missile fit consisted of a weapon with the capabilities and reputation of TLAM.

Britain and TLAM

In 1994, Britain took the decision to procure 65 Block III conventional TLAMs (TLAM/C) from the US.¹⁷ The first fit entered service aboard HMS *Splendid* late

in 1998, and *Splendid* fired Britain's first TLAM in anger on 24 March 1999 in the North Atlantic Treaty Organisation's *Operation Allied Force* in Kosovo. Britain procured TLAM as a weapon of strategic coercion. Britain's 1998 *Strategic Defence Review* (SDR) mandated that all British nuclear submarines (SSN) will be fitted for a torpedo-tube TLAM capability, extending Britain's ability to project power at distance 'for deterrence and coercion', particularly of rogue regimes.¹⁸

To any potential adversary, '70% of the earth's surface is covered by submarines'.¹⁹ With the in-land reach of TLAM, this figure is greater-still.²⁰ Submarine-launched TLAM is a force multiplier which brings new and dramatic enhancements to British capabilities.²¹ For the first time Britain's already-existing SSN force—a fleet with the in-built strategic disposition for power projection—is able to reach in-land, at distance and to beyond the littoral with considerable and precise deep-strike point target force from a covert sea-based platform. To quote *Splendid's* Commanding Officer, Commander Richard Barker RN, for Britain SSNs are 'self-evidently the ideal delivery platform, operating at low levels of self-risk and unsupported for extended periods'.²² TLAM gives Britain the opportunity to apply maritime force across all levels of warfare from deterrence to the shaping of the strategic and operational battlespaces. Also, its stand-off capability and precision offer reduced risks both of collateral damage and to friendly forces and non-combatants.

Reflecting the grand strategic mood of the national maritime military capability—as set out in SDR, in Britain's evolving maritime doctrine *BR1806* and in the Royal Navy's (RN) new operational concept of the *Maritime Contribution to Joint Operations*—aircraft carriers, amphibious forces and TLAM-capable SSNs form an effective power projection triad as the principal platforms in this framework.²³ Power projection is 'the ability to project force from a maritime force into the territory of another state. It is any deployment of force ashore or the provision of fire to influence events ashore'.²⁴ *BR1806* states that TLAM-capable SSNs 'have a power projection capability of considerable range and penetrability, with important uses for naval diplomacy'.²⁵

Colin Gray notes that it is 'the essence of seapower to function as a great enabling instrument of strategy, to be adaptable to evolving technological and tactical conditions, and to function at all levels of conflict with enormous flexibility'.²⁶ TLAM is an important asset in these contexts. Sea-launched cruise missiles such as TLAM bring much to medium-level navies, notably presence. Presence is often defined as 'gunboat diplomacy'.²⁷ To quote US military author John Gresham, 'we used to have gunboat diplomacy, now we have Tomahawk diplomacy'.²⁸

In a new maritime era, the use of the term 'maritime' re-emphasises how maritime power refers not to just naval power, but to the use of forces based at sea to project influence from the sea. With the use of fixed- and rotary-wing aviation, land attack missiles and amphibious forces, there is no longer a need to write of 'joint air-sea, or sea-air, warfare': as Gray argues, the most potent threat offered by navies in a contemporary context is 'the ability to strike from the sky with manned and unmanned aerial vehicles. Air power and sea power have been fused...Seapower and airpower have become inter-dependent'.²⁹ Sea-launched cruise missiles such as TLAM are an emerging technology at the forefront of such strategic thought. TLAM is a core capability at the tip of Britain's maritime spear.

Block III TLAM can provide credible military force in bringing precise fire to bear at the place and time of choice. The USN's new *Tactical Tomahawk (TacTom)* and the Dispenser (TLAM/D) are more appropriate to direct support of ground forces. However, their use arguably requires considerable numbers. When available in such numbers, TLAM possesses greater tactical responsiveness. In Kosovo, for example, TLAM 'was the most responsive of all the weapons available to the task force commander'.³⁰ Yet direct naval fire support is perhaps not so appropriate to limited numbers of missiles assigned to a maritime strike requirement. The Block III is more appropriate to strategic coercion, maritime strike and the shaping of the battlespace through suppression of enemy air defence (SEAD) operations, particularly in joint and combined operations. TLAM use in SEAD operations enabled the entry of follow-on forces into theatre in the Gulf War, *Operation Desert Fox* against Iraq in December 1998 and in *Operation Allied Force* over Kosovo in the spring of 1999. In each of these operations TLAMs, launched from surface ships and submarines, were the first weapons to be fired. The contribution as an enabling agent of a stand-off weapon with the reach and precision of TLAM is well-proven.

Britain has learned two fundamental lessons from its use of TLAM. First, if TLAM is to be employed effectively for strategic deterrence and coercion—as Britain intends—then its employment must be surrounded by a credible and appropriate political context. Second, a widely-held (but unstated) view is that the initial purchase of 65 rounds is, with experience, proving too small for British purposes. US use of TLAM has generated criticisms that: repeated use may have eroded TLAM's coercive and deterrent value³¹; and that use in 'pointless drive-by shootings' questions the viability of employing limited precision bombardment to implement coercive diplomacy.³² Kosovo highlighted the strategic primacy of unmanned, stand-off weapons in projecting power in an age when battle damage assessment is often provided by Cable News Network

(CNN) cameras. In an era of casualty intolerance, TLAM is perceived as a low cost, and politically clean, method of intervention. Yet if precision weapons such as TLAM are to be used for strategic coercion, they must be employed within the correct political and strategic framework. There is a danger that the impact of maritime forces such as TLAM will be undermined if such weapons are used in isolation from other forces. To maximize war-fighting effectiveness, particularly when only limited rounds are available, TLAM should be employed as an in-theatre enabling agent for a total force package. Without a credible, coherent and enduring political context and without a commitment to use force to its conclusion, TLAM cannot be the 'wonder weapon' the target state and user state envisage it to be. For its own purposes Britain must work to develop some principles of coercion. Yet if cruise missiles are of interest to medium navies as an instrument of power projection and coercion TLAM—if employed correctly—is a cost-effective and proven weapon for exercising strategic choice in deterrence.

The case for an Australian cruise missile

Australia's maritime security

Australian security is inextricably linked to that of RIMPAC as a whole. To quote Admiral Archie Clemins, USN, Commander-in-Chief of the US Pacific Fleet, '[t]he Pacific Century is at hand'.³³ Much of this significance derives from the region's economic importance: RIMPAC contains two of the world's largest three economies (in China and Japan). On top of this, six of the largest armed forces and 56 per cent of the world's population are found in the Pacific Rim. With ocean covering most of its 102 million square miles maritime issues, and maritime power, will always been on the agenda.³⁴ The maritime role and economic strength of the region is manifested in the pursuit by many regional players of more capable maritime forces. As Geoffrey Till has argued, maritime power seems to be entering a new era in the new millennium, one likely to be dominated by the new and expanding navies of the countries that are mainly to be found around the Pacific Rim'.³⁵

Australia sits squarely at the fulcrum of critical sea-lanes of communication between RIMPAC and the rest of the world. Revisions of Australian military strategy and maritime doctrine are currently underway. It is widely anticipated that these reviews will signal a fundamental shift in Australian strategic policy from continental defence of the inner arc to power projection, emphasizing the RAN's power projection and maritime strike contributions to joint and combined regional operations.³⁶

The 1994 defence white paper, *Defending Australia*, noted that a:

...primary objective in defending Australia would be to prevent hostile forces from reaching our territory or from launching successful attacks against Australia's interests in our sea and air approaches...The Government has made a substantial investment in recent years in surface ships and submarines. This reflects the strong maritime emphasis in the concept of depth in defence.³⁷

The 1997 strategic policy review, while noting that the *Collins* class conventional submarines would provide a principal platform for maritime strike, concluded that a weapon with the very long range of TLAM was not required to support the enduring strategic emphasis of defence of the maritime and air approaches.³⁸ Also, at the time a key area of interest for the Australian Defence Force (ADF) was the AGM-130E air-launched cruise missile, to be fitted to its F-111 strategic bombers. Yet having a range of only 150 kilometres, the AGM-130E did not provide Australia with the stand-off reach it sought.

Despite the publication of this further review in 1997, the continuing pace of change has mandated fresh analysis as Australia seeks a strategic policy which maintains both effective defence capabilities and an active role in regional affairs. To fit this framework, there is underway a push to improve the combat power of the RAN's force element groups.

Australia and TLAM

Since the early 1990s, there has been much RAN interest in purchasing TLAM. It has been argued that, were it not for the problems associated with construction of the *Collins* class conventional submarines (SSKs), the RAN would have procured TLAM around the same time as Britain.³⁹ Any nation seeking to deploy a weapon with the political profile of TLAM must have a clear strategic concept for its use. Australia is, currently, reconsidering the nature of its strategic policy and the capability gap therein. It is not as yet in a position as to decide upon what can fill that gap.

Several issues should be addressed before it can be ascertained as to whether TLAM is the right weapon to meet Australia's strategic requirements and to fill any capability gap. How and where would Australia envisage employing TLAM? Is TLAM seen as a weapon of strategic deterrence? If Australia was to procure TLAM, whether for deterrent or war-fighting purposes, what message would this convey to other states in the region? Would TLAM be a de-stabilising factor in the region? China, for example, might view an Australian TLAM



Australia's conventional submarine HMAS *Collins*. If Australia were to consider use of TLAM, the *Collins* class submarine would be a launch platform option.

capability as a further extension of US power, although perhaps not as much as if TLAM appeared in the Japanese Navy. There is little doubt that the sale of TLAM to any medium power in the region would raise a whole host of arms control and arms race issues.⁴⁰ TLAM always has met its military expectations. Yet US experience of using TLAM in Afghanistan, Iraq and the Balkans offers conflicting views of its actual political influence. It is also questionable as to whether TLAM can have the same impact in RIMPAC as it has done in Europe and the Persian Gulf, not least because of the naval and nuclear capabilities of other regional powers.

Australia does not need to invest in a land attack cruise missile of the quality of TLAM just because Britain and the US have this capability. With a medium navy, Australia can learn something more from British experience with TLAM. If nothing else, Britain has learned that TLAM is a far more usable weapon than initially envisaged. Re-phrasing this point in the context of prospective Australian security challenges what would the ADF rather send into a hostile environment, such as East Timor? A peacekeeper or a pilot? Or a stand-off, risk free 'silver bullet'? There is danger in either choice.

In terms of capabilities, cruise missiles generically, although very flexible, do not have the political visibility of, say, an aircraft carrier. With Australia possessing already a very capable peacekeeping force, as was seen in Indonesia, a TLAM capability would bring flexibility at a high level. Yet there is an argument that an organic maritime air capability would provide greater flexibility at an interim level. The availability of airpower which could be shore- and sea-based—such as the F/A-18E/F *Hornet*, a navalised version of *Typhoon/Eurofighter*, or the Joint Strike Fighter—would provide a range of options for air-launched cruise missiles from the American *Harpoon 2000* to the British *Stormshadow*. Such air-launched options provide a flexible medium level force and cost-effective and repeatable capabilities in all but the longest-range operations.

This, though, is where the benefits of TLAM come clearly to the fore. What TLAM provides above all else is power and precision at long range. This range is vital to the evolving defence strategy of a country like Australia, for whom distance is perhaps the key factor in strategic policy—a policy which may require Australian forces to undertake continental defence, prevent proliferation, provide the capability to intervene where necessary and, perhaps most notably, to participate more fully and pro-actively in joint and combined regional operations in Australia's areas of primary strategic interest. TLAM would bring to Australia a capability presently unmatched by any other regional power in RIMPAC.

As Britain has discovered, a covert submarine-launched TLAM capability provides military influence disproportionate to overall political standing. If employed correctly, TLAM can be a very effective deterrent and diplomatic tool. This would fit with the requirements of the ADF to generate pro-active policies at the forefront of regional diplomacy. As Jack McCaffrie argued, the contemporary geostrategic context points to 'a continuation of the use of navies in the diplomatic role...We must be able to ask objectively whether the Navy will continue to be the right vehicle to respond to future maritime challenges, and if so, in what form'.⁴¹ A land attack capability with TLAM could be one such form. As a war-fighting weapon TLAM offers a cost effective and easy-to-fit option which would distribute its offensive capability more evenly, increasing potential Australian influence at a national or multi-national level. The ADF must be able to defeat attacks on Australian territory while simultaneously defending Australian regional and global security interests and while Australia seeks to maintain a strong regional presence as a maritime power.⁴² With a weapon like a long-range cruise missile such as TLAM, the emphasis on its employment will fall largely on risk- and burden-sharing and coercive use in joint and combined force packages. In sum, TLAM will help Australia to actively shape its own strategic environment.

A key issue in this debate is the nature of Australian relations with the US. In the current strategic climate, US engagement may endure more in RIMPAC than anywhere else. In Europe, for example, the extent of US commitment is more regularly brought into question, as was seen in Kosovo. One of America's closest and longest-standing regional allies, Australia is the US's main ally in RIMPAC south of Japan. The two countries have a mature and robust relationship.⁴³

The first point that must be made here is that it is questionable as to whether the US would agree to sell TLAM again, after Britain. However, were Washington to agree to such a sale, TLAM is an option for partnership with the US. TLAM would meet the Australian ministerial requirement to procure state-of-the-art technology where possible. Australian strategic and technological developments, such as deploying a TLAM-capable submarine, are an important consideration for US policies, strategies and operations at a time when the US is looking for greater commonality in broad naval capabilities and equipment bases with its regional allies.⁴⁴ This is particularly true in terms of submarines, where US forces are in significant decline. The active participation of the RAN in exercises such as RIMPAC and, for example, through RAN forces operating with a US battle group in the Gulf War, show the extent to which the RAN has worked closely with the USN and other regional navies. The strengthening of these links, for example through procuring TLAM, would augment Australia's ability

to contribute to regional security while representing a further Australian step towards improving equipment compatibility in line with other recent procurements. Although keeping pace with US TLAM technological developments may prove expensive, the procurement of a US weapons system would bring Australia more centrally into US strategic calculations. Also, the opportunity to deploy a TLAM-capable platform to a combined operation would augment US forces and also would provide Australia with the opportunity to show direct approval of US policy. A key issue is whether Australia would find itself operating independently, in other words without the involvement of the US. Analysis of American perceptions of the importance of RIMPAC suggests that this is unlikely. Yet, as was seen recently, perhaps the Indonesian situation is one in which the US might choose not to become involved.

Numbers

As with many other medium powers, Australia is confronted by the imbalance between resources, commitments and programs. Between 2008 and 2015, Australia is faced with the challenge of replacing the framework of almost its entire defence force, with nearly all its major systems reaching the end of their life expectancies. This presents a block obsolescence gap and an opportunity to fill it on a long-term basis. In the wake of the recent crisis in East Timor, many have argued for Australia's development of a cruise missile capability which might be employed as a cost-effective deterrent or an enabling force in such contexts. These have been the primary motivations in the decision of the Australian Department of Defence to re-open the case for the acquisition of land attack cruise missiles.⁴⁵ A government draft paper discussing the implications of the revolution in military affairs has noted interest in examining cruise missile and platform options.⁴⁶

It is difficult to produce a base figure for numbers of missile rounds for a medium navy when the closely-guarded strategic calculus upon which a navy bases its procurement decisions is not known. Yet a relatively small inventory, when aligned with that of the USN, can provide a workable deterrent when employed in the right strategic context. If it is assumed that Australia will continue to operate alongside the US, a small TLAM arsenal is strategically viable. However, given dwindling US stocks of Block III missiles it is questionable as to whether sufficient Block IIIs would be available to the RAN. If the emerging American *TacTom* is the only option, this fundamentally affects the Australian strategic rationale for a land attack strike cruise missile.

As the British experience showed, TLAM can be procured quickly and cheaply. However, it is arguable that the US has no stronger and closer ally than Britain. With the financial commitment to procuring the supporting framework required

for TLAM use—platform outfitting, targeting costs and the establishment of a cruise missile support activity—it makes financial sense to invest in sufficient rounds. Here, the support infrastructure needed for 65 rounds is the same for a single round: there is little correlation between the cost of a particular number of rounds and the cost of infrastructure. Moreover, if Australia envisages using TLAM for other than strategic and operational purposes, then there may be a need for greater weapons numbers. Britain discovered this over Kosovo.

Platforms

If it is decided that TLAM fits the capability gap, the next question is that of finding the right platform. Of primary importance is the need for a platform which can operate effectively in the environments into which Australian forces are deployed and which can maximise the benefits brought by TLAM.

Fitting TLAM to an extended *Collins* class submarine program is the most discussed option.⁴⁷ In 1996 it was reported that the Australian Department of Defence was engaged in extensive high-level operational analysis of TLAM launch options, including the *Collins* class and the *Anzac* frigates. According to one senior RAN official, Australia would look at TLAM 'when we could afford it, when the *Collins* class receive an upgrade, when the *Anzacs* receive an upgrade or when the new destroyers are built'.⁴⁸ Of note here is that both the *Collins* and the *Anzacs* already exist. A new air-launched capability would require a new aircraft and perhaps, even, a new carrier. The key issue for Australian defence policy is distance. The *Collins* class gives Australia strategic reach and effectiveness disproportionate to its size. A submarine's presence and survivability provides a credible deterrent for a medium navy, improving Australia's influence in promoting regional stability as well as augmenting the capacity of the ADF to undertake covert operations and maritime strike. The RAN itself notes that 'submarines are a valuable deterrent against aggressors and are also ideal for conducting covert operations in a hostile maritime environment'.⁴⁹ The *Collins* class has been described as 'probably Australia's most important strategic asset for the decades starting 2000' with the 'potential to be an extremely potent strategic and tactical defence asset for Australia'.⁵⁰ In an era of power projection, the projection of such force requires the ability to control the sea and to deny its use to prospective opponents. A submarine is the archetypal tool for power projection, sea denial and sea control. If coupled with a weapon such as TLAM for a strategic strike role, the *Collins* would have the capability to support key Australian defence roles of sovereign defence, defence of the inner arc and regional power projection in joint and combined operations. Moreover, the strategic role and reach of the *Collins* fits neatly with the prospective strategic role and reach of a weapon like the Block

III TLAM. Submarines maximise the strategic benefits of a weapon like TLAM. The 1994 defence white paper stated that 'submarines by their very nature would create significant uncertainty for an adversary and force precautionary defensive measures. They are therefore an important means of discouraging attacks on Australia'.⁵¹ This is critical when a major component of the concept of maritime strike is conventional deterrence. The presence of a submarine, carrying any number of TLAMs, is something that an adversary can neither confirm nor deny. Stealth is a fundamental precept in an age of knowledge dominance in warfare. The best way to make a naval platform stealthy is to hide it below the surface. The argument for using submarines as land attack strike platforms may be strengthened further by the fact that sensor and weapons technology developments may make surface warships more vulnerable while there is little evidence to suggest that—despite much effort—inroads have been made into improving the transparency of the ocean.

However, there are strategic arguments against deploying a weapon of strategic coercion aboard the *Collins*. Even with air independent propulsion supporting submerged operations for up to two weeks without surfacing, a conventional submarine with only limited size, reach, speed, manoeuvrability and sustainability may be inappropriate for a weapon such as TLAM which requires the forward-deployed sustained presence of an SSN.⁵² With limited numbers of submarines available, there is a debate about whether a submarine deployed for TLAM strike may be largely unavailable for other missions. In Kosovo, the RN was forced to leave HMS *Splendid* both in its launch basket (and thus largely unavailable for other tasks) and in the hands of Britain's political leadership, as the limited numbers of TLAM platforms and rounds available saw the British Government retain the TLAM shooter as a tool for use against more difficult military and political targets. However the US, because of its greater number of TLAM rounds and shooters, was able to bring in TLAM platforms to conduct strike while not overstressing other submarine roles.⁵³ The question for Australia is whether its reasons for having TLAM are more similar to the US or British reasons, or are altogether different.

Surface forces provide visibility crucial in conventional deterrence, while providing sea control and power projection capabilities. To draw on the words of David Stevens, the 'inherent capacity of a surface warship to easily change its posture and apply graduated, disciplined violence'—when coupled with TLAM—fits with the conceptual requirements of maritime strike for deterrence and warfighting.⁵⁴ A TLAM fit for the RAN's surface fleet would also provide a long-range offensive option at a time when it is argued that surface combatants for medium navies must undertake a fundamental shift in outlook towards land-attack warfare.⁵⁵ Several options have been noted here. The four prospective

Kidd class destroyers are large enough to carry box launchers, or a strike Mk41 vertical launch system (VLS). Research suggests that such box launchers could be secured from the US for nothing more than the costs of unit transportation from the US and the purchase of fire control systems.⁵⁶ The procurement of an aircraft carrier would provide another option for a surface-based TLAM fit. Both Britain and the US have, at some point, looked at this option. Also, there remains the option to fit a strike Mk41 VLS into the upgraded *Anzacs*. The *Anzacs* could be fitted for a variety of land attack cruise missiles, from *Harpoon 2000* to *Stormshadow* to *Standard*. However, again TLAM's advantage is its unparalleled range. Other options that have been discussed have included the leasing of *Arleigh Burke* guided missile destroyers. With the US looking to develop an advanced land attack missile—to be evolved from an as-yet-unknown missile—for its DD21 future surface combatant, a VLS surface fit remains an option for any future surface combatant. However, with the strategic strike role played by the *Collins*, TLAM deployment on a surface ship may question the strategic rationale behind Australia's procurement decision.

Costs

With many medium navies, there is a clear trade-off between strategic requirement and affordability. The RAN is faced with the problem of funding a relevant and versatile land attack program within available resources. This may include a new missile, in the short term, and a new platform, in the longer term. A weapon like TLAM also risks using up defence dollars which might habitually have been allocated elsewhere.⁵⁷

At a specific level, with TLAM as an example, if Australia is seeking to use stand-off cruise missiles for strategic (ie., deterrent) purposes, the Block III TLAM is most appropriate. However it retails at US\$1.3 million per unit. It is also an expensive weapon to use for tactical purposes. The closure of its production line may also limit, and increase the costs of, procurement of future Block IIIs. Yet if Australia takes the cheaper option of TacTom, there is the question of what capabilities Australia is trying to meet: buying a weapon that is cheaper does not make sense if that particular variant is not most applicable to the strategic context within which it is intended to be employed. Moreover, funds saved in buying *TacToms* may still have to be spent developing the real-time battlespace picture appropriate for *TacTom* use.

At a broader level, cruise missiles can spread more evenly a defence force's aircraft burden, reducing the need for strike aircraft. TLAM has drawn comparisons between sea-based stand-off capabilities and the role of manned aircraft and between different types of stand-off weapons. Yet the strategic



The Anzac class frigates HMAS Arunta (right) and HMNZS Te Mana.

requirement to degrade enemy air defences before the entry of the full follow-on force package mandates that a stand-off, unmanned weapon like TLAM can be used in SEAD operations to enable entry into theatre of other assets. This should not be viewed as an either/or debate. In the era of joint and combined operations, seapower and airpower are mutually supportive in securing the favourable air situation essential to implementing manoeuvre warfare. To use an analogy, TLAM can be used as a 'left jab' to stun the enemy defences before a full force package follow-up delivers the 'right hook' knock-out blow.

TLAM has greater range and stealth than other cruise missiles, and can exercise coercion from a stand-off, covert, sovereign platform. Moreover, according to one former Director of the USN's Cruise Missile Project Office, 'the reason you buy [a TLAM] is that a B2 costs \$1bn and if a B2 gets shot down that's a lot of

money'.⁵⁸ In Desert Storm, 288 TLAMs were fired. Costing around \$1.3 million per copy at that time, their total costs were considerably less than the 'costs' incurred through the USN's aircraft losses alone.⁵⁹

Air-launched ordnance, with its greater repeatability and greater availability, is more effective in longer-term campaigns, as well as against hardened or mobile targets. One USN source noted that 'you don't keep throwing million dollar weapons at the guy...when you find an aircraft can get in and out relatively unscathed'.⁶⁰ A US Air Force source argued that 'just to deliver the same tonnage dropped in the Gulf War by the F-117 alone (approximately 2,000 tons, worth \$146 million dollars) would have cost \$4.8 billion dollars worth of TLAMs. To deliver all the smart-weapon tonnage expended by the United States in the Gulf War—approximately 7,400 tons—would have required nearly \$18 billion worth of TLAM'.⁶¹

Little data is publicly available on TLAM targeting costs.⁶² Yet weapons costs are not the sole consideration. The costs associated with the purchase of TLAM include: the rounds themselves; platform modification and maintenance; fire control systems; command and control; targeting data; testing and training; mission planning; development of a concept of operations and integration into the order of battle. As Rear Admiral Raja Menon notes, while TLAM and 'its pinpoint strike capability is perhaps common knowledge, not so well-known are the extensive support facilities required to field this weapon'.⁶³ With all these costs in place, it is debatable as to whether the purchase of small numbers of rounds is cost-effective. Using the British example again, Britain procured 65 rounds at just under £1m per unit within an initial program bill of just over £300 million. From this, it is true to say that program support costs for Britain would be in the region of £230 million (the overall program costs minus unit costs). Each round has a through-life cost (for a 20-year period to meet British needs) of around £300,000 (based on a six-year maintenance loop at a unit cost of £75,000). However, with its platform also already in existence, TLAM infrastructure costs are relatively low compared to those of an aircraft. 65 TLAMs seem reasonably cost-effective compared to (for example) *Eurofighter/Typhoon*, 232 of which have been procured at £60m unit costs alone, with additional through-life unit costs of a further £60m per unit and weapons and infrastructure costs on top.⁶⁴ A non-returnable TLAM is not flown to its limits every day, and thus does not have to continually be re-built. A TLAM also does not have a pilot and a family needing to be housed, fed and entertained.⁶⁵ Moreover, once such a program is underway, replenishment costs would consist solely of additional rounds. In a world of ever-tighter quantitative constraints TLAM, arguably, provides a 'bigger bang for the buck'.

Future offensive air systems

Certainly, there are other cruise missiles on the market. But again it is necessary to ask the question of the nature of the strategic niche that is to be filled. If TLAM provides a capable, covert, stand-off, coercive capability with considerable—and unique—reach, other cruise missile alternatives—such as *Harpoon 2000*, the extended range stand-off land attack missile and *Stormshadow*—may find a more appropriate niche as either air-launched land-attack weapons or sea-launched anti-ship weapons.

A key issue in this particular aspect of the cruise missile debate is the nature of a future offensive air system (FOAS). FOAS considers long-term options for offensive air power. The FOAS concepts being developed by Britain, the US, Australia and other 'Western' militaries do not have to be aircraft-based. In an age of precision guided munitions and casualty intolerance from political leaders there are strong arguments that such capabilities could be based on unmanned cruise missile concepts. As Colin Gray argues, airpower is 'identified ecumenically as anything that flies'.⁶⁶

Australia must decide whether it has the political impetus to make a long-term commitment to a land attack capability. This political decision is an important one pre-empting the first steps into a cruise missile capability. Crucially, the near-term deployment of a TLAM capability (and it should also be remembered here that, as with the British case, the decision-to-deployment timescale should be reasonably quick⁶⁷) will give Australia a seat at the TLAM table before TLAM technology evolves into its next phase. The Block III conventional TLAM is a derivative of Cold War concepts and technologies, when it was conceived as a submarine-launched nuclear weapon. Even the much-vaunted *TacTom* is contemporary cruise missile technology only. Current TLAM technologies are probably only the beginning in the evolution of TLAM capabilities.⁶⁸ Moreover, despite the costs of investing in a cruise missile program, casualty intolerance among political leaders and financial restrictions (among other things) question the long-term future of manned aircraft.⁶⁹ This suggests a longer-term pre-eminence for cruise missile technologies in FOAS issues. The US continues to emphasize the need to foster technological (along with conceptual and operational) military superiority. In recent years, land attack concepts and technological developments have changed the nature of naval warfare. Yet such concepts and modular technologies will continue to evolve. Some argue that it might be in Australian interests to anticipate non-lethal cruise missile developments such as electromagnetic pulse, or dispenser variants similar to the Kit2 versions employed to good effect in *Operations Desert Storm* and *Allied Force*.

Moreover, it has been suggested that the F-111/F/A-18 replacement program may cost Australia up to up to US\$5.5 billion.⁷⁰ With an inventory consisting of the F-111 and the F/A-18, a follow-on strike aircraft program would almost certainly be moulded around US programs. Currently there is a strong argument that the US Air Force is re-inventing itself to move away from a strategic strike role. There is only embryonic discussion in the US of a new strategic bomber: thus, there is no obvious strategic strike aircraft replacement on the drawing board. The only possible options are the F/A-18E/F, the F-22 *Raptor*, the *Typhoon/Eurofighter* and the JSF. Interestingly, all of these except the F-22 can be launched from aircraft carriers. The Block III TLAM was initially considered as a replacement for the F-111. Yet an interim solution to plugging any capability gap—until long-term decisions on new platforms and the very nature of FOAS itself are made—could see the already-existing *Collins* class submarines providing a maritime deterrent and strategic strike capability (from torpedo-tube launched TLAMs) complemented by upgraded F-111s carrying any one or a mix of a variety of currently-available stand-off air-launched cruise missiles.⁷¹ This emphasizes the concept inherent in current Australian thinking to examine a stand-off sea-launched cruise missile alongside the Royal Australian Air Force's Project Air 5418 program.⁷² This joint capability would assure Australia of a technological maritime edge in the region.⁷³ When Australia rejected TLAM in 1997, a land attack capability was seen as a singular, individual force element. Today, such a capability is viewed very much as a central element in a joint force package. As Vice Admiral Shackleton noted, '[w]hether Australia will need to stand alone, or whether it operates within the framework of an Alliance or a coalition, [the] circumstances dictate that the context will be maritime and it will be joint.'⁷⁴

Conclusions

Australia, and other medium navies, must have a clear strategic rationale for the employment of such weapons. There is a danger in procuring TLAM for its reputation. There are several factors which must be balanced before Australia can proceed with a land attack cruise missile program such as TLAM: strategic requirement; US agreement; prospective costs; impact on other programs; and domestic political opposition. It is difficult to cost such a program with no firm assessment of a navy's strategic requirements and whether, and where, a weapon such as TLAM fits in. Yet a land attack cruise missile such as TLAM meets the requirements for a flexible, balanced and responsive capability tailored to meet Australia's strategic imperatives.⁷⁵ As part of a joint force package which could include a land- and sea-based aircraft component, TLAM is a weapon which may elevate Australia, in strategic terms, into a different league among medium navies. Yet the ADF needs to develop and articulate its own

understanding of what strategic imperatives a stand-off weapon such as TLAM would meet. If the right policy context is set, a small force can provide a workable deterrent for a navy the size of the RAN when it operates with joint and combined force element groups. Here, Australia's strategic edge would be in having the best, even if not the most, of the equipment available.⁷⁶

In conclusion, TLAM is perhaps the only cruise missile relevant to Royal Australian Navy's strategic aims of combined regional power projection. If it is concluded that Australia wishes to pursue a maritime, expeditionary strategy to support a broader regional foreign and defence policy and if there is a strategic niche into which a weapon like TLAM would fit, then perhaps the best way for Australia to proceed would be to proceed with an interim fit of Block III TLAMs to give Australia a land attack cruise missile capability while the Australian Defence Force develops, clarifies and articulates its position on the nature of its capability gap and how to fill it in the long-term. Thus, the RAN would be in a position to make a more positive decision as to how to further develop its program when decisions on torpedo tube *TacToms*, new TLAM variants, new platforms and follow-on offensive air systems are made. This may also prove to be a critical move towards developing a capabilities-based navy, rather than a platform-centric one. This would be a first for many a navy, small, medium or large.

Notes

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- 7 P. Dibb, *Review of Australia's Defence Capabilities: Report to the Minister of Defence*, Government Publishing Service, Canberra, 1986, p. 1.
- 8 Grove, *The Future of Sea Power*, p. 166.

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- 15 Author's interviews.
- 16 Rear Admiral J.R Hill, *Maritime Strategy for Medium Powers*, United States Naval Institute Press, Annapolis, MD, 1986 pp. 46-8.
- 17 The Block III carries a 750lb WDU-36/B reactive titanium PBXN 107 high explosive/incendiary warhead. This warhead, although lighter in weight, is more powerful than that used in previous TLAM versions. Its titanium casing gives it greater penetrability and, on detonation, it has a much larger and more pyrophosphoric effect. Thus it has the same blast effect as the previously-used 1,000lb Bullpup munition. The missile is guided by the satellite-based, jam-resistant NAVSTAR global positioning system (GPS) and by updated terrain contour matching (TERCOM) and digital scene matching area correlator (DSMAC) IIA navigation. This package steers the missile to within a few feet of its target. This accuracy can be achieved even at the longer ranges of 1,000 miles or more provided now that an improved engine brings greater fuel capacity, greater efficiency and, thus, range than previous variants.
- 18 See: *Strategic Defence Review*, Cm 3999, The Stationery Office, London, 1998, chapter 7, para. 141, p. 37. RN 'Frequently Asked Questions', in *Today's Royal Navy*, p. 2, available on-line: <<http://www.royal-navy.mod.uk/today/faq.htm>>; Then Secretary of State for Defence Lord Robertson MP. quoted in: *The Need for Land Attack*, paper by Commodore Fabian Hiscock, OBE, RN (Assistant Chief of Staff for Warfare, CINCFLEET), presented to conference on Naval Land Attack Weapons, London, 1-2 December 1999 (SMi Defence conferences).
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- 25 *BR1806*, p. 149.
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- 28 Author's interviews.
- 29 Gray, *Modern Strategy*, p. 235 (incl. note 25).
- 30 Vice Admiral D. Murphy, USN, *NATO Naval Forces in the Kosovo Operation*, paper cited by K. Strauss in *The Notion of Precision Land Attack: a Case Study on the Tactical Tomahawk*, paper presented to conference on Naval Land Attack Weapons, 1-2 December 1999 (SMi Defence Conferences).
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- 32 F. Spinney, 'Learning the Lesson We Want to Learn?', *USNI Proceedings*, vol. 125/9/1, 159, September 1999, p. 6.
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- 51 *Defending Australia*. p. 52, para. 5.65. See also: Rear Admiral J.R. Hill, 'Australia's Maritime Interests and Defence: A UK View', in *Australia's Maritime Interests: Views from Overseas*, eds S. Bateman & M. Ward, Australian Centre for Maritime Studies Occasional Papers in Maritime Affairs, no. 6, Canberra, 1990, p. 87.
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- J. Lyall, MBE, RN, *Submarines: A British View*, paper presented to Maritime War in the 21st Century conference).
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- 55 Commodore T. Cox, AM, RAN, (Director General, Maritime Development), *Surface Warfare and Surface Combatants: An Australian View*, paper presented to Maritime War in the 21st Century conference.
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- 57 It is widely acknowledged that, in Britain's SDR, submarine and surface force cuts were made to fund—and to politically support—the purchase of two new aircraft carriers (see, for example: 'Strategic Defence Review to Advocate Big Carriers for the RN-but Frigates and SSNs May Be Cut to Pay for Them', *Warships*, Spring 1998, p. 5; A. Grice, 'Rhine Tanks Slashed in Defence Cuts', *The Sunday Times*, 3 May 1998, p. 24).
- 58 Interview with Rear Admiral Walter Locke, USN Ret., (interview conducted during author's research trip to the US, 1994).
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- 74 Vice Admiral D. Shackleton, RAN (Chief of Navy), *Address to the Inaugural King-Hall Naval History Conference*, 22 July 1999, available on-line: http://www.navy.gov.au/8_archive/speeches/con22-7.htm, p. 2. See also: McLachlan, *Address on Australian Defence Policy*.
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Part | 4

**Command, control,
communications, computers
and intelligence**

Rear Admiral Ron Buck, OMM, CD, CF

This chapter looks at command, control, communications, computers and intelligence (C4I) from the perspective of the Canadian Navy, but contends that the issues are of fundamental relevance to all navies, particularly small and medium sized navies.

Canadian Defence Strategy 2020 puts forth the following themes:

- coalition operations are the future,
- forces must be interoperable,
- operations will be conducted at an accelerated pace with increasing dependence upon information processing, and
- integrated battlespace management is important.

These themes apply to all navies concerned with effective coalition operations and are, in fact, reality today. Navies that are not interoperable will be unable to make a meaningful commitment and will, as a result, be marginalised.

With regard to integrated battlespace management, the following are topical and worthy of consideration.

- revolution or evolution of military affairs,
- network centric warfare,
- interoperability, and
- common operating picture.

These issues speak for themselves, however while it can be debated whether there is a *revolution* or an *evolution*, the fact remains that technological change continues to accelerate which creates not just equipment challenges but also doctrinal and procedural challenges. Canada's *Defence Planning Guidance 2000* summarises Canada's appreciation of the task:

- Generate, employ and sustain high-quality, combat-capable, inter-operable and rapidly deployable task-tailored forces.
- Exploit leading-edge doctrine and technologies to accomplish our domestic and international roles in the battlespace of the 21st century.

- Strengthen military-to-military relationships with our principal allies ensuring interoperable forces, doctrine and C4I.

Again, these are applicable to all nations. They clearly recognise the importance of technology. All navies need to continuously modernise their forces to keep pace with emerging trends, and to stave off the block obsolescence or the 'rust out' that is the inevitable result of a failure to renew or replace equipment. It is suggested that collective strength, on a global scale, rests with ensuring a high degree of interoperability. Interoperability in C4I is the cornerstone.

Canada's situation

This, in theory, is all well and good, but what about reality? Canada has been involved in virtually all recent maritime coalition activities including the Gulf War, the Adriatic, ongoing operations in the Gulf which includes integration into United States (US) carrier battle groups, and INTERFET in East Timor. Interoperability is bread and butter to the Canadian Navy and it is seen as being essential.

The first key challenge for Canada is to ensure there is sufficient connectivity in its ships. If dedicated military satellites are not available from national resources, solving the bandwidth problem (and indeed ascertaining how much bandwidth is enough) can be a fundamental difficulty.

The challenge facing all navies, other than the US Navy (USN), is how to provide sufficient connectivity (bandwidth) to support current and future systems and applications. Such infrastructure includes wire, microwave or fibre-based networks ashore, but it must also address the wireless requirements to ships. A combination of satellite channels and traditional radio frequency (RF) sub-nets are likely, but cost remains a limiting factor. The goals of seamless connectivity are:

- to provide high data rate connections between systems ashore and afloat,
- full support for internet protocol technology,
- to support to all relevant types of information,
- to remain compatible with current and emerging open systems standards, and
- to provide sufficient bandwidth to support increasing data rates.

In fact, Canada has committed to the need for connectivity and interoperability with the US as a key feature of its networks and at-sea systems. Canadian systems ashore are already Global Command and Control System-Maritime (GCCS-M) compatible allowing them to interface with US systems. What the Canadian

Navy must now do is to ensure that it also evolves its at-sea systems to have secure e-mail, web-based data sharing, the recognised maritime picture using GCCS-M imagery, and collaborative planning tools.

Accordingly, in support of C4I afloat, the Canadian Navy is considering a series of related projects to evolve shipboard command and control over the next decade. These projects are designed to evolve Canada's onboard systems to fully support network centric operations by allowing capabilities similar to those just described to be available within the shipboard command and control system.

Collective challenges to all navies

There are many challenges ahead, but possibly the greatest is going to be interoperability. The world is changing technically and evolving faster than many nations can keep pace with while, at the same time, there is a requirement to provide information technology (IT) services that are interoperable with industry, the US, other allies, and other services. As already suggested, navies also have a significant challenge in providing the necessary bandwidth to their ships and the architecture that will provide that bandwidth. There are, of course, other challenges, but these are probably the most demanding.

Interoperability

Interoperability with the USN should be the fundamental C4I goal of any nation that operates or is likely to operate with the USN. However, as can be easily appreciated, this is not always easy or straightforward. The US has adopted standards that are, *de facto*, Allied standards and, if there is a true belief in coalition warfare, there must be an acceptance of this fact. That acceptance must be to the extent necessary to ensure appropriate interoperability. That said, full-blown USN solutions are most likely not affordable, nor operationally imperative for many navies—a balance is required. Military satellite centric systems are problematic for smaller nations, and there is the issue of cryptography.

Additionally, some in the US are *still* thinking nationally while, at the same time, talking internationally. Perception and reality can be quite diverse. One perception is that there is a looming technology gap between the US and the all other nations, and the reality is that this is a matter of resources not technology. There is also a perception that the USN is bandwidth rich while its allies are bandwidth poor, however, the reality is that bandwidth is driven by resources—smaller USN ships are equipped comparable to allies. Finally it is perceived that US security policy excludes allies; in reality US security policy

limits, but does not exclude, allies.

SIPRNET [Secure Internet Protocol Router Network] is a Secret US-only network. However, connections to agencies of foreign governments are permissible through the use of approved security devices employed on each foreign connection to the SIPRNET. These security devices must be in US controlled spaces.¹

As it relates to releasability, the importance of the effort now being made by senior USN commanders to deliver on commitments to allies should not be understated. It is inherent within the policy quoted above that there has been a major shift in the US's security culture: from one that assumes, as a first premise, that nothing is releasable, to one which assumes release may be acceptable unless there is national reason not to do so. However, although senior management have adopted this stance, security organisations are still having difficulty accepting this change.

What about the broader issues of interoperability? The evolution into commercial-off-the-shelf (COTS) was supposed to simplify interoperability problems. This has not been the case. Buying COTS is good—nations can buy the same equipment in their own country. However, whereas previously all that needed to be asked was 'what system?' now it is 'what system, what standard, what version, what settings?' Even then it can still go wrong. A good example of this occurred at *RIMPAC (Rim of the Pacific) 98* exercises where Australian, Japanese and Chilean versions of Microsoft Windows 95 did not work on the coalition local area network, only the US version of the software worked. Same software, but with subtle hidden differences.

Even with technical interoperability, large differences in standard operating procedures mean that rarely is the best performance achieved out of equipment. For example, battle group email (BG EMAIL) has not been integrated into the onboard information management systems of US ships and until this happens, BG EMAIL will remain an impotent stovepipe system.

Interoperability is, by definition, an international consideration. *Global* interoperability must therefore be the goal, but it can only be achieved with a paradigm shift. Being interoperable with the US is therefore the *singular most important issue now facing all navies* in regards to C4I if they wish to provide a core contribution to coalition warfare.

Architecture options

The USN has enjoyed considerable success with naval networks at sea, but their scale of satellite resources is beyond the reach of any other navy.

Commercial satellites are a potential alternative, but satellite time is expensive although these prices are becoming very cost effective, especially when long-term leases are considered. High frequency (HF) radio-based networks should be explored further, but data rates are limited to a fraction of a typical satellite channel. That being said, considerable research and development has been ongoing in Canada and HF data rates using a 6kHz bandwidth have exceeded 32Kbps in controlled tests and trials. Other emerging technologies may have the potential to supplement or replace existing connectivity. Low earth orbit satellite systems are certainly one avenue worth pursuing for future operations.

Bandwidth is a real challenge for everyone and so is the architecture of solutions. The need for access to enterprise systems, as well as operational networks will mean that there is no one connectivity vehicle that will solve all application and system requirements. Although satellite connectivity is essential, there will also be an ongoing need to use the HF spectrum for strategic, operational, and tactical level communications in the foreseeable future. It should be noted that, in the short term, the Canadian Navy intends to utilise HSD Inmarsat satellite connectivity for Pacific fleet operations, buying wide-band channels and multiplexing them for efficient use.

The excellent work being done in HF communications research and development will give HF a new lease of life. Some of the new high data rate techniques however need fairly large bandwidths. These will become more and more difficult to obtain over the coming years. The proliferation of wireless technology which now touches all aspects of life (both from a military and civilian perspective) will also affect future radio frequency allocation. For this reason, military C4I equipment and methods need to be more efficient, and capable of delivering more for less. It is doubtful however that there will be one panacea!

Needed commitments

The only choice for smaller nations is to commit to network centric operations. There must be a move away from hard copy text messages to e-mail, imagery and web based data. It is coming quicker than envisaged and, in fact, technically, it can be done today. Canadian Navy Maritime Forces Pacific ships will continue to evolve with commercial HSD connectivity. Other navies need to do likewise if they are serious about future involvement in coalition operations.

Allies must be able to exchange source data with the USN and each other through SIPRNET and BG EMAIL. With regard to SIPRNET, there is no right to expect full access, but there should be move toward a permanent coalition wide area network with access to needed information. BG EMAIL is a good start toward creating a permanent interoperability tool, but it needs to be

integrated into onboard networks by both the USN and its allies. There is a need to get away from the stovepipe mentality.

C4I improvement opportunities

AUSCANNZUKUS (Australia, Canada, New Zealand, United Kingdom and US Naval Command, Control and Communications Board) is a useful interoperability forum but it lacks 'teeth' when compared with the North Atlantic Treaty Organisation. Other opportunities to develop the way ahead include: joint warrior interoperability demonstration multi-national task group exercises, *RIMPAC* exercises, and BattleLab experiments. These are but a few of the vehicles and opportunities in place to progress to make interoperability a reality. It is important that these opportunities be taken and that they are made more effective.

Conclusion

The way ahead for C4I includes opportunities and challenges. Success will require a commitment to working collectively with a willingness to share appropriate information in order to achieve interoperability through meaningful and attainable standards. We can barely afford to get it right but we cannot afford to fail!

Notes

- 1 Extract from the minutes of the United States Military Communications-Electronic Board dated 7 Nov 1995.

Future C4I | 10 for smaller navies

Dr Norman Friedman

As we move further into what seems to be a computer-dominated age, all navies have to face the question of how extensively they want to invest in the new command, control, communications, computers and intelligence (C4I) technologies, which have been developed most aggressively by the United States (US). Obviously new technology can be expensive; the question is to what extent it acts as a force multiplier—and to what extent a navy which fails to invest will find itself at a severe disadvantage facing a navy, or a country, which has invested more extensively, or perhaps more wisely. Perhaps another way to raise these questions is to point out that heavy investment in C4I may entail a change in the style of warfare, and thus a change in the relative balance of values. Thus some investments previously considered essential may seem much less important. In the US the new style of warfare is developing under the rubric of the ‘revolution in military affairs’ or ‘net-centric warfare’. In fact neither is altogether new, and in both cases navies are already more attuned to the new style of war than are land-based forces.

Although, obviously, the US is in a far better position to invest heavily than are small and medium navies, its programs seem to be the best current indication of just what the new technology and the new (?) style of naval warfare entail. As it happens, the new US programs are particularly well adapted to strike warfare—to naval power projection—and as such should be of considerable interest to many other navies which now find themselves far more interested in such operations than, say, in traditional areas such as shipping protection and anti-submarine warfare.

Perhaps it is best to begin by asking just what it is that makes a navy special, and then just how a new kind of C4I can enhance that set of characteristics. First, unlike an army, a navy is inherently extremely mobile, in a strategic sense. Army units can lunge forward at speeds much greater than those of warships, but the army as a whole must move its logistics dumps forward if that advance is to be maintained for very long. That logistics movement is inherently laborious. Alternatively, dumps can be built up along a planned route, but in that case flexibility is very limited. By way of contrast, large warships often have ranges of many thousands of miles. Because they are more or less self-contained, they can cover such distances with little or no en route logistical preparation.

Second, navies, even large ones, are not very numerous. Ships operate independently or in very small groups. The ocean surrounding them is immense. Much of naval warfare therefore turns not so much on what happens when ships or fleets come into contact, but more on how to detect and track enemy fleets so that contact is either promoted or avoided. At least in the past, the sea sanctuary has made surface ships stealthy as soon as they slip beyond the horizon. The sheer number of ships, moreover, seems destined to decline, as electronic systems, which each ship needs, become more elaborate and more expensive. Note, however, that ship size (ship steel) is relatively inexpensive; it pays to make individual ships larger. Larger ships can carry more (and larger) weapons and should be better suited to resist damage. If ships really cannot be very numerous, it may follow that there is a point in giving any one ship weapons with the maximum possible reach, simply to multiply the targets that ship can hit—assuming that it enjoys sufficient assistance in targeting.

Moreover, ships have very limited capacities for weapons. Although *Tomahawk* is a most remarkable missile, no current US warship can carry more than about 100; and the missile cannot be transferred effectively at sea (at least currently) for reloading. Even so, a US warship armed with *Tomahawk* carries far more missiles than an equivalent ship of any other navy. Thus any plan to attack using such precision weapons carries with it an urgent need for very precise information about the targets. This applies as much to land targets as to sea targets. Note, too, that to employ any cruise missile (such as *Tomahawk*) the shooter needs detailed knowledge of the path over which it is to fly.

At least in the West, navies have drawn the conclusion that much must depend on the local commander. The purpose of most naval tactical data systems, including the new C4I systems, is to provide the local commander with the most complete possible data about his surrounding area. Such data of course includes whatever is known about the presence of hostile and neutral aircraft, ships and submarines. Just what constitutes the surrounding area depends on weapon ranges. For example, faced by ships armed with 300-mile missiles, a commander might well want full data out to a radius of 500 miles or more, to gain adequate warning of an enemy's approach. The area in question is very likely to be beyond the range of the ship's organic sensors, so she will have to depend on externally provided information. The larger the area of interest, the greater the information involved.¹

It is also worth pointing out that weapon range depends on targeting, which means reconnaissance, capability. There is no point in firing a missile 300 miles if the shooter cannot bring it within seeker range of a target. For that matter, there is no real reason to fear an enemy armed with such a weapon if

he cannot detect and track one's own ship. Targeting becomes particularly difficult at sea because the sea is so trackless, and because it may be so difficult not merely to detect distant ships but to identify them.

Then the great question surely is, if navies consist of small numbers of ships of limited firepower, why have they been so effective throughout history? And has that effectiveness anything to do with C4I, given navies' unusual dependence on long-haul communications and their use of the sea sanctuary? One answer would be that navies have been effective against land powers because they present the latter with multiple possible threats, which cannot



The *Ticonderoga* class cruiser USS *Port Royal*. The US currently has 27 *Ticonderoga* cruisers in its inventory.

be distinguished effectively (due to the sea sanctuary) until the attack actually begins. Thus a defender must cover multiple options using ground forces of limited mobility. The greater the number of options, the more effectively the naval force draws down the overall strength of the ground force. One might see this sort of effect in the operations of Wellington's sea-supported (and sea-deployed) army in the Peninsular Campaign against Napoleon.

Long-range shipboard missiles offer something really new, and they offer it because (or, perhaps, only if) they are supported by the appropriate C4I. What they offer is the ability, on the part of a distant surface ship or a submarine, to affect events hundreds of miles away, the way carriers have in the past. The surface ship or submarine is not a carrier, but then again not many navies can afford multiple 90,000 ton supercarriers. The key has to be C4I, because, unlike an airplane with a pilot, a missile cannot change its mind very readily once it has been fired, and at the least it cannot be recovered. Each time a missile is fired, it had better be fired at the appropriate target, because it is a very valuable asset, available to a surface ship in rather limited numbers.²

A new kind of war?

Precision weapons and their platforms are likely to be expensive. War fought using such weapons is often contrasted with an earlier style of attrition warfare. The hope is clearly that small numbers of weapons, if they are delivered very accurately against the right targets, can offer decisive results. Moreover, at least in the US, the belief is growing that attrition warfare is often likely to be unaffordable. That is, the US is likely to be fighting very far from home. To mount an attrition campaign entails moving vast masses of troops and materiel. In the Gulf War, as it happened, the troops and equipment were available nearby in Europe, having been built up to fight a possible land war in Central Europe. Even so, transportation to the Gulf and subsequent assembly to fight took a very long time. The US image of the future is overwhelmingly one of sudden and unexpected conflicts. The US cannot possibly maintain massive forces capable of moving everywhere in the world. Nor can it afford pre-positioning on the scale maintained in Europe before the end of the Cold War. Yet Iraq was by no means a Third World superpower.

So how does a country exert leverage from thousands of miles away, against what may be quite substantial local forces? This question really is relevant to a medium-size navy, which cannot possibly move vast resources (which do not exist), but which may be able to exert leverage—if it is used cleverly enough. In this case, 'cleverly enough' depends heavily on C4I.

Incidentally, the US interest in precision weapons and in precision strike can also be traced to the end of the Cold War—and to the consequent realisation

that nuclear weapons are unlikely to be very usable. In a Cold War context, one might actually gain enormous military effects without moving large weights, since a very small Hydrogen bomb could surely wipe out a very large military force. That is one reason air forces possessing only a few hundred strategic bombers could be considered devastatingly powerful, whereas their World War II counterparts were ineffective unless they deployed thousands of bombers with much larger payloads (in weight terms). Moreover, nuclear weapons could be effective even if they were not very precisely targeted; small errors did not really count. A few hundred or a few thousand pounds of conventional explosives hitting fifty yards away is entirely wasted. In the past, when weapons were used in vast bulk, that did not really matter too much. Now that delivery platforms—not only naval ones—are very limited both in numbers and in carrying capacity, precision matters far more. More to the point, it is not only a matter of hitting a designated target, but also of thinking through which targets are worth hitting, which ones the destruction of which will have the sort of effect the attacker wants.

So just how do a very limited number of attacks win a war? The question clearly affects more than navies, but it is very much a question of just what sort of C4I the navy of the future needs, if it is to exert real power. And if it cannot have a real effect on events ashore, just how does the navy explain to its political masters why the investment in it is worth making?

Simply put, the new concept espoused by the US military is that remote intelligence-gathering systems can now provide much of the tactical information—formerly simply sensor information—needed by a tactical commander, in order to target weapons. Given precise navigation, weapons can be fired well beyond a platform's horizon, yet can still hit their targets. If the weapon is placed close enough to a target, onboard sensors can guide it the rest of the way, even if the target may not have a very distinctive signature. One consequence is that the reach of surface combatants, at least when attacking land targets, is now comparable to that enjoyed by aircraft carriers. In theory, too, the remote intelligence-gathering systems may provide a central commander with very complete information describing enemy dispositions and movements.

This information counts because, again in theory, it can be used to achieve decisive results. That is, if this information can be gathered and analysed quickly enough, then (again in theory) the enemy can be out-manoeuvred and destroyed, even if the weight of fire available to the attacker is quite limited. This last claim is based on the theory of the observation, orientation, decision and action (OODA) loop popularised by the late Colonel John Boyd, US Air Force (Retired). In Boyd's view, warfare (and many other human activities)

can be characterised as a series of competing, intersecting, OODA loops. For each side, the loops form cycles—each side makes decisions as reactions to the other side's observed actions or inactions. The side capable of making accurate decisions more quickly moves inside its enemy's OODA loop, so that its enemy is forever reacting to decisions made several steps earlier. Quite soon that lag induces a nervous breakdown on the part of the enemy's leadership.

Boyd applied the OODA loop idea to the fall of France in 1940. Much of modern combat theory is based on fairly simple quantitative comparisons between opposing forces. Given such comparisons, the French either should have stood off the Germans, or at least should have made the German *blitzkrieg* extremely slow and expensive. Yet observers of the time reported that again and again the French High Command was unable to place its troops where the Germans were attacking, that decisions seemed never to be made properly, that in the end, with the bulk of the French Army not even engaged, France collapsed. Many contemporaries found the collapse mysterious. That was partly due to the prestige of the pre-war French Army, and the explanation was that the army had in fact never modernised. Others pointed to low French morale, and even to treason in the French officer corps and in French politics.

Boyd's thesis was simpler and in many ways more compelling. He was well aware that armies have survived despite massive casualties: war must be about more than simply killing as many of the enemy as possible. Well before he began writing, authors were pointing out that the true target in war is the enemy's high command. It takes a government or a high command to give up. Anything else is an enforced truce. Those disappointed by the end results in Iraq and in Kosovo will see the point. An enemy may be forced to withdraw from disputed territory, but it takes something more to cause the enemy to collapse. Unless that something more is psychological or strategic, the dismal reality is that the West will usually find it impossible to enforce the sort of physical damage required. One might add that experience of heavy strategic bombing, both in Korea and in Vietnam, would seem to prove Boyd's point: it seems just impossible to bomb a country into submission.

Boyd's thesis, first stated in the late 1970s, was particularly attractive to a US military that could not possibly build forces on the scale the Soviets were then deploying in Europe. Boyd promised that a more agile force could defeat a much larger but more sluggish one. The natural implication was that agility would be associated with better intelligence gathering and, moreover, with better and quicker use of the intelligence assembled. In the current form of the 'revolution in military affairs', Boyd's ideas have been interpreted to mean that 'information dominance' can be decisive, and that small numbers of long

range precise weapons can be effective if, instead of being used simply to exact attrition, they can be used instead to attack the enemy's centre of gravity.

Skeptics will point out those earlier military leaders and strategists were hardly idiots. They were painfully aware not only of Murphy's Law but also of its many unpleasant corollaries. In particular, a Boyd-style approach seems to require a deep understanding of the enemy and his society, a level of sophistication very rare in governments as a whole, let alone among their military planners. It is not particularly difficult to devise very precise weapons; the advent of the global positioning system (assuming it is viable in wartime) would seem to imply that weapons with errors on the order of a few meters are relatively easy to build. The key question is how to choose targets that will be decisive.

After all, the enemy may not really care about the OODA loop the attacker has in mind. He may see the attacker the way a prizefighter sees an attacker with extremely agile movements but a very light punch. Instead of dodging the punches, the heavyweight may merely ignore them, then hit back hard enough to win. So the Boyd approach requires an understanding of just what the prospective enemy cares about and fears. Sometimes the goal is stated as an attack on the enemy's centre of gravity—but that assumes that one's intelligence community can identify it (and, for that matter, that a physical centre of gravity exists). It is not always clear that this is the case.

A new approach to naval warfare?

What has all this to do with navies, particularly small or medium ones? Navies have finite but very long-range offensive weapons. Compared to masses of troops or bombers, the damage they can inflict at any one time, at least without using nuclear weapons, is necessarily limited. The key question for navies—indeed, for small or medium powers—is whether some more intelligent application of the power they can wield can be effective against modern states.

The new style of warfare, as proposed in the US, is strike warfare—naval warfare writ large. Navies, more than other armed forces, have always gained their results from quite finite applications of force. When the issue was simply sea supremacy, force was finite because ships, unlike (say) ground divisions or cities, are finite targets. They either float or they sink, and if they sink they are out of contention. Moreover, the great issue in sea warfare has always been the ability to find an enemy fleet somewhere on a trackless sea. That is why so many classic sea battles were fought close to land—in some place where the two fleets were likely to meet. Thus naval warfare has always partaken heavily of a combination of communications and intelligence.

What is happening now is that, thanks to advances in communications and in computers and navigation, it is possible for a ship to hit a target at very long range with a very accurate missile. The question for all navies is whether this new potential is worth the very heavy investment it entails. If it is, to what extent does the potential for a surface fleet armed with long-range missiles change the balance of, say, regional power.

The cost of the new kind of fleet is not so much in the missiles, which are relatively cheap, or in the ships, which are also inexpensive, but in the command/control infrastructure in which both are embedded—in the new world of C4I.

To the extent that the new kind of warfare really works, a surface ship can hit targets at ranges previously reserved to carriers: surface ships experience a dramatic renaissance. A surface ship is not, of course, quite the same as a carrier. She has only a limited number of long range missiles on board, and current launchers cannot be reloaded at sea. Once the long-range missiles are gone, the only remaining precision weapons are likely to be guided shells (assuming that current programs, such as the US extended range guided munitions, are carried through to completion). Unlike big cruise missiles, shells can be transferred relatively easily at sea, so the ship can still attack targets beyond her horizon—but not hundreds of miles beyond. By way of contrast, carriers are relatively easy to reload with air-launched missiles. Quite aside from that, an aircraft carrier accommodates a much larger ammunition load, proportional to her displacement. Even so, the new surface ship strike capability is dramatic, particularly since the surface warship experiences nothing like the manpower cost of the carrier.

Additionally, the surface ship is unlikely to be able to match the aircraft carrier for area air defence. Carrier fighters can intercept and escort potentially threatening aircraft. Carrier radar aircraft can search for hundreds of miles beyond the ship's horizon (though a big land based over-the-horizon (OTH) radar linked to a ship might have something of that effect). As in the case of strike weaponry, the carrier offers far more sustained capability—but at a high cost. Moreover, if intelligence systems provide sufficient warning of the approach of enemy attackers, the surface ship may enjoy some measure of OTH warning.

The classic role of C3I in naval warfare

Command, control, communications, and intelligence, which one might call C3I, have always dominated naval warfare, because naval warfare is about small numbers of ships scattered about on an immense ocean. That is why the advent of radio, just about a century ago, was so revolutionary. For the first

time, a fleet commander could communicate with scouts beyond his visual horizon. An admiralty could command a distant fleet, and in so doing could communicate intelligence it had. Within a few years, navies were exploiting the other side of this coin, intercepting their enemies' communications and using the information thus obtained to detect and track enemy fleets, and sometimes also to discover their intentions. To understand the immense change involved, contrast Nelson before Trafalgar with Jellicoe before Jutland. Nelson had been blockading a French fleet in Toulon. He had to stay close inshore, because otherwise he would miss the fleet as it sortied. It evaded him anyway, and he spent weeks in a long chase, first in the Mediterranean, and then to the West Indies and back. Several times his ships put into port only to discover that the French had been and gone. Nelson had, moreover, no way of intercepting the French fleet at sea; the sea was far too vast, and his radius of vision far too small.

Now go forward to Jellicoe in 1916. The really dramatic difference between his fleet and Nelson's was neither steam nor armor; it was radio. Because the Germans used radio, the British gained a priceless advantage: they could detect the movements of the High Seas Fleet. Without needing pickets off German ports, they could be sure of receiving warning that the Germans were about to put to sea. Because they could break German codes, moreover, they could gain reasonable certainty of where the Germans were going. They could get there first; they could be reasonably sure of intercepting the High Seas Fleet at sea, out of sight of land. As it happened, these advantages were not fully exploited. Largely because the potential of radio intelligence was unappreciated, the information was not properly used. Jellicoe did intercept the High Seas Fleet, but he did not credit the radio intelligence that gave the escape route the Germans were taking. As a result, his success was strategic but not tactical, and his fleet was tied down for the rest of World War I, with very unfortunate consequences. Even so, the change from 1805 had been dramatic.

Radio had made all the difference—both in providing information as to the German movements and in making it possible for the Admiralty to pass that information to Jellicoe in time for it to make a difference. One consequence of the World War I experience, in which the British repeatedly used radio intelligence at sea, was for the Royal Navy (RN) to become very sensitive to its own vulnerability to hostile radio intelligence. The RN adopted a posture of extreme radio silence, which translated into radar silence during World War II. For example, apparently HMS *Hood* did not switch on her fire control radar before sighting the German battleship *Bismarck*, possibly with fatal consequences (her doctrine was apparently to switch on radar only after a

visual sighting, when the radar's signals could no longer give away her presence).³

Another interesting consequence of the rise of radio intelligence was a change in the relationship between afloat commanders and ashore organisations like the Admiralty. There is an inclination to think of naval staffs mainly as planners and administrators, far removed from combat. However, it was entirely possible that an admiralty receiving the fruits of radio intelligence would actually have much better information about enemy dispositions (beyond the fleet's horizon) than would the fleet commander. In this case there would be an enormous temptation to make the Admiralty or its equivalent an *operational* level of command. In the two World Wars there was an additional consideration. The radio link between the Admiralty and afloat commanders had very limited capacity. There was no possibility of transmitting the Admiralty's overall plot of enemy movements, or indeed any other sort of plot. Thus there was no way of providing the afloat commander with anything like the information available only at the Admiralty end. Those in the Admiralty were thus enormously tempted to make operational decisions. The most famous, and most disastrous, example was the decision to disperse Convoy PQ 17, on the basis of radio intelligence indicating that the German battleship *Tirpitz* was about to sortie.

On the other hand, radio intelligence was extremely successful, at least until 1942, in locating patrol lines of German U-boats and thus enabling British commanders ashore to order convoys to evade them. For that matter, the U-boats themselves relied heavily on orders based on radio intelligence gathered by the German Navy. In neither case (nor in the case of American submarines acting against the Japanese) was there much point in providing individual commanders at sea with details of overall enemy dispositions. They simply received orders based on that data. Yet we can see that if the battles had been fought with much longer-range weapons, there would have been good reason for the afloat commanders to want much more complete data. By the 1970s, for example, American ASW tacticians were imagining that in a future Battle of the Atlantic, combat, directed by a single force afloat, might range over hundreds or thousands of miles, and that tactical decisions really would have to be made in terms of a very complete picture of overall enemy dispositions. Any such tactics would, then, have entailed not only the creation of longer-range aircraft and sensors and weapons, but at least as importantly of C3I links capable of carrying the sort of information density now required.

Communication capacity: Bandwidth

The point of the historical examples given above is that communication matters not so that a distant political master can command ships in detail, but because

a distant intelligence-gathering centre may be able to provide a commander afloat with information which he would otherwise lack, generally about events beyond his sensors' horizon. In Jellicoe's case, that information was gathered by intercepting and often deciphering German radio reports. The Admiralty in London had access to code-breakers and to experts on German communications practices. In effect it could assemble a good, though not perfect, picture of German fleet movements well beyond the Grand Fleet's ken. Radio made it possible to provide the British fleet commander, Jellicoe, with some of that information.

But radio, as it existed in 1916, was limited. It could not provide Jellicoe with anything approaching a complete picture of the plot of German fleet movements the Admiralty maintained. It could only provide a short message giving what the Admiralty analysts and the war staff hoped was the most important piece of information. The problem was twofold: bandwidth and receiving information capacity. Modern C4I tries to overcome both limitations. The issue for a medium navy is the extent to which new technology solves its problems, versus the cost inherent in adopting the new technology. A second issue is to what extent new C4I technology can or should change the way navies are built and the way they fight. Although the US Navy (USN) is in many ways in the forefront of these issues, they should apply to all navies. It would be extremely unwise to imagine that those not as rich as the US should ignore the impact of the C4I revolution.

The first problem, in 1916, was bandwidth, i.e., the frequency range over which radio information is distributed. The wider the bandwidth, the more information a radio link can carry. Since effective bandwidth is a more or less a fixed fraction of the frequency at which the radio operates, higher frequencies provide more bandwidth, i.e., more information per unit time. In 1916 the RN operated at what we now call low frequency (LF) and medium frequency (MF), tens or hundreds of kilohertz (kilocycles in the jargon of the time). Transmitters and receivers were, moreover, crude, so those radio signals took up far more bandwidth than was necessary. As a consequence, information capacity was very limited, to a few dozen letters or numbers per minute.⁴ After World War I, navies adopted high frequency (HF) radio because it offered greater information capacity. It also offered worldwide reception, thanks to the ability of the ionosphere to reflect HF signals.⁵ Even then, the capacity to transmit information was quite limited, generally to about 75 characters per second. Obviously it takes a great deal more to convey a picture of shipping over an area hundreds or thousands of miles in radius. Unfortunately higher frequencies do not travel very great distances, because they cannot bounce off the ionosphere. They are, then, usually limited to line of sight, i.e., out to the radio horizon, which

is about four-thirds the visual horizon. The closest anyone came to a solution was the Kineplex system used for Link 11, in which multiple signals were sent in parallel on neighboring frequency bands.⁶

Ultimately, the only solution to high signal density, above say ten thousand bits per second, is a higher-frequency signal, which generally travels in something close to straight lines. Unless it can be reflected off something aloft, it is limited to the radio horizon, which is four-thirds the visual horizon. Such radios were initially valued because they could be used relatively freely, with little fear of enemy interception. Hence the use of very high frequency (VHF) for intership communication during and immediately after World War II. Ultra high frequency (UHF) succeeded VHF because the latter offered more information capacity, i.e., more channels and clearer voice circuits.⁷

This is why satellites and information capacity now go together: the very high frequency signals, typically UHF and above, pass directly through the atmosphere and are received by the satellite, which can then direct them back down. Clearly the retransmitter need not be a satellite: for years, for example, the USN advocated unmanned aerial vehicles (UAV) as 'poor man's satellites'. Because it is much closer to the receivers, a UAV need not have anything like the power capacity of a satellite. On the other hand, it covers a very small area, and it must be maintained over a fleet or an operating area. The UAV does provide OTH coverage, and (like a satellite) it has the advantage that because all the transmitters point up, their signals are difficult for an enemy to intercept and direction find (DF). The effective range of the UAV is related to the radio horizon. For example, the radio horizon at 10,000 feet is about 150 nautical miles, so a UAV placed exactly halfway between two ships 300 nautical miles apart can communicate between them. A chain of UAVs can do better. It is possible that new very long endurance UAVs will offer just the sort of performance regional navies' want. For example, a UAV at 90,000 feet would have a radio horizon at about 450 nautical miles, so it could connect two ships nearly a thousand miles apart.

Raw frequency clearly is not the whole story. Channel capacity depends on how cleverly signals are coded and, for that matter, how carefully a channel is used. For about the last fifteen years the USN, and then the US military as a whole, has been working hard to increase the capacity of existing channels, in the unhappy realisation that existing satellites could not easily be replaced. It might be argued that it would have been easier to give up on military satellites altogether, and piggyback on a growing constellation of high-capacity commercial ones. However, a navy instinctively prefers to control its own communications. For years, moreover, US authorities feared that in an

emergency, exotic forms of attack, such as electromagnetic pulse strikes, could knock out the commercial satellites. Their own satellites were better protected. Now that the nuclear threat has declined dramatically with the end of the Cold War this is not so obviously an issue—but there is still reason to want control of vital communications.

Note that most ways of improving the efficiency of a radio channel require a computer. Typical communications procedures are inefficient: a channel is often dedicated to a single user, often leaving it unused. The obvious solution is to place messages in a queue, automatically sending them one after the other. That generally requires that messages fill a standard time interval, so that short messages waste communications capacity. Efficient queuing requires a computer to store the messages both before transmission and on receipt, and often there is a computer distribution system that takes them from receiver to user. The next step is to adopt something more like the Internet switched-packed protocol, in which all messages are chopped up into very short segments, the hope being that the full length of each segment will be used all the time. Each segment is tagged with a sequence number and an identification; the segments are sent as quickly as possible, then reassembled into messages on reception. Internet users will recognise this technique; typically they get a burst of data, then they wait for the next burst (while other users receive their bursts). This sort of technique clearly depends on computers. The faster the computers, the more finely messages can be chopped, and the more efficiently a given channel can be used. There are, to be sure, other ways of squeezing more out of a channel, but they generally require changes in transmitters and receivers.⁸

Compiling the tactical picture

The other element of the problem lay in the use to which the incoming signals were put. Ultimately a naval commander needs a picture of the tactical or strategic situation, on the basis of which decisions can be made. The picture may or may not be graphic; it may be no more than something in the commander's mind. For example, generations of submarine commanders have learned the trick of forming a tactical picture (in their heads) from a quick periscope sweep. Jellicoe himself was lauded after World War I for having understood the tactical situation at Jutland as soon as he saw the smoke of the German fleet, and for having made the correct decision as to how his own Grand Fleet was to deploy. In a more modern case, a computer weapons control system makes decisions on the basis of threat evaluations, which are themselves based on a tactical picture it carries in its memory.

That having been said, the classical tactical picture really is a picture, a plot of where ships and aircraft are and where they are headed. In pre-computer



Integrated operations are made possible by the combination of communications links and computerised tactical systems.

times, it was put together by plotters, working on the basis of signals received by a ship. The signals might include reports from the ship's own sensors and radioed reports from other ships or from the shore. The great World War II innovation was to make the earlier plot into a decision-making centre, the Combat Information Centre (CIC) or Action Information Organisation (AIO).⁹ After the war it was discovered that human factors limited the rate at which a CIC or AIO could handle incoming information. For example, no matter how well designed, a manual CIC could not deal with more than about eight air raids per hour.

The problem was latency. At each stage in the formation of the plot, delays were incurred. Imagine, for example, a radar operator at his scope. He sees and reports a new blip. The report is slightly delayed, because it takes a few seconds

for the operator to recognise that it is a target and then to measure its coordinates. He then reports the coordinates, which are already slightly stale, to a plotter (teller, in British parlance), who imposes another slight delay in marking the plot on his board. In fact single plots are almost irrelevant; what matters is the target's course and speed. These data help indicate the target's intent, the degree to which it is a threat, and also the extent to which available resources (such as fighters and anti-aircraft weapons) can be directed against it. So the plot is not really formed until the target or raid has been detected and plotted two or three times, and a vector drawn through those plots. Each time delay in each step imposes a degree of error. Moreover, the teller can only plot one target at a time, so as the number of targets mounts, he imposes additional delays in plotting each one.

As the delays mount, the plot has less and less resemblance to reality. At some point, it is so badly delayed and so inaccurate that it is no longer worth maintaining. In 1945, for example, the USN faced saturation raids by Japanese *Kamikazes*. The CICs, lauded until then for their war-winning value, were very nearly abandoned on board many destroyers. Instead, a lookout aloft called out which aircraft were approaching in a simple clock code—twelve o'clock for dead ahead, three and nine for the beams, six for dead astern. Radar did not really help, because the CIC below decks was flooded with far more information than it could digest.

Enter the computer, which could digest the information, and whose plotting delays were far more tolerable. By the late 1950s, several navies were working on computer-based CIC systems, which we would now call tactical data systems or even computer command systems. A computer could compile a tactical picture, display it to a commander, and also use it internally to test the feasibility of intercepting given targets. Given a computer plot, its elements could be transmitted to other ships. This sort of system is now so universal that many must wonder how navies operated without it. Once, of course, it was limited to the most valued ships. Once, too, computers were expensive and rare. Now they are cheap and virtually universal, and we find computer-based tactical display systems on board virtually all warships, often simply as adjuncts to their radars.¹⁰ We also find digital radio links between ships, so that they can exchange information to form a common tactical picture. The combination of links and computerised tactical systems is so important that it forms the basis of integrated naval tactics, for example within the North Atlantic Treaty Organisation (NATO) and associated countries. For naval operations, the common links (Link 11, and now presumably Links 16 and 22), make integrated NATO operations possible. Conversely, ships *not* fitted with the appropriate links cannot effectively cooperate with NATO ships.

This reality raises some interesting questions for the future. Besides its standard data links, the USN is increasingly interested in a new kind of link, associated with its cooperative engagement capability (CEC). As CEC matures, it may become a prerequisite for effective tactical cooperation between ships defending themselves against air threats. To what extent will US allies find themselves wanting (or needing) this type of capability?¹¹

Link 11 is a tactical link, not the sort of strategic link with which this talk opened. It is current reality for most navies (those without it usually use some variant of the simpler Link 10 or Link X or Y developed by the RN and the Royal Netherlands Navy).¹²

Note, incidentally, that computers turned out to be essential, not merely to compile each ship's tactical picture, but also for the communication between ships required to maintain a common tactical picture within a force. Without the common tactical picture, it is difficult to imagine effective communication; how would two commanding officers even know with certainty that they were discussing the same target, or the same task? Hence, incidentally, the spread of the standard Link 11 through NATO and associated navies.

As for communication, the computer is needed, in effect, to plot the information coming in via Link 11 or a similar digital mechanism. The link does not carry the full tactical picture. Instead, it carries a series of updates. Because the computer can keep track of them, it builds up a picture—which is common to all the ships (and, in some cases, aircraft) which shares the link circuit.

Now consider the current situation, in which many navies find themselves more and more interested in power projection. Often that must mean supporting troops who have gone ashore. A country that has a limited navy probably also has a limited-size army. Mobility in any case limits what the army can take ashore. If the whole point of ships is that they are self-contained and that they can carry heavy loads more or less effortlessly, then surely they must make up for the limits on the troops they convey. If the navy does not possess substantial numbers of sea-based aircraft (which is generally the case), then it would seem that shipboard weapons ought to make up the difference. The most stressing case, presumably, would be one in which lightly armed troops well ashore suddenly find themselves facing armour.

It is quite possible to imagine a solution, in the form of one or more precision-guided weapons called in by the beleaguered troops. The key issue, however, is C4I—the troops need some way to call in the weapons, and to specify where they must go. The implication would seem to be that the troops need some sort of data link back to the ship; ideally, not merely a channel to call for help, but some way of sharing a tactical picture (i.e., situational awareness).

Some armies are already singing the praises of information systems which look, to a naval eye, like the computer-based systems of the past boosted by several orders of magnitude—from, say, 256 objects in view to perhaps 25,000 or even 100,000.

Armies operate very differently from navies. The army's view of its emerging information system, at least in the US, seems to be that it will: greatly simplify planning, such as combat logistics, speeding what in the past was laborious staff work associated with changes in plans; and that it will help eliminate 'friendly fire' casualties because all involved will have a much clearer picture of the battlefield. However, it may be far more important, at least from a power projection point of view, because it will make possible much more efficient use of such heavy resources as artillery. If the army of the future is to be truly agile, it must have a very small footprint, and it must minimise its dependence on anything that is difficult to move. Of course, if units can easily call down long-range fire, then the weapons involved need not land at all; they can remain on board ships offshore—if, and it's a massive if, the communications links to the ships work properly. Obviously these points affect any ground force launched from the sea, such as the US Marine Corps, which is currently sharing the US Army's emerging digital systems.

Because the land battlefield is so complex, any data link involved with it must operate at very high frequencies, perhaps extremely high frequency (EHF) or super high frequency (SHF), and operation OTH would seem to entail either a satellite or, perhaps more efficiently, a fleet of UAVs. Obviously UAVs can also provide the ships doing the firing with better ideas of what is happening beyond their horizons, and the data link will share that information with the troops ashore. For that matter, really efficient communications may make it possible to keep the bulk of the army's headquarters (shrunken by digitisation) offshore, where it need not be guarded by troops better employed offensively. It may also be argued that if the main artillery weapons of the future are very long-range shipboard guns, then troops may manoeuvre much more fluidly. Computer control may also make it possible for a higher-level commander to handle many more groups of troops simultaneously, breaking the earlier rule that the 'span of command' was only three units.

At least in the US, the army seems not to realise just how closely its emerging digital systems follow the path navies trod several decades earlier. One of the key naval lessons was that the alliance had to buy a common data link. Might this not apply to the new army systems as well? After all, the ships will have to be able to deal with the army's links and its digital command and control, because their future is likely to be intimately connected with operations ashore.

Note that adoption of digital links changed attitudes towards radio silence. In the past, messages were sent only as needed, and there was a premium on avoiding radio traffic—the enemy would surely be listening. Ships on a Link 11 net, however, transmit updates automatically. The tactical picture cannot be maintained unless they communicate very freely. Reportedly the RN disliked tactical links for just this reason. During the Falklands War it discovered what the USN already knew, that effective fleet air defence was impossible without tactical links and a computerised fleet-wide picture. As it happened, the RN had invested not in Link 11 but in the much simpler Link 10; the latter's success led to a decision to scrap it in favour of the more sophisticated—and much more expensive—Link 11. That in turn helped make Link 11 a true NATO standard.

The lesson, for small and medium navies, is that politics and investments in communication systems go together. One reason a small or medium navy is valuable to its political masters is that it can be offered to larger powers as a valuable partner; the larger powers may then be inclined to help the smaller in other matters. Readers of contemporary history generally associate such agreements in entirely political terms: a treaty is signed, ships steam off to a distant conflict where they provide essential help. However, in the world of modern command/control, unless the ships steaming off have the appropriate data links, they cannot provide the sort of essential assistance that brings the political dividends desired. That applies, moreover, not only to anti-air warfare but probably also to other kinds of operations. For example, many modern mine countermeasures ships have computerised combat direction systems, which enable them to plot mines and mine-like objects (and neutralised objects) electronically. Since any one ship is unlikely to neutralise an entire field, it is important that the resulting charts be exchangeable between ships. That is not too different from the tactical picture exchanged by two anti-aircraft ships via Link 11. Moreover, as new kinds of mine countermeasures, such as remote devices, enter service, it will become more, not less, important that they be electronically compatible.

None of this should surprise anyone who has bought computers and modems that have to be compatible with each other and with the standard electronic mode of communication, the Internet. Unfortunately, the Internet, with its packet-switched techniques, is far more forgiving—and far more universal—than the various data links, invented in an era of much less powerful computers.

One important issue is how Western navies, which are so familiar with our data links and our style of naval warfare, can cooperate with other navies, such as the Russians, with whom we may badly want to operate for very good political reasons.¹³

The new kind of naval warfare, which employs remote sensors and strategic links, was pioneered by the US and Soviet Navies during the Cold War.¹⁴ It began with the Soviets, who wanted a means of attacking US carrier battle groups from well beyond the latter's horizons. The Soviets deployed special radar-equipped maritime patrol aircraft (generally converted Tu-95 bombers), which had a data link down to surface ship or submarine shooters. Later they deployed radar and electronic support measures (ESM) satellites, the purpose of which was to detect and track target formations. The satellites reported to a shore-based control centre, on the basis of whose data shooters were cued into position. The satellites were then ordered to dump their data to the surface ships or submarines intended to make the actual attacks. Satellite data was also used to cue *Backfire* (Tu-22M3) bombers, which could fire their missiles from beyond the horizon, on the basis of the cueing (they did not receive the satellite data directly).

The Soviet systems were a waypoint towards the new warfare. They followed classical Soviet practice, in that the shooters simply obeyed commands. Real decision-making rested, as always, at the centre of Soviet power. Thus, for example, although a submarine (generally an *Oscar* or a modernised *Echo II*) could receive a tactical picture, it could not query the satellite directly; it only received the data after it had been ordered into position and also ordered to put up the necessary antenna (*Punch Bowl* in NATO parlance, *Kasatka* in Soviet).

The US reply to the perceived threat of Soviet missile-firing ships was more subtle. It was accepted that a US commander needed a reasonably good picture of the shipping activity, both Soviet, neutral and friendly, over about a 1,500 mile radius. That sort of data would provide early warning. For example, a carrier group might have the time to set up a combat air patrol over potentially threatening missile ships—remember, during the Cold War, there was always the real possibility that war might break out with a surprise naval attack. Part of the problem was simply to collect enough information, and for that the USN combined all the sources of information it had. It produced the resulting world shipping picture at new Fleet Command Centres (FCC), which worked with Fleet Ocean Surveillance Intelligence Facilities abroad. One interesting feature of this approach was that it clearly showed that what in the past had been considered an intelligence-gathering net was now often an operational sensor system. That distinction had always been somewhat misleading: after all, when Jellicoe was vectored out to meet the German fleet in 1916, surely the British intercept system was functioning as his OTH sensor.

One question does, however, come up. The new style of long-range warfare places a premium on the sort of intelligence which shows exactly where things are,

because it is strike warfare, and it feeds on target data. What becomes of the classic, subtler kind of intelligence, the kind that is concerned with enemy intentions and morale and thinking? Perhaps not everything is strike warfare. Then again, if Boyd was right, strikes and manoeuvres, properly and crisply executed may have the appropriate devastating effect on the enemy's thought processes. Of course, a great deal depends on whether the enemy really cares about what we are hitting—and that is always an interesting question. Just how much did Mr Milosevich really care about what we bombed during the Kosovo crisis?

Enter satellite communications

In a more technical vein, there were two key issues. One was how to convey the masses of data to the deployed fleet, thousands of miles from the centre at which data had been collected and correlated. The other was how to make sure that the fleet could correlate its own shorter-range data and shorter-range targeting with the picture assembled at the distant centre. These two questions are at the heart of any attempt to realise the ideas of the new kind of warfare.

When the USN faced these questions in the late 1960s, there was already widespread dissatisfaction with HF radio as a long-haul medium for naval communications. Its message capacity was quite limited, and it was unreliable—whole days could pass during which a shore station could not raise a ship thousands of miles away. Moreover, communication depended on a network of ground stations, and in the late 1960s and early 1970s the USN was being ejected from some key ones, such as Asmara, Ethiopia. It had to face 'radio deserts' in some Third World areas of extreme interest. The solution, a pair of special radio link ships, was very expensive to operate and made the fleet vulnerable to surprise attacks on its communications (among other things, the ships were most effective if they operated well away from other ships, to minimise interference).

Space offered a way out of the problem. Satellites would use line-of-sight radio, which meant frequencies well above HF, hence, at least potentially, much higher data rates. As an incidental bonus, because a ship sending data to a satellite pointed her relatively narrow beam upward, it seemed that the old fear of interception and DFing could be forgotten. For example, during the 1980s the USN embarked on an aggressive deception program as a way of defeating Soviet anti-ship missile forces. Deception required a degree of coordination among very distant forces, and satellite communications seemed to solve the problem.

At the very least, satellites offered reliable long-haul communication at high data rates. The new command centres could formulate their long-range tactical



The Arleigh Burke class destroyer USS Curtis Wilbur is based at Yokosuka in Japan.

pictures, based in part on satellite sensing systems, but it was even more important that they could communicate those pictures to the deployed forces. If all this seems abstract, one might point out that the system was responsible for the success of the blockade of Iraq in 1990–91. That is, given a very limited number of blockading ships, it was vital that their interceptions be cued and planned on the basis of an overall tactical picture covering the very wide area of the Arabian Sea funneling into the key port of Basra. It might also be noted that, once the system had been designed (to deal with the Soviet Navy), it was remarkably easy to deploy. Allied ships on blockade duty were given standard US commercial-type tactical computers with the necessary software, and they received their satellite data via standard modems and dishes. This example,

incidentally, belies the claim that modern C4I systems are invariably far too expensive to deploy.

For the USN, the goal has been maximum communications capacity, because the deployed fleet (and now the deployed army and air force) demands more and more information. When the main naval targets were Soviet warships, the main role of the fleet communications system was to transmit the tactical picture of ship locations, plus warnings of possible Soviet attacks. The next stage, in the 1980s, was to provide enough capacity to warn of the approach of Soviet missile-carrying bombers, using warnings from, among other sensors, OTH radars. Once the fleet re-oriented towards land attack, matters grew considerably more complicated. It generally takes detailed images to direct missiles against ground targets. For example, missiles must be directed away from mountains (they lack forward-looking sensors to warn them of obstacles) and, if possible, away from radars and anti-aircraft missiles (they are not very difficult targets). Missile strikes are generally planned in detail aboard ships, to preserve maximum flexibility, so the necessary information must be provided. Since things can change very quickly ashore, the information must come by radio link, and pictures take up enormous bandwidth—as anyone waiting to download images from the Internet knows very well. A single image may represent a million bytes or more. One US solution has been to use satellite television techniques. A US Internet provider once offered to use a high-bandwidth satellite link to download from the Internet; subscribers would send their queries in by conventional telephone line. The US military system operates roughly the same way, using low-capacity links back from the ships and forward-deployed formations, and a wideband broadcast link out from US data banks. In this way those on board a ship can, in effect, browse through intelligence files roughly the way an Internet user browses through a web site.

Another element of the US concept of the 'net' is that all users have full access to a kind of universal (multi-service) tactical picture, held in common, and built up cooperatively. This is the ultimate development of ideas like Link 11 and CEC. One interesting question is how (and whether) such a picture can be shared with other forces. Another is how it can be protected against deception or even against corruption by bad data. Given the common tactical picture, commanders can, in theory, target weapons and take other tactical decisions. If the US tactical picture is actually much better than an enemy's, in theory Boyd-type tactics can be carried out.

All of this is the theory and justification for a future much more competent C4I system. Right now most navies have computerised tactical data or combat direction systems aboard their ships and aircraft, and many navies have

connected their ships and patrol aircraft with computer data links, sometimes with greater capacity than the current NATO Link 11. To the extent that these systems are entirely software-controlled, and to the extent that in a broad sense they follow the same logic as the NATO systems, one question is whether they can be adapted to connect with Link 11 and its NATO successors, Link 16 (TADIL-J) and Link 22 (Link 11 media using Link 16 message structure). Conversely, it would be interesting to know to what extent ships designed with the NATO links can act as gateways to other Link types and standards. In theory, computers can be programmed very flexibly; perhaps the issue is spare computer capacity, or even an interest in these questions.

In a very few cases, such as Greece and Turkey, Link 11 is used not only between cooperating tactical units, but also between the fleet and a naval headquarters maintaining a large-scale strategic/tactical picture. Such use of Link 11 is attractive because the ships are already adapted to it; but the Link itself is designed only for short-range use. If it is used at longer ranges, then the number of subscribers on any one Link net is limited. During the 1980s the USN demonstrated a satellite version of Link 11, but it was apparently not popular. The USN is currently deploying a satellite version of Link 16, however. In this case, too, the delays inherent in the satellite up- and down-link process would seem to limit the number of potential subscribers.¹⁵ In the case of Link 11, one attraction of the satellite was that ships could radiate without having their signals intercepted and DF'ed. Another was that the Link 11 net could extend over a much greater area, the footprint of the satellite, and thus a fleet could disperse widely yet still be coordinated. In the case of Link 16, the radio frequency used (for increased data capacity) is line-of-sight, so without some other sort of transmission the area the link covers is very limited. That was originally acceptable because Link 16 was intended for aircraft, and thus the line-of-sight range could be considerable (including line of sight from a carrier to an airplane). Although Link 16 can carry images (at a very high cost in the number of subscribers on the net), it is not really well adapted to that role.¹⁶

The C4I future for medium navies

So what really ought to be done? The historical examples suggest that the communications link between shore and ship is the single most important element. Ships have to be adapted to accept high-capacity satellite links, which ultimately entails some adaptation of topside arrangements. Moreover, it is probably essential that ships be able to transmit more or less continuously to high-capacity satellites. Remember that a satellite dish is roughly equivalent to a radar dish, in size and in the extent to which its side lobes leak into other antennas. The great question, then, is how to shield ESM antennas from the

ship's own satellite radiation. This is hardly an academic point. During the Falklands War HMS *Sheffield* was serving as radar picket protecting the carrier HMS *Hermes*. Perhaps too well aware of the possibility that even satellite dish side lobes might be detected and DF'ed, the British had *Sheffield* rather than *Hermes* communicate by satellite with the UK. When she did so, the side lobes of her satellite dish spilled over into her ESM antennas. To avoid false alarms, the ESM set was shut down—so it never detected the *Exocet* that hit the ship. The postwar solution was to operate the satellite dish in bursts, automatically shutting down ESM while it transmitted. Unfortunately, everything written here implies that satellite communication will be more, not less, continuous in the future; it will be impossible to shut it down for everything but a few bursts per second. If there is a solution, it may be to accept spillover and automatically subtract out the satellite communication waveform.

Step one, then, is to fit ships with satellite communications systems, which initially will probably be linked to commercial satellite systems under foreign control. This combination may well be unacceptable, but at the least it places hardware aboard ships and it motivates the development of the appropriate computer software. Clearly much depends on the way in which satellite communications are used. If they are merely a more reliable replacement for HF radio, then the fleet itself does not change its style of operations. Satellite communications really add value if they are used to transmit masses of tactically essential information from shore to ship. At least in theory, satellites (or perhaps UAVs using very high frequency radio links) can also connect deployed ships with troops ashore, who the ships may be supporting using missiles and long-range guided shells.

So the first major change to a fleet will be the shift to UHF or SHF links both via satellite (including the 'poor man's satellite', UAVs) and line-of-sight from the current mix of HF and higher frequency short-range systems. Connected with this switch is an expansion in computer capacity so that much higher data rates can be used effectively. Given the very low cost of current computers, this last step should not be too expensive; the main cost is probably in the software.¹⁷ Many navies already participate in US-sponsored programs to receive a US-assembled world shipping picture, the NATO Command and Control Information System.

If shore attack/support is to be a major future naval mission, then satellite link capacity must enlarge to the point where graphics files are easy to receive. That should not be a major technical issue, since existing commercial direct-television links have the necessary capacity. The only important issue is the provision, on board a major surface ship, of the necessary computer capacity

to capture and display the data. Much the same can be said of receiving data from troops ashore, and of communicating with them beyond the horizon.

The most important change is in the fleet's expectation of the sort of data it can and should receive, and in the command's use of that data.

Obviously satellites offer much more. In its IT-21 program, the USN gives its ships what amounts to Internet capability, and that allows communication on a scale previously unknown. For example, ships relieving each other can pass extensive files indicating their understanding of a situation. Ships operating together can communicate using what amounts to a chat room. An e-mail or Internet browser equivalent makes it possible for a deployed ship to obtain information it needs on a large scale, e.g. software its command needs to plan for a previously unexpected operation. All of this is clearly very convenient, but it is not as revolutionary as providing the commander of a deployed unit with full information about what is happening out to a radius of, say, 1,500 miles—which is what he needs to make use of the new kinds of long-range missiles.

The second major change is the creation (or major improvement) of the shore centre which assembles intelligence information for the deployed fleet. Such a centre almost certainly already exists, but the difference between traditional and satellite links is that much more of the plot or other summary it maintains can be provided to the fleet. If the fleet is armed with land-attack weapons, then the shore centre can now provide the fleet with the sort of graphics (mainly photos) needed for targeting. Without satellites, the shore centre could presumably provide the deployed fleet with specific missile target instructions; but the key is that the deployed commander be able to use the weapons tactically, without referring constantly to the ashore headquarters.

The first change is relatively inexpensive in hardware and software terms, since computer and radio hardware is becoming less and less expensive. The second change demands considerable investment, but more importantly it demands a change in attitude. It implies a change in the usual relationship between intelligence and tactical sensing. At least in the US, intelligence data is very closely held, and there is real resistance against using it tactically. Yet the sort of long-range time-late picture implicit in the new kind of war is assembled from intelligence sources (in the US case, often from a mix of satellites and other radio intelligence). In the US, it took considerable arm-wrenching to make this transition. It is entirely possible that in the process an important dimension of intelligence, understanding of the opponent and of the opponent's thinking, was lost—and ironically, it is this dimension which becomes so important if Boyd's ideas are to be used in practice.

At the shore end, the issue would seem to be to think through how the output of specific current and proposed long-range sensors can best be merged into an agreed tactical picture (because as range increases all the services automatically become involved), and then how that picture can best be distributed to operational commanders operating forward. Distribution will clearly be electronic; issues that arise include the frequency of update and thus how important time-lateness really is. Clearly, too, the forward units must have some way of contributing their own updates to the overall picture. Probably this is as much an organisational issue, as it is a technical one. Indeed, the more that C4I developments are examined, the more human issues seem to predominate over purely technical ones.

The last stage is the satellite link itself, since much of the value of the new forms of C4I can probably be realised using commercial channels, or perhaps leased commercial channels (after all, the main IT-21 channel is leased from the International Maritime Satellite System). Probably too the satellite is the only really expensive element.

In the end, the most important implication of the new C4I would seem to be its ability to support long-range missile fire. So the most important investment, in the end, is in the sort of fleet capable of firing and using long-range weapons. Without the weapons, much of the investment in C4I is likely to be wasted. With them, the character and capability of a fleet, whether medium or small or large, can be transformed.

Notes

- 1 The information is presented as a tactical picture, and one might imagine a more or less constant distribution of ships and aircraft over it. On that basis the amount of information needed should increase as the square of the radius involved. That would be bad enough, but a commander looking out over greater distances may well want information on more kinds of ships and aircraft. The longer the engagement ranges, for example, the greater the number of neutrals that must be tracked well enough to avoid engaging them. Geography becomes more important, and the tactical picture must take it into account. What this means is that the larger the area involved, the greater the data rate required to maintain a useful tactical picture. The situation on land is of course far more complex than at sea. If a ship is to support a land battle from a distance or if the land situation is to be represented clearly onboard ship, then the amount of information required is increased by several orders of. First, forces ashore (not to mention neutrals) are numerous and densely packed. Second, there is real terrain, which affects decision-making. Terrain may be pre-loaded into a tactical display in the form of (say) a CD-ROM, but some things change very quickly, e.g. buildings and walls.

- 2 In fact the new *Tactical Tomahawk* is designed so that it can be redirected in flight, or made to loiter in a holding pattern while awaiting orders. However, this is a very limited capability. Note, incidentally, that this sort of capacity places further demands on C4I channels, since there must be some means of monitoring the missile and sending it orders. *Tactical Tomahawk* is also to carry a battle damage assessment camera, offering the operator a means of feedback after an initial strike.
- 3 As it happened, at this time the Germans were almost certainly unable to intercept British radar signals. As another example of this attitude, reportedly *HMS Hermes*, en route to the South Atlantic during the Falklands War, had her tactical air navigation antenna cut from her mast and tossed over the side, so that its emissions would not alert Argentine intercept stations to her position.
- 4 Because transmission and reception involved considerable extraneous noise, and because the signal was distorted by 'atmospherics,' the limit on the rate of transmission was the need to be able to distinguish a character—a dot or dash—from the space between characters. The ultimate limit is more difficult to specify. According to the mathematics of Fourier Analysis, any given signal is made up of sine-wave signals of different frequencies. The range of frequencies needed to form the character (in effect, the bandwidth) depends on the time duration of the character: the shorter the character, the greater the bandwidth. If the only characters are 1s and 0s, duration is the inverse of bandwidth. Since information rate is inverse to the duration of any given character, it is proportional to bandwidth. However, it is possible to substitute multiple energy levels for the simple 1 or 0, so if enough energy is available (or if a channel is noiseless enough, so that small energy differences are clearly detectable) a given bandwidth can carry several times as much information. Conversely, transmission problems may impose a greater minimum length per character. That is the case in most high frequency (HF) systems.
- 5 LF and MF transmit via both sky and ground waves, the latter adhering to the surface of the sea. The sky wave is typically trapped in a sort of waveguide formed by the surface and the ionosphere. They can thus achieve long ranges. HF also has a ground wave, but it does not go as far (typically out to about 300 nautical miles). However, it has a sky wave that reflects off the ionosphere at a shallow angle. The reflected sky wave returns to earth at a great distance. There is a blank 'skip zone' between the area covered by the ground wave and the area in which the sky wave returns to earth. Apparently there is also a short-range sky wave, striking the ionosphere at very steep angles (the sky and ground waves interfere, a phenomenon called multipath). Recently a German firm, Rhode & Schwartz, has advertised an HF antenna offering gapless transmission out to about a thousand miles, by exploiting steep-angle sky waves.
- 6 HF transmission was limited by smearing due to multipath. Because signals could travel via several different paths (mainly ground wave and sky wave) a receiver would hear the same signal in versions with different delays, and these versions

could interfere. The solution at the time was to use signals of sufficient duration that the interference would have little effect. Long signals equated to slow transmission. A more modern solution, which permits transmission at a much higher rate, up to 4,800 or even 9,600 bits per second, uses a computer to detect multi-path interference and to adjust reception to overcome it. In these systems, a special test signal is sent periodically. The associated computer adjusts transmission so that it can always recognise the test message. A similar solution has been applied (by, among others, the USN laboratory at New London) to underwater signaling, so that it now appears that high data rates can be achieved over tens of kilometers. Should this technique prove successful, it will have important implications for unmanned underwater vehicle and submarine operation.

- 7 Before the advent of VHF, the main hope of avoiding enemy interception of intership HF or MF communication was to limit power. A recent book on the Pearl Harbor debacle claims that the Japanese fleet in fact turned on its radios, at very low power, when ships scattered by a storm had to be shepherded together. Due to freak atmospheric conditions, some American receivers supposedly intercepted the signals, though it seems unlikely that their significance was understood. Note too, that at some frequencies (L-band) the atmosphere refracts signals (an effect called troposcatter), returning them to earth. This is the basis of some long-range (200 mile) communications systems, and was presumably used by several navies, including the RN and the USN, to track Soviet warships using L-band radars such as *Big Net* and *Top Sail* (the relevant electronic support measures receivers were the British UA-13 and later versions of the US SLQ-32 with higher-gain low-band antennas). Troposcatter has not, it seems, been used for sea communications, although it is used on land, because it requires directional antennas; the transmitter has to be pointed at the receiver. Since an important point of naval operations is independent movement, that is generally impossible at sea. Note that, unknown to the West, from the late 1950s on the Soviets first experimented with and then used both troposcatter and ducting to target surface warships beyond the horizon. The antennas contained in *Band Stand* radomes seem to have been the main types used; the Soviets also characterised the *Plank Shave* targeting radar (*Garpun*) as a beyond-the-horizon system.
- 8 For example, if signals are transmitted at higher power, it may be possible to use different power levels to distinguish characters, so a given time interval may indicate (say) not only a 0 or 1 but 0, 1, 2, or 3. This technique is now commonly used in satellite communication. Unfortunately, it takes a lot of power to gain much. Quadrupling power doubles effective data rate (it takes only two bits to indicate a 4); multiplying power by sixteen only quadruples data rate (16 is 2 to the 4th power).
- 9 US and British expressions, respectively. The British preferred to emphasise the function, and concentrated on the Action Information Organisation.

- 10 In this sense the automated radar plotting aid (ARPA), which is a required feature of all modern merchant ship radars, is a very close relative to a tactical data system. Using an ARPA, the radar can keep track of a limited number of targets, automatically measuring their relative courses and speeds, and displaying their vectors.
- 11 CEC began as an extension of the Aegis anti-air warfare system. The associated SPY-1 radar was so effective that one ship could use her radar to guide missiles fired by another. The next step was to set up a link which could transmit, not processed data, but rather the individual plots (detections) made by each radar in a group. Each ship would produce track files based on all such detections. One consequence was that ships grouped around islands would be able to engage incoming missiles even though terrain might block them from direct view. For that matter, approaching stealthy aircraft and missiles are generally fleetingly visible, since their radar cross sections cannot be reduced in all directions. A group of ships using the CEC link would presumably be able to engage such targets based on a composite track set up from the series of fleeting detections obtained by ships seeing the targets from various directions. It is easy to imagine an extension to multi-static operation. CEC was extended to anti-ballistic missile use, since it allowed any one ship to make direct use of remote sensor data. This extension has apparently run into difficulties, but the essential value of CEC is still clear. The system has also been extended as a one-way supplement to the radar data obtained by ships with inferior radars; the ships thus can see beyond their own horizons. That provides them with valuable warning time. It is difficult to imagine a fleet equipped with CEC integrating with an air defence ship lacking this system, just as it was difficult to integrate ships lacking Link 11 with computer-linked forces.
- 12 Link X/Y does not use Kineplex transmission, and as a result at least in its initial form it could transmit only at 75 bits per second; Link 11 stacks up 30 signals in parallel, and so transmits at 2,250 bits per second. As a consequence, data is (or originally was) far simpler and limited to the positions of targets. The system could not automatically transmit target identity, or tell-backs when weapons were fired, or commands, among other things. The current Link Y Mk 2 seems to be closer to Link 11 in the range of information it carries. For an account of data links and current tactical data systems see Norman Friedman, *The Naval Institute Guide to World Naval Weapons Systems*, Naval Institute Press, Annapolis, the current edition is 1997-98, published 1997.
- 13 An interesting side issue is just how a navy using systems from a wide variety of suppliers, such as the Chinese or the Indian, gets around problems of internal incompatibility. Possibly these navies have not yet realised how essential data links and computer combat systems can be, and their willingness to live with such variety may indicate that ignorance. As for Russian links, we seem to know enough to know that they do not work on Western principles. It appears that a Russian fleet is

organised in a strict hierarchy. Subordinate ships simply send their local pictures to the flagship, which processes the data and returns commands. It is even possible that commands can, sometimes, be executed automatically by the subordinate ship's combat direction system.

- 14 For a more complete account, see Norman Friedman, *Space and Seapower*, Chatham Press, UK, Spring 2000.
- 15 Both Links use time standards. Link 11 is a round robin, in which the master ship calls the roll of the other ships (pickets). Picket reports follow each other without delay, to form a complete cycle; cycle time determines how timely the picket reports are. The number of subscribers on the net is presumably fixed by an estimate of the longest acceptable cycle time, which in turn is set by the allowable lateness or error in the overall tactical picture. In the case of Link 16, each subscriber is assigned a time slot within the overall cycle. The time delays inherent in a satellite transmission would take up several slots, and thus would limit the number of subscribers.
- 16 There is current interest, at least in the US, in using Link 16 to retarget attack aircraft in flight. Retargeting entails sending the aircraft sets of images of their new target areas, so the pilots can recognise the area and identify way points. Since only a few images are involved, relatively slow transmission is acceptable. At Euronaval 1998, the French demonstrated the use of Link 16 to transmit video from the carrier *Charles de Gaulle*, moored at Brest, to Paris—but they could not have used the link for tactical purposes while it was so engaged.
- 17 US experience is instructive. In the 1970s, the USN planned to install Tactical Flag Command Centres (TFCCs) on carriers to receive the satellite links from the shore FCCs which assembled a picture of world shipping (to indicate the location of Soviet surface ships and to make it practicable to plan attacks on them). A TFCC was quite elaborate, and it took an extended shipyard availability to install it. One US Flag Officer, Rear Admiral Jerry O. Tuttle, realised that existing commercial computers were quite as powerful as their navalised counterparts, and that they could run the same software, since both were general-purpose computers. Eventually he and others produced a software system which could run on a standard Navy-issue commercial computer, at that time a Hewlett-Packard, but which could mimic many of the TFCC features. The computer was inexpensive, and software reproduction cost almost nothing. The resulting JOTS system (joint operational tactical system, if one did not call it the Jerry O. Tuttle system) was deployed on board virtually all US warships, at least down to the level of frigates—and many of those ships did not have the capacity to receive and display Link 11. The conclusion is that satellite link capacity need not be terribly expensive. Having said that, it really may be difficult to meld the satellite data, which is generally time-late, with the timely data received over a conventional tactical link.

Making maritime coalitions work: the future C4I perspective

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Captain Thomas Keithly, USN

Modern warfare is changing. Its shape and effectiveness are going to depend on the interoperability of coalition forces. What is meant by interoperability? The term covers all aspects of common equipment, operations, logistics, training, doctrine, planning and policy. In the maritime arena, discussions about interoperability quickly focus on command and control; part of that larger set of issues normally described as command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR). The missions of modern navies, large or small, run the gamut: blue water operations, the projection of power ashore, defence of the sea lanes, coastal defence, etc. But, their ability to perform assigned missions, particularly as a partner in some future coalition task force, will rely on interoperability that assures clear and reliable communications.

Strategy, technology and the 'revolution in military affairs'

The United States (US) *Joint Vision 2010* combines littoral warfare and operational manoeuvre in the discussion of *dominant manoeuvre*. Its vision of future warfighting 'embodies the improved intelligence and command and control available in the information age'. This vision has taken form. Forces from Australia, the United Kingdom, New Zealand, France, Argentina and others have been vital to successful maritime interdiction operations in the Arabian Gulf. Canadian ships have participated in deployments with US battle groups. Operations in Kosovo highlight the evolving role of coalition forces.

The pace of technology will change the conduct of war. Technology promises a 'revolution in military affairs' (RMA). While military planners have always looked for a 'silver bullet' to change the face of battle, current technological changes will lead to non-linear gains in capability, particularly in command, control, communications, computers and intelligence (C4I). Advances in C4I offer the greatest promise as an RMA. In this area, the commercial sector is setting the pace. Observers often comment on an 18-month cycle for the replacement of one generation of technology by another. How this technology reaches our forces is the key question. The factors that affect these transitions are many: national priorities, budgets, the sharing of information, and even the competition and globalisation of defence industries have much to say about future force structure and fighting capabilities.

Allied concerns about the direction of C4I

US allies are concerned about the pace and direction of C4I. A dynamic commercial sector makes possible big strides in information technologies. However, the leaps in capability make even 'high tech' partners wonder about where this leads and where to invest. So what are medium and small navies to do? Other navies state repeatedly that they do not know: where the US is heading; how they can deal with the growing 'gap' in C4I; or what C4I equipment they should invest in today to participate in the coalition operations of tomorrow. The US is perceived as moving too fast for them to keep up either operationally or fiscally. Lacking in recent studies within the Washington beltway is how to bring smaller and less technologically advanced navies into the picture. Future coalitions cannot be limited to navies who can afford the latest equipment. Also, C4I capabilities must not limit the expression of political consensus represented by coalition operations.

US Navy (USN) concepts in C4I

The US is pursuing a number of exciting and innovative approaches to make the best use of information technologies. These include:

- *The Copernicus architecture*. This reflects current strategic thinking of interoperability, flexibility, responsiveness, mobility, survivability, and sustainability. It seeks to accomplish these principles through a C4I architecture that supports the warfighter, with a common tactical and operational picture, described in terms of latency of information.
- *Network centric warfare (NCW)*. This is a concept promising major gains—a non-linear improvement. It is described as an associated group of fundamental changes, which shifts from the platform to the network as the fundamental element of warfare.
- *Information technology for the 21st century (IT-21)*. This is the USN's umbrella strategy for enabling the information technology (IT) elements of NCW. The IT-21 goal is to enable voice and video transmission from a single desktop PC.
- *Cooperative engagement concept (CEC)*. This is the USN's effort to create a network to achieve 'sensor to shooter' control.
- *Horizontal integration*. This is a systemic approach to develop, integrate and align the range of naval C4I programs with a common information exchange structure, the defence information infrastructure common operating environment.

USN Policy in Support of Interoperability

USN policy is fully supportive of efforts to achieve needed levels of

interoperability. The US Chief of Naval Operations (CNO), Admiral Jay Johnson addressed the important role of coalitions in international security last fall at the *International Seapower Symposium* in Newport, Rhode Island. He admitted that much work needs to be done to achieve the combat capabilities necessary. In his view, there are three major areas at the core of interoperability: technical, operational, and political-legal. These areas encompass the individual challenges to interoperability that navies struggle with daily, like, commonality in language, doctrine, rules of engagement, C4I connectivity and others.¹ The CNO said that there are positive indications that many navies of the world from nations with global interests are working diligently to overcome these obstacles and improve interoperability.

The USN is working hard, focusing on network centric communication capabilities rather than on specific equipment. Within each capability is a family of equipment from which individual systems can be selected to achieve the desired capability. Both 'low' and 'high' data rate solutions for connecting allied IT systems with USN IT-21 networks have been successfully demonstrated. These solutions offer a scaleable approach to providing for Allied C4I interoperability. Allies capable of 2400 bits-per-second or greater line-of-sight TCP/IP data transfer can pass limited, essential information with an IT-21 battle/amphibious group. Allies capable of broad bandwidth line-of-sight or satellite communication may exchange a full range of administrative and operational data with the USN. System requirements are based on mission needs—what type of information is required, what latency can be accepted, and how often information must be refreshed.²

The USN is committed to systems that provide the common operating and common tactical pictures that naval forces require. A prime objective is *situational awareness*, which is essential to battlespace dominance in war and to control of the operating environment in peacetime. We have made great strides in achieving situational awareness through systems such as the global command and control system—maritime and data link systems such as Link 16. These technical solutions to interoperability—choosing what 'gear' we use—will dictate in a real way how we achieve the operational interoperability we seek.

USN international programs

The USN International Programs Office (IPO) works to provide an interface between USN policy and acquisition on the one hand, and the US's international partners and American industry on the other. Navy IPO's interests cover a wide range of issues that deal primarily with matters of technology transfer: Foreign military sales (FMS), the disclosure of classified information, the export of



Interoperability is a key consideration for all navies, small or large.

defence-related technologies, and cooperative research and development. Three ways Navy IPO is working to facilitate coalition interoperability are:

- *Harmonisation of requirements.* The USN IPO supports interaction with other navies to define future requirements and cooperate in key areas of research and development. Allied partners benefit from the standardisation and interoperability that result from co-development or design. An example of an emerging program that represents the future of interoperability is Link 16 multifunctional information distribution system (MIDS). It uses open systems architecture with state-of-the-art technology to miniaturise Link 16. MIDS comes under a US program manager, but is directed by a steering committee including four other North Atlantic Treaty Organisation nations.

From my experience, Link 16 is essential to gaining a clear tactical picture. MIDS represents the future of C4I.

- *Improving the disclosure process.* Disclosure is the number one concern of both US industry and foreign customers. The US process for technology transfer has come under a great deal of criticism lately for being slow and unrealistic. The US Department of Defense has taken steps to reduce the time it takes to process licenses. And high-level groups are assessing the feasibility of removing whole categories of items from review—the concept of ‘higher walls around fewer items’. In addition, Navy IPO is working to facilitate C4I releasability. Unlike traditional transfers of US technology, the releasability process for C4I has its own unique set of rules. Navy IPO has two roles in this regard. First IPO ‘quarterbacks’ the process to ensure the US regional Commander-in-Chief (CINC) obtains all necessary information required to justify system release from in-country US Security Assistance Offices and from US component commanders. The release is then shepherded through the range of joint and national agencies that have oversight responsibilities.
- *FMS reinvention.* FMS is the US process for the government-to-government transfer of defence-related goods and services. FMS has taken a lot of heat in the past few years. It is seen as archaic and unresponsive, and a holdover from the Cold War. IPO, with assistance from representatives of industry and foreign embassies in Washington over the past year, studied the so-called ‘dissatisfiers’ with FMS. A number of initiatives have been identified that will help streamline FMS to make the transactions more visible to the foreign customer and to support USN and US Marine Corps interests. One outcome of reinvention is the concept of ‘hybrid’ cases, combining FMS and direct commercial sales, where it fits the needs of the foreign customer.

A pragmatic approach to solving the gap

The USN clearly needs to press on with concepts like NCW and CEC. But, these should be accepted as just that—concepts; a conceptual framework to appreciate the power and utility of linked information systems, at sea, ashore, and in the littorals.

The current trend is to procure one ensemble of capabilities that can do it all. Initiatives like IT-21 are making excellent progress toward a common tactical picture, with the full array of intelligence, imagery, text, voice, etc. to get each unit and the commander a perfect picture of their environment. Horizontal integration seems to take this a step further in creating a unified system. But, when considering the inclusion of other navies, three problems become evident. First, this doesn’t allow the incremental demonstration or procurement of

capabilities. Second, the price of admission for most navies may be too great. The third factor to consider is complexity.

The world is getting more complex, not only the technology, but the vast amounts of data and growing numbers of participants who have instant access. Articles on NCW cite Metcalfe's Law that the effectiveness of a network increases exponentially with the square of the nodes. The more participants the more relevant, timely and accurate the information. This needs to be looked at carefully, with some thought about how to simplify communications, especially with the inclusion of non-US participants. Increasing the number of players, connected together with many different types of systems, would seem to have the potential just as easily to drive a network into chaos. Instead talk should be in terms of required capabilities rather than specific equipment. The USN is identifying those required capabilities and families of equipment that meet those requirements. In meetings with allies and friends, the USN is frequently asked what equipment it is currently buying. Members of potential coalitions need not buy the latest gadget when a piece of equipment already in inventory will meet the operational requirement.

The actual execution and achievement of interoperability needs to be more pragmatic and incremental. The USN needs to let its allies make informed and affordable decisions, today, to procure the right C4I 'gear'. This should not be taken as a recommendation that the USN slow down its technological improvement. However, informal reports from the people on the waterfront indicate that the USN is creating some problems for itself in its dash to IT-21. Perhaps the USN also needs to take a more 'bite-sized' approach.

Recommendations

The USN should define needed maritime capabilities in command and control and how various C4I systems support them. From this it should map out which C4I capabilities will achieve the operational and tactical roles and objectives; across the spectrum of warfare, from forward presence to regional conflict. The US needs to publish this plan to its regional, 'warfighting' CINCs, via the naval component commanders so that the CINCs endorse a common approach to C4I, valid for any region of the world. Their endorsement of the interoperability requirement is essential to the releasability of systems, and tells nations in the region what they need when they join in future coalition operations.

One approach is for the US to show its friends and allies how naval command and control relates to maritime capabilities, and then lay out a transition of technologies, so that they can 'buy in' according to their sophistication, budget and intended missions. Doing this effectively will require that friends and

allies are shown where the US is going, when it plans to be there, and what entry points the US has in mind for them. As the US defines a plan to deal with the growing 'gap,' it might consider the use of a coalition advisory panel—such as the international group in attendance at the annual Copernicus Requirements Working Group conferences—to advise problems and to work toward matching programs.

Two elements of such a plan may include:

- Using the Copernicus methodology (according to latency) to draw timelines for the development and transition of systems that support the C4I maritime capabilities. This would include detailing, as far as possible, where the programs are, with a view to showing other navies how they can 'buy in' and what equipment will fill the various roles. It should be noted that the proliferation of equipment in the USN makes it appear it is changing capabilities rather than improving on existing capabilities. Furthermore, milestones should be identified, as systems evolve from one generation to the next. Additionally it should be defined how a given program will transition from demonstration to development and how other navies can buy it, share it, or make it themselves.
- Using the concept of packets of interoperability. Not only should the US continue to pursue ambitious and 'wide bandwidth' concepts such as IT-21 and horizontal integration, but it should make it obtainable in pieces as well—right now. Although the US often refers to 'seamless' communications, 'seams' are not the problem. The US should allow friends and allies the ability to procure C4I a piece at a time. 'Low end' navies need a way to obtain systems that match their budgets and their intended missions. This may be as simple as the use of very high frequency for search and rescue. The 'high' and 'low' end solutions for wide area networks, proposed by the USN and discussed previously, is another approach.

Training is important to flex these systems and ensure their utility. Regular fleet exercises that require our forces to periodically demonstrate C4I capabilities with joint and combined forces should be defined. Also, we should reinforce the use of 'liaison teams' or ship rider programs, whereby friendly nations have the opportunity to borrow or rent the gear as they develop their knowledge and experience. Provided the US regional CINC has stated the requirement, the availability of C4I equipment will also allow them to pursue the incremental funding to install the equipment on a permanent basis.

The US should change the data link approval process so that consideration of interoperability is not narrowly confined to one US area of responsibility (AOR).



The *Ticonderoga* class cruiser USS *Port Royal*. Coalition warfare, particularly in the maritime environment, is the way of the future and coalitions will only be successful if there is a high degree of interoperability amongst all partners.

For example, if CINC 'A' does not have a requirement to interoperate with country 'B' in his AOR, CINC Central might have such a requirement if country 'B' is willing to deploy assets in support of Arabian Gulf coalition operations.

One of the more complex and restrictive aspects of C4I is the releasability of classified communications security (COMSEC) data and equipment, and for good reason. The US must safeguard data and information security that it needs for its own unique uses. The US National Security Agency, therefore, looks skeptically at the release of all COMSEC to non-US forces. Maybe the solution is the development of 'coalition cryptography'. This would give us a means to ensure selected access to data, quickly adaptable to the inclusion of new coalition partners—without releasing US cryptography. New commercial off-the-shelf technology and software—such as personal key encryption—may make this easy. The US needs to budget for such development as a US requirement based on national strategy. The devices themselves would still be

sold as end items. On a broader scale, the ideas of common standards and backward compatibility need to apply to future systems wherever possible.

Conclusion

Anyone who has participated in exercises or in real-world operations realises that good 'comms' are always a challenge and always more difficult than planned. Modern technologies are offering some exciting new capabilities. But, of all the principles of war, a key principle for the future direction of C4ISR should be *simplicity*. There is a need to deal with real solutions to gaps in technology. Pragmatic solutions may help assure the participation of coalition forces, from navies large and small, to keep the peace or fight the war of tomorrow.

Notes

- 1 Remarks by Rear Admiral Kenneth Heimgartner, Director Political-Military Affairs (N52), given at the International Navies Luncheon, 12th National Symposium of the Surface Navy Association, 14 January 2000.
- 2 Captain W. Ide, USN and Commander M.J. Dale, USN, IT-21 Allied Interoperability, CNO N60, United States Navy.

C4I: | 12 the view from Japan

Captain Takao Hirayama, JMSDF

This chapter provides an overview of command, control, communications, computers and intelligence (C4I) systems currently in use within the Japan Maritime Self Defence Force (JMSDF). The shortcomings of the existing systems and future C4I plans will also be discussed.

The Japan Defence Agency (JDA) consists of the JMSDF, the Japan Ground Self Defence Force (JGSDF) and the Japan Air Self Defence Force (JASDF). The JDA has a Joint Staff council like many other defence forces, however, it does not have authority or power of command over the three defence forces. The Joint Council makes recommendations to the Prime Minister and the Director General of JDA. The Joint Council can command a joint force raised for a special operation.

The JMSDF consists of a Maritime Staff Office (MSO), a Self Defence Fleet, five Regional Districts, and other units and organisations including, Central Communications Command. The Self Defence Fleet consists of a Fleet Escort Force, a Fleet Air Force, and a Fleet Submarine Force. Therefore, the JMSDF must consider C4I from the perspective of platforms such as ships, aircraft, and submarines in addition to bases ashore.

The Director of Operations and Plans in the MSO has overall responsibility for C4I. Currently different divisions within this directorate have responsibility for C4I policy, C4I systems requirements and communications requirements, however this directorate was restructured in December 2000 to create a C4I Systems Division which will combine all C4I requirements planning responsibilities.

Current C4I systems

Restructuring in May 2000 saw the creation of the new central command system (NCCS) in a new relocated JDA headquarters. NCCS is an overarching C4I system that incorporates each Self Defence Force through their staff office C4I systems.

The JMSDF uses the Maritime Operations Force command and control support system (MOF) as the backbone system of its command and control organisation. This is a relatively new system that achieved initial operational capability in March 1999. The MOF combines the maritime air operations centre, regional



Japan's new amphibious ship JDS *Osumi* was commissioned into JMSDF service in May 1998.

operations centres, maritime operations centre, and other commands and activities. It can support decision making by commanders and can support information exchange. The fleet end of MOF system is called C2T, command and control terminal.

The C2T provides tactical decision aid and near-real-time information to afloat commanders. Main ships such as flagships and *Aegis* ships have C2T terminals with large screens to assist fleet commanders and escort flotilla commander's in their decision making processes.

The JMSDF communications network, called the JMSDF data exchange network, combines a number of different systems including the MOF, a logistic support system, various local area communications systems and an automatic teletype processing system. The JMSDF data exchange network interfaces with the JGSDF and JASDF data exchange networks through the automatic teletype processing system. In the JMSDF data exchange network messages are transmitted and received through the local area communication systems at ashore bases, and through satellite and very low, high, very high and ultra high frequency radio systems at sea.

Current JMSDF satellite communications arrangements consist of three satellites and five earth stations. Each satellite, called *Superbird*, enables the JMSDF to exchange information with platforms and shore facilities. The most recent satellite, *Superbird C*, which was placed in orbit in 1997 and commenced service in 1998 is also used independently by the JGSDF and JASDF.

Shortcomings of current C4I systems

There are three weaknesses with the JMSDF's current C4I systems. The first is stovepipe architecture. Each Self Defence Force has unique systems which are constructed from, and being updated with, outdated architecture thus resulting in decreasing connectivity, rather than increasing connectivity. Secondly only limited media can be used and there is not seamless operation across the different systems within the JMSDF. Third is weakness in information assurance. The JMSDF C4I system has a low classification level, low integrity, and low availability resulting in much vulnerability. JMSDF communications have a lack of expanding capability for operator's requirements, therefore it is planned to make capacity higher and to extend the coverage of satellites.

Future upgrades and enhancements of the JMSDF C4I systems

Each Self Defence Force data exchange network is a unique system that operates independently of each other. The JDA is investigating how to integrate these networks by using standardised systems and ATM. This connectivity will allow for a joint communications capability upgrade sometime in the future.

Currently communications lines (morse, teletype, message and voice) are constructed separately so the capacity of each line is not very high. It is intended to upgrade communications lines by combining existing lines and expanding total capacity to allow multimedia capabilities to be used.

Future satellite communications upgrades include the replacement of the *Superbird B* satellite with the *Superbird B2*, which is in orbit and is expected to enter service in 2002. *Superbird B2* will provide enhancements to coverage



The JMSDF Asagiri class destroyer JDS Setogiri.

through a spot beam capability and high-speed communications allowing the use of multimedia.

The JMSDF is now constructing a local-wide-local area network architecture that will connect existing command and control systems with the other systems. Also being investigated is the how C4I systems can be connected to the Internet through the use of appropriate security hardware and software such as firewalls, VPN, and security routers. Examination of security routers is currently underway at the moment. There is also a study looking at the contents of ISO15408 to determine how the concepts can be introduced into JMSDF C4I systems.

Smaller navies and C4I: the view from Singapore

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Major Kum Chee Meng, RSN

Being a small navy the RSN cannot afford to invest in a large number of ships to match any potential aggressor. Instead, with the benefit of a highly educated and skilled core of naval officer and specialists, we have elected to exploit technology as a force multiplier. While there are inherent risks in going for high technology, the navy has reaped quantifiable benefits from adopting this approach.¹

The size of a modern navy is largely shaped by its manpower, fiscal resources and missions. Size in terms of physical dimension and quantity of ships need not limit the scale, scope and ability of a navy in carrying out its missions successfully. In an era of high technology, smaller ships, packed with advanced weapon and sensor fits, can operate just as effectively as bigger ships. The Republic of Singapore Navy (RSN) has found that smaller combatants with strong firepower, integrated with key air and land assets, result in a powerful and decisive combination.

This synergy comes about because the RSN does not operate alone. The RSN operates closely with the other two armed services of the Singapore Armed Forces (SAF) to exploit what could be called technologies of scale through the co-sharing of information. This helps the RSN to concentrate and apply force where it can deliver the most significant impact, achieving a superlative state of combat power whereby the destructive potency of any naval force put to sea is more than the sum of the single units.

From the RSN perspective exploiting technologies of scale basically means leveraging command, control, communications, computers and intelligence (C4I) systems to give a winning-edge in detection, identification and targeting. For example, the RSN has invested in common C4I systems which allow its ships to operate effectively with its maritime patrol aircraft in addition to aircraft of the Republic of Singapore Air Force to provide early warning and surveillance, close monitoring of surrounding sea-lanes, and assistance in search and rescue missions. It is clear that the effective employment of a combatant's self-defence and offensive weapon system today, is predicated on the availability of timely and accurate information processed by intelligent operators and their accompanying information system.

Some of this information can be obtained using organic sensors on the ship, such as radar, electronic support measures, sonar, etc, but increasingly more information will also be disseminated to units from external sources. Therefore, the communicative means, organisational environment and the decision-making systems that manage the information and its processes will determine the quality of decisions taken, as well as the responsiveness of the people and systems to the demands of different warfare environments. Whether as a single ship or as part of an integrated force, it is becoming increasingly critical to put in place a reliable and robust C4I system to handle the deluge of information traffic and complex high-speed processing requirements to survive in the modern



RSS Courageous is one of 12 *Fearless* class offshore patrol vessels built in Singapore in the late 1990's for the Republic of Singapore Navy.

battlespace of simultaneity and light-speed change. A robust and efficient C4I system will help to engage in what many have now called the emergent standard of 'network-centric warfare', through good command and control and real-time situational awareness.

Characteristics of smaller navies

Koburger has suggested that 'small navies' strength lies in its local standing while the medium navies are those of strong regional value'. He goes on to say that 'the instruments of maritime power are time, space and resources. In the narrow seas, modern technology can help small navies achieve sea denial without requiring superior surface naval forces'.² Advances in technology have removed bigger navies as obstacles to the attempts of smaller navies to gain superiority in their local area. With help of technology, the characteristic differences between the smaller and bigger navies seem to have blurred almost to the point of vanishing especially when the 'big boys' venture into narrow and littoral areas. Koburger has advocated that the characteristics of smaller navies can be categorised as follows:

- Modern, high-tech automation-inclined.
- Functions are similar to the big navies (maritime presence, sea control/denial, power projection and deterrence).
- Excel in littoral, riverine, coast and archipelagic water.
- Mainly small to medium sized combatants.
- Low to medium manning.
- Time sensitive, quick re-locatable designation and destruction of targets.³

From this perspective, the characteristics of small navies rely heavily on technology and the timely and accurate acquisition of information to enforce its 'superiority'. Therein underlies the importance of a highly reliable, robust and seamless C4I to support the required information exchange and processing requirements. Therefore, the RSN being a small navy is able to stay focused on acquisition of the right technologies and building the right capabilities to maintain the required nimbleness and efficiency in an operational environment.

C4I vision

The RSN's vision is to provide an integrated, dynamic, robust and real-time C4I relationship to support operational requirements towards the achievement of battle dominance and information superiority. This will give the RSN the capability to collate, process and disseminate information without disruption and in real-time, allowing it to maintain continuous battlefield awareness and to orchestrate battlefield manoeuvres.

Strategic thrust

In future, the Navy cannot continue to rely solely on simply acquiring high technology to stay ahead of the competition. What will provide the edge for the Navy in force development terms must therefore lie in our ability to innovate, to synergise, to meticulously package various platform and combat system technologies, both on system as well as individual unit levels, to achieve a quantum multiplier effect.⁴

To achieve a survivable C4I infrastructure, there is a need to systematically walk through C4I processes to identify weaknesses and interoperability gaps. The RSN is aware that the key factors affecting interoperability gaps are current resources and how procedures are written. It is a continual and iterative process that is currently being undertaken to overcome such gaps and it requires a paradigm shift from operating the airforce, army and navy as stand-alone forces to that of an integrated force. There are numerous challenges ahead, but given time, the synergy of a real-time, seamless and dynamic channel of information sharing can be achieved.

The present day C4I systems are more powerful and sophisticated than ever before, permitting a high capacity of information sharing about the battlespace that accords with situational awareness. The side that can acquire early warning of the aggressor's force disposition can position itself more favourably for an encounter and pinpoint the aggressor's location to a high degree of accuracy. Hence, in mapping out the battlefield and the disposition of the aggressor, the adoption of a C4I-based strategy in the RSN can help propel it to new levels of synergy and supremacy across the spectrum of conflict.

Processed information is knowledge and if this is conducted in real-time, it equips the integrated force with an edge over the aggressor. The wonder of current C4I technologies has also added to the ease of information exchange and it is most beneficial to the intelligence community for supplying real-time information to support a commander's decision making. As the RSN becomes more technologically sophisticated, it needs to be ready to employ and use technology more efficiently and effectively. Hence, C4I relationships and its technology are central to greater situational awareness by enabling RSN forces to acquire large amounts of information, analyse it quickly and communicate it to combatants concurrently for coordinated and precise action. C4I technological breakthroughs are already changing the way we manage and conduct operations and the way we prepare for the unexpected and high-risk missions.

An effective C4I system allows one to control the information battlespace. This enhances situational awareness and gives rise to more information about

the aggressor while denying the enemy similar information. The achievement of the right formula will allow the commander to direct his forces to the right place at the right time and yet appear to his aggressor that he is everywhere, eventually causing the aggressor's decision processes to be overloaded and breakdown.

The key element in each decisive victory is knowledge of the battlefield and the aggressor. Thus, real-time information access and processing is required in order to collate the information into useable knowledge for battle consumption. To do this, the RSN has looked into reforming the way it obtains the information required to direct forces. This could be the way forward as the RSN organises itself to optimise information exchange and consumption, while at the same time continuing to seek new ways to operate. Hence, it is recognised that the revolution of new C4I technology is a continual process and that identifying the suitable technology and optimising it to meet operational strategies will provide the RSN with the right formula suited for its needs. The RSN incorporates the latest technology in information theory to exploit information in order to transform its operating posture from reactive to pro-active. This will allow the RSN to operate in virtual organisations by moving knowledge without moving people. Through synergistic combination of these two areas, the RSN will be able to put in place intuitive human-C4I interactions.

C4I relationships in the RSN

With the developments occurring in military technology, we are witnessing the evolution of the application of force on the battlefield to a new level of high precision and controlled destructiveness through improved telecommunications technology. The technology is providing the ability to instantly access large amounts of detailed information anywhere in the world. However, such advancement in telecommunications technology creates substantial problems for the planners too. This is because information that helps achieve decisive victory against an adversary can also be used to confuse or worse, backfire on own forces if it is not managed properly. Therefore, information critical to decisions must be timely and accurately processed to facilitate commanders making the right battle decisions.

The C4I infrastructure has thus evolved from a simple radio-line to a complex architecture to support current information requirements. Over the past twenty years in the RSN, there has been fascinating innovations in technologies in the area of C4I that facilitated the exchange of information between higher echelon and ground commanders. C4I provides the combatants in the battlefield and war-room with timely and accurate information updates. Commanders at all levels are now provided with instant access to increasing amounts of information including near-real-time intelligence, weather forecasting and

battlefield targeting data. They are also equipped with current state-of-the-art e-mail capabilities for dissemination of essential information down to the combatants in order to appreciate and exploit the tactical situation in their favour. This allows ground units to synergise and synchronise from the bottom-up.

This seamless, rapid and direct nature of the current state-of-art C4I applications allows a commander to command the activities of an integrated force; something that was once deemed difficult. A real-life example is search and rescue operations where information is critical to the timely employment of assets to save lives. Similarly, the C4I element has provided these rapid and direct linkages to allow a naval commander to orchestrate operations involving not only navy assets, but those of the other services as well.

With the advent of instant-communication and data-retrieval technologies, strength lies not in the size, complexity and divisions of a battle force, but in its ability to stay connected and interoperable. These two have become more important and relevant in present day military environments as multi-level information exchange feeds decision at all levels of command rather than relying solely on the wisdom of a single commander or his staff. With effective C4I, battles fought would have less temporal limits or spatial boundaries. This would mean that the commander if given a superior integrated force would know where and when to direct his force to a specific target and the best type of weapons to be employed against it.

For a small country like Singapore, the concept of 'integrated warfare' is vital as it enables force multipliers to come into effect by matching our unique capabilities into a form that would prove deadly for an aggressor. To develop an effective C4I, the ingenuity of C4I experts is required to match and revolutionise the employment of a new and better technology to the way battle management is conducted. This is a challenge faced now, and with an articulated C4I vision, the aim is to make the relationship more integrated and dynamic to respond to future integrated warfare requirements. The challenge is to make C4I flexible and dynamic so that it can merge into any system in order to carry out an integrated engagement of the aggressor simultaneously in time, space and depth by employing the full range of its strategic resources to achieve strategic paralysis in the enemy. The ultimate goal is to hit him without him realising who did it.

However, technology is dynamic and the advantages that the RSN now has could be diminished as new technologies with better processing and management of information architecture quickly makes current C4I technologies redundant or even irrelevant. Hence, the RSN needs to constantly review and



Singapore's *Victory* class corvette RSS *Valiant*. C4I is an important component in the development of future RSN force structure.

incorporate commercial C4I technologies and continue to maintain or widen this edge over potential aggressors. This makes it difficult for the aggressor to leverage this capability. To retain its edge, the RSN needs to focus on improving the strength of its C4I relationship. This requires the navy, the army and the airforce to work out new concepts of C4I operations, strengthen its robustness, refine the process and ensure seamless interoperability in common C4I architecture that would be hard to imitate.

Challenges

The RSN needs to achieve the ability to disseminate and exchange information anywhere within its areas of interest. Equally important is the management and use of crucial information in all its forms and at all levels to facilitate the commander's ability to achieve a decisive advantage in an integrated warfare environment. The challenge is to put an effective system in place to ensure integrity, availability and interoperability of C4I under such a dynamic environment.

A C4I relationship is more than just an electronic means for information transfer and sharing. Disruption of the C4I infrastructure would likely create havoc that would allow an aggressor to seize the initiative and possibly achieve victory. A successful communications attack on the C4I infrastructure would result in the inability to detect and coordinate a defence against the first strike from the aggressor. This underlies the importance of a seamless, interoperable, dynamic and highly survivable C4I relationship.

There is a challenge to cater to different operating requirements and processes in the various arms of the SAF. The RSN will require the ability to implement systems that are compatible and interoperable with the other services.

Opportunities

The RSN recognises that it can no longer maintain a pure military technology base because of high research and development costs. Hence, it will be important to exploit the rapid rate of innovation of commercial communications technology, eg, satellite communications, to meet military needs in this area. In a way, the RSN is able to leverage commercial C4I technology to create synergy and achieve advantage without compromising any of its capabilities.

With the educational profile of the general population rising to a higher academic level it is expected that assimilation of the required knowledge and expertise required by the navy's combat-technical specialisations will be faster.

The RSN will have to select the suitable technologies and then configure them to do more than is currently achieved by exploiting the advancement in

information retrieval, processing and telecommunication technologies. With this information, 'decision support' will transform them into useable knowledge to aid in battle decisions.

High connectivity can only be achieved if proper standards are established to ensure seamless connections, information exchanges and protocols. The present pace of innovation and globalisation has facilitated and accelerated the formalisation of standards across inventions. A comprehensive list of operating standards will avoid being impeded by interface and processing characteristics and protocols so as to enhance efficiency and improve robustness of the entire system.

Conclusion

C4I will play an important role in the development of future RSN naval force structure and operations. To be sure, the RSN will be maximising the synergies with the other services to enhance the effectiveness of C4I towards achieving the SAF's mission objectives. In a joint operations environment, superior C4I will give navies an edge over larger-sized aggressors in terms of maintaining real-time situational awareness and faster responsiveness. For the RSN the choice is crystal clear: either continue to assimilate, infuse and utilise C4I effectively in order to achieve a quantum multiplier effect for victory in the 21st century or face obsolescence in rapidly changing technological environment.

Notes

- 1 'Building Tomorrow's Navy', an interview with Colonel (now Rear Admiral) Simon Ong, RSN, Naval Forces, no. II, vol. XVIII, 1997, p. 20.
- 2 Charles W. Koburger, *Narrow Seas, Small Navies and Fat Merchantmen*, Praeger, New York, 1990, p. xiv.
- 3 *ibid.*, pp. 2-3, 38-39.
- 4 'Building Tomorrow's Navy', Naval Forces, p. 20.

Part | 5

Surface warfare and surface combatants

Surface warfare and surface combatants: an Australian view

14

Commodore Tim Cox, AM, RAN

As we approach the 21st century, all navies face daunting challenges in developing an affordable force which will be effective in the wide range of scenarios that they may face. Strategic uncertainty, doubts about the nature of future conflict, and constrained defence budgets are problems confronting almost all navies. For medium navies in particular, there are other difficult questions. They include deciding the level of capability that can be afforded, whether it should be developed and built locally or procured overseas, and how it will be made interoperable with national land and air forces as well as with allies and potential coalition partners.

Modern surface combatants are flexible and highly capable war fighting platforms, and a key part of a modern defence force. They exercise sea control and are thus vital enablers for many military operations and other requirements to use the sea. They also have the potential to project power ashore, in support of land forces or in independent strike. They can perform these roles concurrently, for long periods of time, far from home. But this capability comes at a high price, both in capital and operating costs. The Royal Australian Navy's (RAN) surface combatant force is one of our most cost effective capabilities, but its vital importance must be constantly emphasised and explained if it is to continue to receive the funding necessary to maintain it as a key component of the Australian Defence Force (ADF).

This chapter provides an Australian perspective on the role of surface combatants, and then looks at some of the issues we face in maintaining and developing the RAN's surface combatant force.

The nature of maritime warfare in the 21st century

Range of conflict

Ten years after the end of the Cold War, the world remains a complicated and unstable place. While the prospect of a large war between major powers has receded, the 1990s provided many examples of periods of tension and conflict on varying scales. They have involved various combinations of state and intrastate actors, and the fighting has involved weapons from machetes to the most sophisticated weapons systems available anywhere. The level of violence



Australia's *Adelaide* class frigate HMAS *Darwin*. Surface combatants are flexible and highly capable platforms and are a key component of a modern defence force.

has ranged from isolated skirmishes during peacekeeping type operations, up to full-scale war fighting in, for example, the Gulf War.

Today Australia still enjoys a relatively benign strategic environment, but continues to be engaged around the world in many trouble spots, most recently in East Timor. We are involved in multiple peacekeeping operations, and regularly get involved in other operations. The Gulf War and its aftermath continue to involve the ADF. The RAN, and the surface combatant force in particular, have been involved in many of these operations. It should be expected that these kinds of contingencies will continue to occur, and will continue to require an ADF response.

Lastly, it should go without saying that Australia is a maritime nation in a maritime region. Australia's geography determines this, and means that Australia is dependent on maritime trade for over 90 per cent of its imports and exports,

and that it is also heavily dependent on maritime resources. Any direct military threat to Australia must come on, over or under the sea.

All of this suggests that a wide range of conflicts will continue to occur and that, for Australia at least, many will have a distinctly maritime flavour that imposes heavy demands on maritime forces. Strategic analysis will continue to assess the likelihood, scale and time scales of potential threats, and these assessments provide important guidance in determining how defence resources are to be allocated. However, it must also be remembered how often strategic assessments prove to be wrong, or fail to predict major crises. The structure of a defence force must therefore try to hedge against the widest possible range of contingencies, without diluting specific capabilities to the point they lack credibility, so that it can provide the government with useful options when the unexpected does occur. Maintaining a balanced force remains important.

Technological developments

If the political conditions continue to exist for a wide range of conflicts, war-fighting technology is also widespread. Nations continue to procure new generation ships, submarines, aircraft and weapons, and the list of nations that field these sophisticated capabilities continues to expand. The existence of these capabilities, and the fact that nations see a continuing need to acquire them, suggests that high level conflict continues to be a conceivable proposition. The platforms and systems being introduced now incorporate incremental, rather than radical, improvements in capability, and will still be operating in 30 years time. They will shape conflicts that occur in that time scale, which suggests that future conflicts will have many of the features of conflicts of the last few decades.

Some specific developments merit mention. Ballistic missiles proliferate, with a number of countries developing very long-range missiles. North Korea, for example, has, or is developing, the *No Dong* (1,000 kilometres), *Taepo Dong 1* (in excess of 1,500 kilometres) and *Taepo Dong 2* (4,000-6,000 kilometres) missiles. Such weapons could present a threat in a variety of contingencies, so defences of some sort must be a consideration.

Secondly, there is the continuing development of anti-ship missiles (ASM) from primitive missiles like *Styx*, through the more capable weapons in service today, such as *Exocet* and *Harpoon*, to the next generation of missiles with combinations of supersonic performance and far more sophisticated seeker head technology. These missiles pose a major threat to surface vessels, but they are expensive and inventories are not large. This raises a question for navies with constrained budgets: Is a surface warfare capability, which includes

surface and air (helicopter) launched missiles and guns, cost effective? In particular, given the third party targeting requirements, will surface launch continue to be practical? The 1990s have seen extensive use of TASM, but not much use of ASMs, and United States Navy (USN) priorities seem to have shifted very much in the direction of land attack weapons from the sea.

A third question is how much investment in anti-submarine warfare (ASW) will be necessary in the 21st century? Active ASW for surface ships has been of limited value since the 1980s, and passive ASW against a submarine with long range weapons, reduced signature and low indiscretion rates is now of questionable effectiveness. Active/passive towed arrays may be an answer, or perhaps there is another solution; there will be a need to determine how much should be spent and how the capability is deployed.

Not all technological developments are evolutionary in nature. Information technology is leading to very rapid developments in the field of command, control, communications, computers, intelligence, surveillance, reconnaissance, and electronic warfare (C4ISREW), and this will have an impact on the conduct of conflicts at all levels. It offers the potential for greatly improved situational awareness at all levels, and the more effective employment of combat forces. It offers the prospect of information warfare, which may go well beyond the bounds of conflict experienced to date. These developments offer opportunities and vulnerabilities for any nation in conflict.

One particular development with great potential is cooperative engagement capability (CEC) which, in conjunction with improved command, control, communications and intelligence (C3I), offers greatly improved air warfare effectiveness. It also brings considerable challenges, especially in rules of engagement (ROE). If your missile is fired by another ship based on information from a third party sensor, who will be responsible if the wrong target is engaged? Can a way to deal with this issue in a multinational force be conceived?

Validity of maritime strategy

Maritime strategic thinking describes a range of constabulary, benign, diplomatic and military tasks for maritime forces that span circumstances from peace through times of tension to conflict. Constabulary tasks include surveillance, exclusive economic zone protection, customs and immigration tasks, and environmental protection. Benign tasks may include nation building, humanitarian assistance and disaster relief. Diplomatic tasks, such as maintaining a presence, have application in times of peace, and as diplomatic tension rises. They may well be relevant for peace keeping and peace

enforcement operations. Lastly, the classical military tasks of sea control and denial and power projection are focussed at the higher intensity end of the spectrum of conflict.

The question is whether this kind of tasking will remain valid in the face of the changes that are occurring as we move into the 21st century. For Australia, as for any maritime nation, it seems probable that the basic concepts of maritime strategy will stand, although the means of achieving them may change in some respects. The constabulary and benign tasks listed are all growth industries, and there is no shortage of peacekeeping missions to be performed. Should a more serious crisis occur, there will still be a need to establish a credible presence to establish our interest and concern, and to show a determination to respond where our interests are threatened.

Australia's maritime forces are structured for the defence of Australia, and our remote northern regions and limited force structure mean that we must have the 24 hour a day offensive and defensive capabilities to maintain sea control, at least until other forces can be brought to bear. In the event of a direct threat to Australia, our merchant shipping will continue to trade, and the ADF may wish to move amphibious forces around. This means there will be a need to be able to exercise sufficient control of the sea to be able to perform these tasks. There will also be a need to deny an opponent the use of the sea. As in the past, control of the sea and the air above it will be the enabler for many other potential missions.

The final purpose of maritime forces in the 21st century will continue to be to influence events on land, by projecting maritime power ashore. This will require the ability to move forces around, to land them and then support them from seaward. It may also require the ability to conduct strike against targets ashore. This prospect raises a new question for medium navies. If they can provide effective land strike, should the emphasis shift to land attack as a primary role?

Maritime missions

These strategic concepts suggest that existing maritime warfare missions will retain their validity. Control of the sea will require capabilities in submarine, surface and air warfare, as well as in mine warfare. Power projection requires the ability to put forces ashore, and to provide fire support and strike. All these missions require sophisticated C3I support from ashore and afloat if their potential is to be maximised.

To this point, none of the argument has been platform specific. Ships, submarines, aircraft and various kinds of missile all make their contribution to

the maritime war. The dominance or otherwise of a particular capability will depend very much on the scenario. It is probably fair to suggest, however, that it will be very rare that a particular platform provides the sole answer to the problem. The joint use of all maritime capabilities is likely to provide the most effective response to any given situation. Indeed, medium size navies can only be effective if the synergies of joint operations are realised.

Role of surface combatants

Nevertheless, one platform that does have an important role to play in all the maritime missions mentioned is the surface combatant. Depending on their design and size, these ships can offer impressive capabilities in under sea, surface and air warfare. They also have very good C3I capabilities, with the ability to finely graduate responses and escalate or de-escalate situations when required. With the advent of capabilities such as extended range guided munitions (ERGM) and land attack missiles, they can also offer a potent strike capability. They therefore offer key capabilities for both sea control and power projection. Moreover, they can perform many of these roles concurrently, 24 hours a day, anywhere in the oceans except for territorial seas.

These capabilities are mounted in a platform that has a unique combination of attributes. The concepts of flexibility, mobility, readiness, poise and persistence have been enunciated, sometimes using different terminology, in a variety of naval doctrinal publications. These attributes mean that surface combatants offer governments a wide range of flexible responses to contingencies that may occur around the world.

Surface combatants do not generally operate alone. More usually they operate in a task group structured to perform a particular mission, supported by shore based C3I and aircraft. A task group will include the afloat support necessary to sustain the force for the duration of the mission, as well as any mission specific units, such as amphibious ships and their embarked forces. The task group as a whole has a force multiplying effect, providing far more capability than the sum of the individual parts.

In this task group environment it is not necessary for every surface combatant to mount the full range of combat capabilities. It will be sufficient if the group as a whole musters sufficient combat capability to achieve the mission. It also needs to be stated that the absence of a credible capability in any one area of warfare within the task group will directly affect the ability of the force to operate in the face of a particular threat, and may also limit the ability of air and land forces to achieve their tasking. For example, an inability to deal with a mine threat could mean the immediate suspension of seaborne movement

within the affected area, preventing deployment of land forces. The absence of air warfare capability will greatly increase the risk to seaborne forces, especially when beyond range of land based air cover, and may also increase the demands made upon land based air, limiting their availability for other tasking.

Air warfare

The point about air warfare (AW) needs to be stressed. AW is fundamental to the surface fleet of any medium size navy. Without it, task group operations will be severely constrained, and amphibious operations may be impossible. The point is that it is available 24 hours a day throughout an operation, whereas air support may be limited by a lack of bases within range and, in any event, cannot be there at all times.

There is an argument that suggests that, even with good AW capabilities, surface combatants remain vulnerable to air attack, and that so much money has to be spent on self defence that the ship develops a defensive focus at the expense of offensive capabilities. This is an important point; any platform costing as much as a major surface combatant must not only be survivable, but must also have offensive capabilities that any opponent must take into account and attempt to counter. Otherwise surface combatants may not be cost effective. Surface and submarine warfare capabilities are offensive in terms of a sea control mission. The two areas of offensive capability that have not perhaps been associated with surface combatants are AW, which has tended to be regarded as defensive, and a strike capability, at least beyond medium range gunnery for naval gunfire support.

In the Cold War, the offensive capability of the USN's carriers was intended to present such a threat that the Soviet bomber force would have to be used to counter it first, rather than attacking North Atlantic Treaty Organisation shipping. In setting up an irresistible target, the intent was that AW capabilities in the carrier battlegroups would be used to destroy the Soviet bomber force, thus eliminating it as a threat to other shipping, and making a large step towards control of the seas. There is no way that a medium navy can expect to perform such a role against such a major threat, but this does not mean that the logic does not have application in lesser contingencies against lesser foes. If a task group presents a substantial threat to an opponent through its amphibious force, its strike capability, or its ability to deny the opponents use of the sea, it will have to be countered, and will attract the attention of enemy forces, including air power. If, in conjunction with land based air and organic AW capabilities, the task group is both survivable and capable of destroying opposing air forces, that becomes a very real offensive capability.

By providing another option to destroy opposing air power, it would relieve pressure on friendly air forces, because a small opposing air force cannot be everywhere at once.

This is not to suggest that organic AW capabilities in a surface combatant can perform this task alone. Rather, they would operate jointly with airborne early warning and control (AEW&C), tanker and fighter aircraft, as well as with maritime patrol aircraft and organic helicopters. Indeed this joint application of maritime forces, together with the potential for greatly improved C4I and CEC suggest that this kind of operation is, perhaps, more achievable than it has been in the past for a medium navy. Nevertheless, the point is that unless these organic capabilities exist, the burden of air defence rests much more heavily on land based air power. It would limit the employment of naval task groups, as well as the ability to take the fight to the enemy on our own terms.

Strike capabilities

The other prospective capability that can be built into a surface combatant is strike, through systems such as land attack missiles and ERGM. Strike capabilities may be an important part of any defence force. In terms of surface combatants, however, they offer a long range threat from anywhere in the oceans, as well as an organic task group capability that an opponent may feel compelled to counter, thus reducing his ability to conduct other operations.

Current RAN surface combatant force structure issues

This general discussion of maritime warfare and surface combatants leads to some specific issues facing the RAN and the ADF. The current surface combatant force comprises the *Adelaide* class guided missile frigates (FFG) and an increasing number of *Anzac* class frigates as the build program continues. The last *Perth* class guided missile destroyer will decommission in 2001, and with it will go our best command and control platform and the last three dimensional radar in the fleet. At the same time, the *Standard* SM-1 missile system which will remain at sea in the FFGs is aging and will be obsolete before the end of this decade.

The net effect of these changes will be that the RAN will be left with a surface combatant force that offers effective under sea and surface warfare capabilities, but has very limited AW capabilities, restricted to ASM defence and very limited area defence. It will have no capability against aircraft launching missiles at long range. In other words, the ADF will have a surface combatant force that has significant limitations in its ability to conduct task group operations in the face of an air threat, especially beyond range of shore based air. This is a most undesirable situation, because Australia's geography and the relatively small numbers of air assets available in the ADF suggest that there may often

be need to operate beyond range of friendly fighter cover. Even within range of fighter cover, there can be no guarantee that sufficient combat air patrol (CAP) will be available in the right place at the right time, so there is a need to be able to control the air environment until friendly air can arrive on task. As long experience in exercises and operations shows, it is the combination of a layered defence that makes a task group survivable in the face of a significant threat.



Air warfare is a fundamental capability of any medium sized navy. Here HMAS *Darwin* is seen firing a *Standard SM-1* surface to air missile.

New surface combatant

For the reasons outlined above, the procurement of a new surface combatant with good AW capabilities, C3I facilities and the growth potential for strike, CEC and theatre ballistic missile defence (TBMD) is now a very high priority for the RAN. What should such a ship look like?

Firstly, the ship is needed as soon as possible to retain the AW capability of the force. Moreover, it must be on the drawing board and under construction now if it is to be acquired in a short time scale. It is proposed that this new class be adapted from an existing, proven design. Several ships entering European service are under consideration.

Assuming a new construction program, the class will remain in service until about 2050 if life of type is 30–40 years. Because the ship will be in service for such a prolonged period, and to hedge against obsolescence, there must be substantial margin for growth. For a medium size navy, a ship of about 6,000 tonnes would seem to be the minimum, although perhaps 8,000 tonnes would be better. We do know, from experience with the *Anzac* warfighting improvement program, that a ship between 4,000–5,000 tonnes is much too small to be able provide firepower commensurate with the cost of the capability, let alone the room required for growth.

The core capability will be the AW missile system. For reasons of equipment commonality, both within the RAN and with likely allies, and given its proven pedigree and performance, this will be based around the vertically launched *Standard* SM–2 missile. These ships will be the AW umbrella that will allow task groups to project power into the region, independently of ground based aircraft in some circumstances. In the ideal situation where ground based aircraft are present, the ship's SM–2 missiles will be an important contributor to the battle for air superiority. The powerful surveillance radars and long range missiles will be force multipliers that will increase the effectiveness of the ADF air warfare effort. AEW&C aircraft will be able to rely upon the continuous protection of these ships while the fighters can be fully committed to the air battle. Similar protection can also be afforded to tanker aircraft.

In other circumstances, these ships would be able to provide continuous, long term protection of vital areas. A single ship could remain on AW patrol for weeks, providing continuous protection, reducing the demand for CAP and freeing up fighters for other tasking. The air warfare destroyer (AWD) would also be required to provide tactical offensive support to ground forces. ERGM could be used to destroy high value targets at considerable range from the shore. At shorter ranges, less costly gun ammunition with precision guidance could be used to destroy lesser value targets or in tactical support of own forces.

Further surface combatant developments

A relatively large ship also offers considerable potential for growth. The vertical launch systems (VLS) with which these ships will be fitted will also permit the launching of other missiles, providing a growth path to long range strike capability such as land attack missiles. This, coupled with the ship's ability to go in harm's way, would make these potent power projection ships. Although their strike capability will carry markedly less weight than that threatened by an aircraft carrier, they will be a threat that an enemy cannot ignore. Other options for growth include CEC and perhaps TBMD. An important advantage of a maritime TBMD capability would be its flexibility in times of crisis; a ship could be deployed and held in readiness outside territorial seas, able to protect coastal areas where we may be conducting operations.

These ships will be limited in numbers, because of their expense. They may not always be available due to maintenance and refit requirements. Clearly there is a need to balance a core force of high capability ships with adequate numbers of less capable ships that are able to defend themselves and contribute to task group operations. These ships are more affordable and will be the numerical majority of the Fleet, allowing lower tempo operations to be conducted in widely dispersed areas while the AWDs form the core of task groups undertaking high tempo, high risk operations. Initially, the FFGs and *Anzacs* will have this role. The question is, what ships will form the bulk of the Fleet after the *Anzacs* are retired?

The logical successor to the *Anzacs* is a derivative of the AWD. The hull design will have been proven and will have the necessary industry and military support mechanisms already in place. The requirement for more surface combatants to maintain the fleet's ability to operate in various localities would be best met by building more batches of the AWD hull. These follow on units would not incorporate all of the high capability of the AWD but would have sufficient to protect themselves and contribute to task group operations. Although the ships would be large for these tasks, their size would contribute to their survivability and would also ensure they could be upgraded if desired. The ships would cost marginally more than a smaller ship of the same capability, but steel is relatively cheap. The extra expense would be easily recouped in the benefits of commonality across the fleet. For example, logistic infrastructure would only need to be expanded rather than replicated for a new class. There would also be major benefits in rationalisation of training and maintenance.

The improved survivability of the baseline ship also helps overcome another difficulty related to lead times. A larger ship that is able to sustain some damage can still make a valuable contribution to operations. Smaller ships

that sustain similar hits are unlikely to be able to continue and might as well be considered as sunk, at least in a short conflict where there is no prospect of replacement or repair in time to rejoin the fray. Another benefit is that the second tier ships could support the AWD with bulk missile magazines. Given that CEC, or some derivative of it, is likely to be introduced, these ships could provide missiles for AWD engagements. The common design would ensure there was room for the VLS cells and the extra missiles in a task group that would greatly enhance collective firepower. The VLS cells are also relatively cheap and need not be filled with missiles until threat projections might dictate procurement of the weapons themselves, which would then be the latest variants. This concept could be extended to all new construction and there is no reason why amphibious units and tankers should not also have VLS bunkers to enhance the task group's air or strike capabilities.

Other technological advances will also benefit the lower capability ships. Just as CEC will enable them to contribute to the air battle, ASW multi-statics will integrate the undersea battle. The sensors of the task group will be integrated to the extent that each unit, no matter what their sensor suite, will have the best undersea picture available to the best-equipped ASW unit. These advances will further enhance the collective capabilities of task groups.

Offboard sensors will play an increasingly important role. The booming development of C4ISREW will lead to maritime forces being able to reach back to vastly improved, all source recognised pictures that will complement organic task group sensors. This widely shared recognised picture will ensure that lesser capability units within the task group have the same situational awareness as their better equipped consorts.

Other issues

Interoperability

Adding complexity to the future roles of maritime forces is the likelihood that the majority of operations will be conducted in coalition with other nations. Australian maritime forces must be able to operate, in an integrated manner, with those of the United States. This demands a commitment to match, to some extent, the technological advances introduced in the USN in order to maintain interoperability.

The ADF must also be able to operate with the forces of our regional neighbours and other potential coalition partners. The challenge is to be able to maintain adequate interoperability across the spectrum of partners, operations and technology.



Each unit in a task group contributes important sensor and weapon capability that makes the whole greater than the sum its parts.

Procurement

The approach to providing capabilities in the RAN's surface combatant force described today may seem to be rather conservative. There has been little discussion of radical hull forms or entirely new ways of war fighting. Over some years it has been argued that Australia's unique strategic circumstances require unique capability solutions. This has led Australia away from off-the-shelf purchases of foreign ships. Instead, ships have been pieced together with weapons and sensors drawn from a variety of manufacturers. Similarly, the commitment to indigenous research and development requires the

integration of new systems (such as *Nulka*) into existing designs. The result is that some of the RAN's ships and aircraft have become unique entities that require a full train of service infrastructure and a solid industrial support base to support them. Such a capability is crucial to full self-sufficiency in any given area, but is also very expensive. As a medium navy, in the future the RAN must be more selective about what systems it needs to be able to fully support. For other systems it is much more cost effective to adopt a collaborative approach with other nations, sharing designs to limit costs. This may mean that a particular platform does not meet every detail of a national requirement. In some cases the capability to modify or update such a platform, as well as being able to maintain and support it may be desired. But, in making such changes there is a need to understand the full cost of meeting unique requirements, because in many cases it is simply not cost effective.

Budgetary pressures also limit design options for new units. Technological innovation is inherently risky and does not sit well with a risk adverse procurement system such as that used in the ADF. Necessarily, Australian capability development tends to be evolutionary rather than revolutionary. Proven designs will usually be chosen ahead of innovative, unproven designs because the costs of failure are not affordable.

This is why Australian maritime forces in the new millennium will probably be built from proven designs imported into Australian shipbuilding yards. The ships will be the evolutionary descendants of current surface combatants and will not take technological leaps that have not been proven in service elsewhere. While some of the systems may be designed and built in Australia, the majority will enter the country as the result of technology transfer deals. The integration of the variously sourced systems will, of necessity, be a requirement imposed on Australian industry, as will the ongoing support of those systems. This procurement approach will also see increasing parent navy responsibilities for the RAN as it continues to introduce hybrid ship classes.

Conclusion

Despite rapid and unpredictable developments in information technology, the political and technological conditions Australia will face for the foreseeable future are such that much current maritime strategic thinking will remain valid. The underlying principles of sea power and sea control will stand and the purpose of sea power will continue to be to influence events on land.

Therefore it should be expected that there will be a steady evolution in military platforms rather than radical new capabilities that render existing platforms and concepts of operation irrelevant. In this environment, the surface combatant

will continue to be one of the most flexible and capable platforms in maritime warfare, providing useful capabilities in operations across the spectrum of conflict from peace time to war. They remain essential for recognised under sea, surface and air warfare missions to control the sea, but developing technology now offers much more capable power projection capabilities than has been possible from maritime platforms other than aircraft carriers in the past. The ADF and RAN are therefore seeking to maintain and develop the capabilities of the surface combatant force through acquisition of a new AWD that provides highly effective capabilities in the near term, and also offers the growth path necessary to take advantage of new capabilities as they become available. There are also some specific issues to consider in the future. Air warfare is a fundamental organic capability within a task group. Some surface combatants must have this capability, or task group and amphibious operations will be severely constrained in many circumstances. If capable surface combatants seem very expensive, I would suggest that less capable surface combatants that cannot be employed when needed are a cheaper but far less cost effective option. Land attack, both for independent strike and support of land forces seems to be a potentially very attractive growth path for surface combatants, and TBMD could be a vital capability in the future.

The other development that has tremendous potential, and offers equally major challenges, is CEC and the C3I environment that must go with it. It offers far greater situational awareness and more effective weapons employment that can make even a medium navy task group a most formidable military force, but it also offers great command and control and ROE difficulties. In looking forward to the 21st century, think back to the Gulf War ROE conference in Bahrain in 1990; sharing ROE was not an easy concept, yet coalition operations in a CEC environment will be many times more complex.

Small stealth ships: | 15 invincible or invisible

Commander Magnus Söderholm, RSwN

The mission of the Royal Swedish Navy (RSwN)—the fleet and the coast artillery—is to protect Sweden’s sea borders and to react on dangers and threats, in peace, in crisis and in war. Sweden has 2,700 kilometers of coastline and over 60,000 square kilometers of territorial waters—this is a territory Sweden is obliged by international law to maintain. Free access to Sweden’s ports, coastline and territorial waters is decisively important for Sweden’s freedom and independence.

Up to 90 per cent of Swedish imports come by sea. In a crisis or in war, hostile forces and minefields could almost entirely strangle its supplies. In such a situation, the RSwN must be able to protect Swedish interests by protection of territory, shipping or fisheries.

In the last 40 years, the RSwN has gone through considerable changes. At the end of World War II the RSwN had significant power and a large number of ships in various sizes. The smaller ones, torpedo boats and minesweepers, for example, operated in or near the archipelago where the threat was lower, while the larger ships, mainly frigates and destroyers, had good survivability in the open sea, thanks to their anti-submarine (ASW) capability and their, at the time, sufficient air defence.

During the 60s and 70s the air threat grew significantly larger. At the same time the Swedish Armed Forces had to face financial cutbacks. Additionally a greater portion of the military budget was directed to the Swedish Air Force. The RSwN suffered the most significant cutbacks. The larger ships were replaced with small highly efficient units with high striking power, the size though, making them more sensitive to weather in the open sea and dependent on nearby support.

In the recent decades the air threat has grown with missiles and sensors becoming more and more intelligent and as a result the sea has become a very dangerous place in a conflict situation. The cost of an effective air defence warship has increased substantially. Furthermore the threat scenario has become more complex, with conflicts on all levels and with many actors.

Shallow water operations

In the naval threat picture of today, targets are more silent, they have a reduced signature and are operating longer in concealed missions than in the past. The last verified submarine intrusion in Sweden occurred in 1992. During more than a decade, with intrusions coming and going, the RSwN worked intensely on rebuilding its ASW capability, resulting in new systems being put into service around 1992–93. The regaining of ASW capability was based upon scientific, technical and tactical experience and knowledge of operating in very shallow waters.

Operating in the littoral zone, land is not far away, thus widening the scenario of the underwater threat. Conventional, small or midget submarines, diving craft and divers may occur. When combined with the ever present mine threat, it is obvious the underwater environment presents multiple threats. The difference between ASW and mine countermeasures (MCM) operations, in a way, could be said to be about targets varying in size with some being mobile and some not.

The post-Cold War era has seen many new strategic doctrines, and operations within the littoral zone have gained in interest and importance—not the least due to the requirements of United Nations peace support operations. Professionally, warfare in shallow waters is considered a difficult task, increasingly so with decreasing water depth. Environmental areas of interest are: water depth, bottom topography, hydroacoustic conditions, land and archipelago, currents, optical sight in water, and magnetic anomaly.

Operational weapon systems of today are therefore facing the same problems, among them: severe hydro-acoustic conditions, i.e. salinity and/or temperature stratified waters; shallow waters; and targets making tactical movements near the bottom. Above this, the torpedo threat from submarines is still very much present, as is the above water warfare threat in forms of anti-ship missiles. The former requires some form of torpedo countermeasures and the latter a way of using seduction chaff as well as infra-red grenades. The guiding-star for Swedish weapon systems will therefore continue to be the very short time from target detection to decision of engagement and to time to impact.

Why stealth?

Reducing signatures and signals which expose a ship's existence constitutes one method to avoid detection and therefore have higher survivability. The aim is, as far as possible, to delay detection by enemy sensors. Thus, the ships own protection is extensively increased. Stealth is the adequate term for this kind of counter-measure and, additionally, a generic term for a number of different defensive devices.

Among navies, stealth in itself is not new. Cover and concealment have always been used to achieve an upper hand against an opponent. For submarines, stealth is the natural foundation for survival.

It is important to state that the choice for stealth is a rational alternative for future RSwN surface ships. The main reason why the RSwN has chosen stealth is that it has proven to be a very cost-effective way to meet the threats of the seas of tomorrow. Numerous predictions, simulations and war games in combination with full scale trials have shown the RSwN that it is more beneficial to go for invisibility (stealth) rather than invincibility through the use of multiple self-defence systems.

The beginning of the stealth ship era

To meet this new situation, The Swedish Defence Materiel Administration (FMV), and the Naval Staff, carried out studies during the 70s and 80s with the aim of finding cost effective solutions. As a part of these, a test ship, HMS *Smyge*, was built and tested. One of the results is that stealth technology was proven to be a most effective tool to achieve cost effectiveness on the battlefield. Stealth, combined with passive countermeasures, has also been shown to be effective in a complex scenario, where it is hard to know who is and who is not the enemy. With strong passive self-defence it is possible to operate in a hostile environment without an active first strike capacity as the main weapon of choice.

The Swedish Government gave their approval to the FMV to start the procurement process of the *Visby* class corvette in 1995. Research and development (R&D) and early phase studies had already been going on for several years within the next generation naval surface combatants program, known as the YS 2000 program. This program will consist of two series of flexible surface combatants the first of which is the *Visby* class. The six ships in the *Visby* series are currently under construction and the first was launched in 2000.

The *Visby* class corvette is a totally new type of ship with revolutionary technology. It is the first ship in the world with high operational versatility combined with fully developed stealth technology. Fully developed stealth technology means that all signatures, active and passive, above water as well as under water, has been considered and minimised.

The ships are primarily designed for MCM, ASW, anti-surface warfare and mine laying. They are highly effective for reconnaissance, combat, and command and communication. Exclusive features in the ships self-defence capability are; a small radar cross section, low hydroacoustic signature, good magnetic properties and high shock resistance. The ship will be effective for all levels of conflict from peace crisis to war.

Stealth and signatures

The efficiency of the weapon systems on a ship like the *Visby* class corvettes depends among other things on how well they harmonise with the stealth concept. In the YS 2000 program this is managed by a continuous evaluation of the design to ensure the stealth properties are understood in every detail and maintained throughout the life of the ship.

When designing a weapon system for a multi purpose ship it very soon becomes obvious that different types of mission put different requirements on the weapon system and sometimes these requirements are contradictory. On a stealth ship where all signatures have to be considered, it does not become easier. In effect it is an optimisation problem and the RSwN is convinced it has succeeded very well with the *Visby* class corvette.

The concept of stealth technology includes everything that minimises signatures and signals with the aim of increasing the efficiency of own countermeasures systems and own sensors and hindering or preventing detection and identification by an adversary.

The first effect obtained when beginning to reduce a vessels signature is increased performance of own sensors, thanks to the decreased noise levels. Going further, the next effect is that the performance of own passive countermeasure systems increases. To achieve that a certain level has to be reached; a level where the vessels reflected or transmitted energy is substantially lower than that of the countermeasures systems. The next level to aim for is when the signatures are so low that even if it is possible to detect the ship, identification is made difficult. The highest level is to completely avoid detection. To reach this level the signatures must be at a level about the same as, or lower than the environmental background noise. On all levels, but particularly at the highest, environmental factors, such as weather and operational area, are of great importance.

On the *Visby* class corvette actions have been taken in all stealth areas—above as well as under the water—the aim being to achieve effects on all levels, including the highest one described previously. The following is a list of stealth technologies used on the *Visby* class corvette and its effects.

- Radar signature
 - Measures: Optimisation of hull form and hull material. Equipment, weapons and sensors are specially designed or placed under hatches, radar absorbing material is used.
 - Effects: More effective air defence, shorter detection/identification range, simpler/cheaper countermeasures, tactical advantages.

- IR and optical signature
 - Measures: Optimisation of hull material and paint, concealed exhaust and emission outlets, spray, camouflage actions.
 - Effects: More effective air defences, shorter detection range, tactical advantages.
- Hydroacoustic signature
 - Measures: Silent waterjet propulsors, low speed machinery and generators double-elastically mounted inside noise hoods, noise producing equipment mounted according to special instructions.
 - Effects: Shorter detection range, increased performance of own sensors, tactical advantages
- Magnetic signature:
 - Measures: Optimisation of hull material, depermed equipment as far as possible, degaussing system.
 - Effects: Shorter detection range, more difficult for detonation of the mines.
- Transmitted Signals:
 - Measures: passive sensors, sectored transmission, tactical adaptation.
 - Effects: Obstructs reconnaissance, obstructs signal-seeking weapons.

The *Visby* class corvette

General arrangement

The *Visby* class corvette's design integrates the lowest possible signatures. The hull has large, flat surfaces and sharp edges. The vessel has a built in work deck which is a novelty on such a relatively small vessel. The advantages of this are many: weather-protected working area which allows for great endurance and the opportunity to carry out missions in rough weather. The ship's armaments are concealed, which makes it impossible for an observer to determine its mission. The ship's signatures, with radar cross section in particular, have been strongly reduced without extensive cost-increasing measures being taken.

A helicopter can take off, land and refuel on the upper deck and preparations have been made for installing a hangar on the ship. The hull has been built for optimal seagoing qualities and course-stability without compromising manoeuvrability. It is specially designed to accommodate waterjet propulsion. The ship is equipped with combined diesel or gas turbine machinery with four gas turbines for high speed and two diesel motors for low speed, connected to two gearboxes that run two waterjet propulsors. This allows speeds of up to 15

knots in silent mode and a top speed of more than 35 knots. As a complement to the waterjets the ship is equipped with rudders and a bowthruster for harbor manoeuvring. New technical solutions have been adopted to give low noise radiation internally, externally and hydroacoustically—generators and low speed diesels are mounted double—elastically inside noise-hoods.

Material technology

It became clear early in the YS2000 program that a very low hull weight at a reasonable cost would be decisive for the ship's total performance and power. To achieve this aim and at the same time obtain adequate stealth quality, the hull is built using a sandwich construction technique consisting of a PVC core with carbon fiber/vinyl laminate. This gives high strength and rigidity, low weight, good shock-resistance qualities, integrated radar signature surface qualities, and low magnetic signature at a reasonable cost.

The different parts of the hull are built from flat panels manufactured with a vacuum injection process. The panels are then joined together to form larger units. This method guarantees high fiber-content and laminate-quality combined with low weight. The ship is built in three parts and joined together. The *Visby* class corvette will be the largest ship ever built in carbon reinforced plastic or any other fibre reinforced plastic material.

Visby class corvette missions

Anti-submarine warfare

The ASW philosophy of the RSwN implies among other things that each unit shall be fully autonomous i.e. equipped for all parts of the ASW chain; detection, classification and adequate weapon launch. Since one of the main tasks of the *Visby* class will be passive and active ASW, the ships are equipped with a highly qualified sensor system together with effective weapon systems which can react rapidly in any environment.

The ships will be so silent that it is meaningful to use passive sensors against a very silent electrically powered submarine and have a reasonable chance of success. In open sea, the main sensor is a passive towed array sonar (TAS). For ASW in coastal waters or archipelagos, the ships are equipped with an active variable depth sonar (VDS). It is used for reconnaissance, localisation, and classification as well as for target homing. On submarine contact with TAS, the VDS can be used to detect and obtain the target position for weapon usage. The hull-mounted sonar can also be used as an aid in classification. For a non-moving target on the seabed, the remotely operated vehicle (ROV), which is used for mine hunting, can be deployed for classification.

The ships are also equipped with 40 centimetre torpedoes as the main ASW weapon. They are wire-guided with active/passive target seekers. The second system is an ASW grenade system which allows for short reaction time usage.

Mine countermeasure

The future mine threat, i.e. attack mines, demands that objects must be detected at a greater distance than they are today. This means that apart from low magnetic signature and low acoustic levels for vessels, the search and classification range must be extended and the problem of layer formation in the water must be solved.

For MCM missions, the ships are equipped with a ROV carrying sonar, which will operate a long distance in front of the vessel and at a depth adapted to the sound distribution profile. The hull-mounted sonar is used primarily for mine warning.

The low-speed machinery allows the ships to precisely follow a geographical line at low speed, so called track keeping and remain at a fixed point (hovering).

Mine warfare

For mine laying missions, the *Visby* class will be equipped with mine rails and mine launching equipment together with support functions for mine planning and the registration of mine positions.

Air defence

A modern 57 millimetre automatic gun with the latest generation of 'smart' ammunition increases the systems effectiveness against hostile missiles. To meet the future threats of highly manoeuvrable missiles, space has been reserved onboard for an air defence missile system. Electronic countermeasures include a jammer and different kinds of flares and chaffs.

Conclusion

Revolution in modern warfare is upon us. There are no true answers to the question: where is tomorrow's technical evolution heading? However, it is quite clear that it lies within the interest of each country to make it clear what impact the new technology will have upon demands for new R&D, the needs for new strategies and changes in tactics.

The RSwN is convinced it is on the right track with emphasis on the importance of thinking 'stealth' in all dimensions. The YS2000 program is seen as a cost-effective concept to meet the demands of tomorrow in a tight economy.

The stealth venture has, among other things, meant that the RSwN has been able to create an entirely new air defence strategy, resulting in an enhanced ability to obtain lower costs, where, for example, stealth technology has thoroughly improved the system power of the passive (silent) sensors. The *Visby* project, has succeeded in developing a new unique construction material that will be of interest to a large number of application spheres in the future and not only in ship building. By means of newly developed power aggregates, the noise signature has successfully been extensively reduced. A newly developed gunnery piece hood with a concealed barrel reduces the radar cross section and infra-red signature, in parallel with newly developed sensors being optimised to fit the stealth concept, etc.

The *Visby* is seen as an interpretation of the YS 2000 concept, which can serve a wide variety of different purposes and needs. Its high flexibility in design (for example the cargo deck) requires relatively small changes to meet future changes in demands. Even though the payload of the 625-ton *Visby* is equivalent to that of a 1,200-ton conventional steel ship, designs for larger ships have also been studied.

New ships, new solutions: surface combatants in the 21st century

16

Mick Nicholson

Frigates and destroyers have been the mainstay of the naval capability of medium navies for the second half of the 20th century. They have held that position because they offer capabilities that cannot be produced by other units. However the threats and the capabilities of other types of unit are changing and so are national political objectives. Naval forces are being tasked with operations that were not in their national defence policies a few years ago. These changes have made it necessary to re-evaluate the naval force mix and the design of ships and combat systems.

While aircraft carriers are, technically at least, surface combatants they are not discussed in this chapter. It is clear that they confer additional capabilities to any country that possesses them, and that many operations absolutely require them. However their capabilities do not replace any of those of surface combatants.

The surface combatant is the only platform which can deploy to a theatre and maintain a visible presence without depending on the support of local countries. It provides an integrated unit able to sense, analyse, command, control and destroy. It is able to move, house and sustain its personnel. This integrity and independence gives a nation the capability to monitor and influence events without resort to overly aggressive actions. Few other military systems consistently demonstrate their ability to rapidly deploy far from home as an effective sustainable unit.

This chapter looks at the high level capability requirements of nations and then at the role that can be played by the surface combatant. It then discusses the developments in surface combatant design and operation that are necessary to meet the evolution in these required capabilities. Many of the ship and combat system designs being developed at this time show evidence of similar analyses.

There are many generalisations within this chapter, but very few statements that can be made on this topic are universally applicable. Placing caveats on every occurrence of such statements would delight the pedants but add little of value.

Operations and environments for surface combatants

National (homeland) defence

Defence of the homeland is the hardest operational requirement to generalise. It is heavily dependent on the national geography and the capabilities of the neighbours identified as potentially hostile.

Nations face three primary threats to their sovereignty, that of invasion, blockade and strategic raids. The role of the surface combatant in each of these operations is changing due to the technological changes over the past decades.

Such operations are much simpler from the political viewpoint, defence of the homeland from direct attack is obligatory and all national resources will be made available. In particular every military unit will contribute to the maximum extent possible and with little concern for casualties and bad press. Many nations may expect support from friends but they will want some degree of self-reliance.

Invasion

The defence against invasion of the homeland is the primary military objective of any nation. For some medium and small countries invasion is also a credible threat in the near and middle term. For some nations the primary threat of invasion is not by a maritime approach but by land. But for many others, particularly in this region, a maritime invasion is a credible threat.

To defeat an invasion the earliest possible warning of such an operation and the readiness to meet it is crucial. The warning comes strategically from intelligence and tactically from surveillance.

The general surveillance function is currently conducted most efficiently by land-based aircraft. They offer the most cost effective means of covering a wide area. In many cases land based radar can aid this. In the future satellites may be the best source of surveillance data, even for smaller countries.

The next stage is one of confronting such a force. An important part of this is to establish that the operation being mounted by the aggressor is indeed an invasion. This usually needs to be established for a world audience and in any case most countries have been unwilling to rely on intelligence for this process. In the modern context such a force must be confronted so that an aggressor has no option but to escalate the situation into a conflict if he is to proceed. If a nation waits until its 12 mile limit is crossed it will have missed its best chance to cripple the invasion force, before its troops and equipment have disembarked. This escalation has to be gradual and controlled if an operation

which appears to be threatening but is not an invasion is not to be turned into a major conflict.

Aircraft cannot challenge an invasion force in a graduated manner. The only means aircraft have of challenging such a force is to attack it. This may be a premature action since the 'invasion force' may only be intending to exercise aggressively rather than mount an attack. Legally they might be seen to be exercising their right of passage. Surface combatants offer flexibility of response combined with the ability to remain on the scene until the threat has passed.

Challenging such a force by a gradual escalation of harassment and counter threat will enable the defending country to determine the intent of the operation. This escalation also returns some of the initiative to the defender, who is able to determine when to transition to war.

The surface combatant is the platform most able to conduct this task. It is able to exploit the surveillance capability of patrol aircraft and the persistence of land based sensors to interdict a hostile force at a significant range. Only when this is completed can the invasion force be attacked. There are significant advantages in performing this confrontation as far from the shore as possible, but usually it will be limited to within the exclusive economic zone (EEZ).

Once it has been determined that an invasion is indeed underway the major strikes against the main body are usually best conducted by aircraft. However surface combatants will often be the most effective platform for the coordination and control of these attacks as it is able to maintain a continuous presence in the area.

The attack aircraft is the platform with the mobility to react and the lethality to destroy an amphibious invasion force. Aircraft based over wide area can be concentrated on the invasion force while it is still in the critical phases of making the approach and establishing the bridgehead. At this time the enemy's air defences will be at their weakest.

However beyond the capability of individual platforms it is the command and control system that is most important. Few countries can construct and maintain fixed defences that are able to repel an invasion. Even if they could such systems are hardly the most efficient use of resources. In order to defeat an invasion it is necessary to be able to concentrate ones forces and coordinate their actions. This requires manoeuvre—which is so much more than mobility.

Britain owes its very existence to successful command and control. During the Battle of Britain the Royal Air Force had smaller numbers of aircraft that were only equal to those of the Luftwaffe. Even the British radar system, which is

often given the credit for the success, was inferior to that operated by the Germans. However it was the system of command and control of the fighter aircraft, exploiting the information from the radar, which made the difference. That system had been developed and exercised over the years preceding the war. The Luftwaffe had all the elements necessary to coordinate their attacks in real time, but did not do so effectively.

Such command and control must be inherently joint if it is to succeed. Naval vessels have consistently shown that they offer the best combination of flexibility, mobility and persistence (poise) to provide the platform for area level command and control in the maritime environment.

The other element of defence against invasion is to disrupt its supply chain. Land-based aircraft can do this over a wide area but large surface combatants and submarines are effective at greater range. The maintenance of such a supply train is the most difficult aspect of the enemy operation. If the enemy is forced to defend the supply train over a wide area then that will weaken the depth of such defence.

Blockade

Most nations are heavily dependent on sea borne trade for their prosperity and survival. Economic globalisation is not only increasing the volume of sea borne trade it is also making it more vital as national economies become less self reliant.

The ability to escort vital supplies through or around a blockade, or an area made unsafe by a war between other parties, is a common element of many nations prosperity and survival. In some cases such blockades and the counter to them can be conducted by land-based air power but usually that cannot achieve the full coverage required.

The increasing volume of merchant traffic and the diminishing numbers of naval ships and combat aircraft pose problems for those attempting blockades and those defending against them. Success and failure are unlikely to be total except when there is a significant disparity in capability or particularly restrictive geography. It is possible for such shipping to be harassed and the overall flow to be damaged but reducing it to the point where a nation is strategically threatened is quite difficult. Most countries hold relatively low stocks of sophisticated weapons able to be used against defended shipping. This is unlikely to change in the foreseeable future.

Raids

Strategic raids on the homeland are now becoming more credible than invasion. The availability of long range missiles, both cruise and ballistic, and of

unconventional warheads enables attacks when the aggressor does not have the resources required for a conventional assault. The threat of such attacks can seriously limit freedom of action. The defence against such attacks is difficult since it must be very effective if it is to be useful. In many cases the only effective counter is to have the means of retaliation. In a sense this will proliferate the doctrine of mutually assured destruction to a wider range of countries and contests.

Protection of the EEZ

Another form of attack is that aimed at occupying isolated territories and structures. Such national assets are vulnerable to seizure or disruption. They often have disputed ownership and little or no population, reducing the political and diplomatic impact of such actions.

The surface combatants role in countering this threat is essentially similar to that in prevention of invasion. In addition the EEZ must be patrolled and policed if it is to be maintained. This requires a presence at sea level.

In many cases it will not be possible to prevent the occupation of such assets by an enemy and a counter-force, basically a small scale amphibious attack force, is required.

Expeditionary warfare and peacekeeping

The capability to conduct expeditionary warfare is increasingly sought after by national leaderships. The breakdown of the Cold War has allowed the development of more local disputes. This has in turn increased the possibility that such conflicts will threaten further countries within the region. Many nations are vulnerable to larger neighbours or to the spillage of internal disputes. Participation in such operations is a price many countries are willing to pay, motivated for the requirement for collective security and regional/global peace. Some countries face little direct threat in the medium term but have interests in world order long term.

These international operations may involve alliances according to treaties or by coalitions. Alliances tend to be supported by naval forces who have made some commitment to interoperability and who exercise with each other frequently. Coalitions, on the other hand, can involve countries who have been antagonistic in the past and who could be antagonistic in the future.

Peacekeeping operations can very quickly deteriorate into war. It is a minimum requirement of a peacekeeping force that it can either win such a war or withdraw with tolerable losses. This means that it must have the same capability as a war fighting force, but perhaps with less ammunition sustainability. The



HMS Richmond (left), *HMAS Melbourne* (centre) and *RSS Vigour*. International operations may involve alliances according to treaties or by coalitions.

sanction offered by the threat of strike weapons will significantly reduce the risks that are faced by a peace keeping force. This will often make such weapons more useful in such an operation than in war itself.

Expeditionary warfare and peacekeeping are normally joint operations. The adversary's capabilities and motivations will often be unfamiliar and so will those of ones partners. The adversary may not even be a single distinct entity, but may be amorphous or factionalised.

The threat faced in such operations can be varied and difficult to predict. It will be necessary to provide fighter aircraft to cover the amphibious ready group in the littoral area to achieve some degree of air superiority. However it

cannot be assumed that continuous air *supremacy* will be achieved. Mine countermeasures and anti-submarine warfare (ASW) may also be required. Likewise dominance in these fields cannot be relied upon, so every ship will require its own defences against such threats. Attack aircraft, missiles and gunfire directed from ashore are threats particular to this type of mission.

However the most significant distinguishing feature of such operations is not military in nature but political. The criteria for success are much stricter than those of national defence where winning or even survival is sufficient. In particular the requirements for low casualties and a 'clean' victory create particular problems. However unlike the defence of the homeland the participation of a country in such a conflict is optional and the level of its participation is scaleable. Consequently a nation can determine the level of risks it is prepared to accept. Not all of its forces will be capable of, or committed to, such operations.

In many cases, particularly where the major power is involved, the most significant contribution a nation may make to such an operation is the political and diplomatic significance of its participation. This may be out of all proportion to the military capability that it might add to the coalition force. In such cases the contribution made by any ships able to sustain and defend themselves (or better still provide sustenance for others) will be useful.

Surface combatants are required to provide an area defence to cover both the amphibious ships and ground forces. They will also be required to provide the command and control of the defences. Surface combatants and aircraft carriers will be the only providers of such defence in the days surrounding D-Day. The requirement to provide an area defence against surface, land, air and submarine threats together with each such ship having a high degree of self defence against a wide variety of threats inevitably lead to large and powerful surface combatants.

Budgets

Few navies can expect to see increases in budgets for acquisition and operation. New acquisition and management methods are looked to provide efficiencies. Technology is increasingly being seen as a method to reduce costs as much as to increase capability.

New technology for surface combatants

Complement

The ability to find, train and retain personnel is becoming a major constraint for most navies. Even for developing nations the skills required to operate and support warships are becoming increasingly transferable to a civilian high technology market that makes competing demands. At the same time

the call of the sea is becoming less attractive as travel becomes more affordable. The personnel costs are the most significant element of the through life cost of a warship.

Crew sizes have fallen steadily over the past few decades. This has been the result of technological improvements in the integration of systems and their maintainability. Initiatives are now underway to achieve more radical reductions in complement. These initiatives require a detailed modelling and analysis of how ships and their crews operate in a wide variety of operational states for prolonged periods. This human/ship system is much more complex than the most high technology systems aboard. As such the analysis is inevitably prone to errors. Any undermanning that results will undermine the capability of the ship and exacerbate training and retention problems.

Human beings may be expensive and sometimes unreliable but they are extremely adaptable. Few conflicts are fought as envisaged when a ship was specified and built or refitted. Technology is developing fast but it is unable to respond within the timescales of modern conflicts. It is people who adapt to operate the ship as required. Any replacement of people with technology will result in a loss of flexibility. Nevertheless the potential savings in this area are so large that some risk taking is demanded.

Given the risks that the crewing analysis will be incorrect and the potential loss of flexibility significant, maybe a responsible way forward is to automate where possible but to retain some of the 'hotel' provisions for a larger crew. If the automation is successful the space can be used to provide improved standards of accommodation and support 'passengers' such as special forces, command staff, trainees, civil relief teams when required. The provision of space, particularly volume, is relatively inexpensive.

Command, control, communications, computers and intelligence (C4I)

Increasingly the surface combatant will be valued, particularly by medium and small navies, for its C4I capability as much as its weapons. It will be a hub in the network and a decision maker.

Bandwidth and the reliability of the communication is the limiting factor on what can and should be done on a surface combatant in the foreseeable future. It is because of these limitations that we have tiered command and control. Modern communications technology is increasing the available bandwidth but it will always be finite. It is now becoming common for C4I systems to share bearers for many purposes. This makes most efficient use of the bearers but requires organised management, which modern tools are providing.

In a tiered command and control system the next problem is one of data management, ensuring that each unit has the data it requires, but avoids burdening them with data of little or no value. 'Pull' technology where the user specifies what they want (as with a web browser) is being proposed as a solution to this problem. This method is however just as difficult to manage and is fundamentally a radical change to the established methods of command and control. To be successful it relies on providing tools to enable the required data to be indexed and found. In military systems the issue of security greatly complicates this method and makes many civilian tools unusable.

Communication with coalition partners may require the development of 'bolt on' cryptological devices or perhaps the wider use of public key encryption systems. However such communication is unlikely to be very secure. In many operations communication with civil powers ashore, and possibly the capability to provide a public broadcast is useful but this can normally be achieved with a temporary fit of portable equipment.

Antenna arrangements are becoming a severe problem as communications increase while deck space has not changed. The use of multi-purpose antennas and antenna switching systems is only a limited solution, since the peak load requires all channels at the same time.

Offensive weapon systems

Offensive weapons against land, surface and air targets are being developed with greater range and precision. Multi-purpose weapons and launchers are also making the most of limited budgets and space.

For medium and small navies land attack is going to be limited. The ability to quickly place ordnance in response to an urgent call for fire from land forces will always be useful but widespread sustained bombardment is best achieved by strategic air power or land based artillery. Tactically such weapons can be a very cost effective means of suppressing the enemy's capabilities to counter attack by striking at the fixed bases that they operate from.

Defensive weapon systems

The defence of high value units which must approach and operate in the landings area is extremely challenging. These include not only dedicated amphibious ships but also commercial ships pressed into naval service. While surface combatants may provide them with area coverage it is not easy to provide close in cover. It is almost always true that the closer to the intended target that a threat can be killed the cheaper that kill is. If a required level of defence is to be achieved then point defence and inner layer systems are necessary, partly

because close in kills against threats are cheaper than longer range ones and partly because some threats could be launched from close range.

In the past various 'bolt on' systems, particularly decoys and small calibre guns have been used to provide a defence for non-combatant ships. This approach has had limited success in the past. While proposals have been made to have more comprehensive 'self defence kits' available which could be fitted these have not been implemented. A major problem with such systems is the detailed control required to avoid friendly fire in such situations. This problem is becoming worse as the range of defensive weapons is increasing and as we consider constrained navigation in littoral waters. Modern communications networks provide the means by which such control can be exercised remotely, from a surface combatant in the area. This eliminates the need for these 'non-combatant' ships to have surveillance and identification sensors and the people required to operate such systems. Such control could be directive or cooperative, and allow the ship to have some independent self defence when appropriate. The manning of such systems can be reduced to that necessary for maintenance and possibly reloading. It is even possible that self defence modules using standardised interfaces will allow a small number of such systems to be fitted across a wide range of ships as necessary.

Torpedo defence systems are becoming available and are increasingly necessary as the number of nations with submarines is rising, particularly in this region. In confined waters where conditions make ASW difficult, anti-submarine mines may be used to protect an inshore operating area. Modern signal processing is making periscope detection a valuable deterrent to submarine operations.

The mine threat will require ships which operate in confined and shallow waters to have an organic mine avoidance capability. Nevertheless this threat is still a major constraint on such operations where the enemy is able and allowed to prepare for it.

Sensors

Multifunction radars are now becoming affordable for medium navies. They offer the most effective use of power and space on a ship. This flexibility can be exploited to significantly increase the surveillance coverage of a force if the management of radars on several ships are coordinated. Such radars are also able to adapt to the physical and tactical environment. These radars can operate effectively in the littoral environment.

Electronic warfare (EW) is becoming more difficult. The explosion in communications across the radar spectrum is presenting significant problems to EW in the littoral. Some current systems are becoming inoperable, and

communications technology development is outpacing that of EW systems. In fact conflicts between communication and combat systems is having widespread effects.

Electro-optical sensors are becoming cheaper and more effective. They are relatively easy to fit and maintain. Infra-red search and track sensors are valuable in many environments, particularly if integrated with other sensors to avoid requiring additional operators. Weapons which incorporate optical sensors and transmit pictures back to the ship enable identification to be verified before impact.



The *Adelaide* class frigate HMAS *Sydney*. Surface combatants can contribute to a wide range of non-military operations such as peace support operations and law enforcement.

Unmanned aerial vehicles (UAV) are capable of providing surveillance over a wide area. They can perform some tasks that would otherwise fall upon the helicopter, which is always a stretched resource. Initially UAVs had just cameras but more capable systems with radars are now being developed.

Underwater warfare is becoming more important as the number of nations with conventional submarines is increasing. For self defence an active hull mounted sonar is necessary. Towed array and passive systems are more difficult to operate but are necessary against the most advanced and skilfully operated submarines. Area underwater warfare against modern submarines requires very low frequency active towed arrays and helicopters. Such systems are extremely expensive to acquire and operate. They are difficult to operate in shallow and littoral water. Some local area defence can be achieved with medium frequency towed arrays. If a navy has its own submarines these are generally the most appropriate platform for such operations.

Propulsion and machinery

Range (endurance) and economy are the most important factors in propulsion. High speed is an important advantage against conventional submarines. Developments in integrated electric generation and propulsion offers a high degree of redundancy and the flexibility to meet the power demands of modern weapons systems. The prime movers can be a flexible mixture of gas turbines and diesels to achieve economy at all speeds and future power and propulsion systems will require less monitoring and maintenance than current systems. They also enable radical changes in hull design and arrangement, which can bring other benefits including reduced vulnerability.

The provision of ship services is also becoming more automated and integrated. Most of these developments are following civil marine technology. Damage control, which has resisted automation until now, is receiving a lot of attention since available technology leaves this as the limiting factor in crew size reduction. Initially the most progress has been made in the use of sensors and controls within the damage control system, which can be duplicated by crew members if available, such as the communication and recording of compartment and watertight closure status.

Hull

Novel hull designs are being developed, led by the smaller ships. The developments in small and medium ships are primarily aimed at improving sea keeping and increasing the amount of useable upper deck space, where sensors and weapons traditionally compete for real estate. Good sea keeping

characteristics are necessary for the efficiency of the combat system and the crew. It improves the living conditions and so helps alleviate the problems of crew retention. Increasing the deck space has been another significant objective. It is deck space rather than overall size that is becoming the critical limit on the combat capability of the ship. The more radical designs such as the United Kingdom trimaran offer the potential for improved sea keeping and stability, increased speed and range, greater flexibility in upper deck arrangements and improvements in vulnerability and damage survivability.

Conclusion

The operating roles of surface combatants and the threats to them are developing. The technology available for surface combatants is also developing, enabling them to retain their position as a necessary element in the defence forces. The new types of operation, requiring flexible responses, sustained capability and integrated forces, increase the necessity of such ships in a balanced force structure of maritime nations.

21st century capabilities: the US Coast Guard integrated deepwater system | 17

Lieutenant Commander Mike Lupow, USCG

Beginning with a military skirmish with France near the end of the eighteenth century and continuing to recent operations in the Persian Gulf and off the Albanian coast, the United States Coast Guard (USCG) has helped defend US and allied interests in combat. In 1790, the first Congress of the United States (US) created a fleet of cutters to enforce tariff laws. With the disbanding of the Continental Navy following the end of the American Revolution, these cutters served as the only warships protecting US coasts, trade and maritime interests, wherever they were at stake. Since that time, cutters fought the British in the War of 1812, bombarded forts and chased blockade runners during the US Civil War, escorted Atlantic convoys in World War I, sank submarines and conducted amphibious operations in World War II, and served on the gun line and performed riverine and interdiction operations in Vietnam before participating in more recent joint and combined combat operations all over the world.

As it has been for well over 200 years, the USCG is a military, multi-mission, maritime service and one of the US's five armed services. Its paramount role is to protect the public, the environment, and US economic and security interests, in America's ports and inland waterways, along the coasts, on international waters, or in any maritime region in which US interests may be at risk, providing unique benefits to the nation because of its distinctive blend of military, law enforcement and humanitarian capabilities.

US maritime areas of concern are enormous: 95,000 miles of coastline, four major maritime and ocean areas, and more than 3.5 million square miles of territorial seas and exclusive economic zones (EEZ), the largest in the world. Increasingly, moreover, the 'world is our coastline,' a fact-of-life that will drive our operational requirements in new ways.

In all key USCG mission areas, the enduring tasks of providing a meaningful, credible presence; conducting surveillance; detecting, sorting, and identifying targets of interest; and intercepting and engaging those targets remain at the core of the service's five principal roles.¹

As General Hugh Shelton, Chairman of the Joint Chiefs of Staff, said in September 1998, 'determining warfighting capabilities that the joint force will

need in the next century begins with defining the threats that our nation may face'.² As the USCG looks to its third century of service, a complex mosaic of maritime users, interests, and threats, will challenge America and its allies as never before. Secretary of State Madeleine Albright has stated that 'whether it's...enforcing sanctions against nations who threaten others with aggression, foiling terrorists, or interdicting the shipment of illicit arms, the United States must always ensure its maritime security and, with our allies, protect the free and legitimate use of the seas.'³ Likewise, Secretary of Defence William Cohen has underscored four security challenges—large-scale, cross-border aggression; failed states; transnational dangers; and the flow of potentially dangerous technologies—that will certainly drive the need for a full spectrum of military and law enforcement capabilities to protect US interests.

Recent forward-looking intelligence reports⁴ have indicated that missions traditionally assigned to the service responsible for the maritime arena of US national security are likely to constitute a significant growth area. With the end of the Cold War and massive increases in international commerce and transportation, the focus has shifted somewhat from making preparations for major theater war (including naval battle group on naval battle group exchanges) to finding ways to counter more subtle forms of transnational dangers. America's 'national security' is no longer solely focused on direct military threats to the US. It encompasses economic, social, environmental, political, diplomatic, cultural, and military dimensions.

The US Commission on National Security in the 21st Century, headed by former senators Gary Hart and Warren Rudman, was mandated to examine changes that have taken place over the last fifty years and the appropriateness of current institutions to handle these during this first quarter of our new century. They have recently issued the first of their three reports, and one of their conclusions has particular relevance as the USCG moves forward with recapitalisation plans:

The type of conflict in which this country will generally engage in the first quarter of the 21st century will require sustainable military capabilities characterised by stealth, speed, range, unprecedented accuracy, lethality, strategic mobility, superior intelligence, and the overall will and ability to prevail. It is essential to maintain U.S. technological superiority, despite the unavoidable tension between acquisition of advanced capabilities and the maintenance of current capabilities.⁵

A blue-ribbon panel, the President's Inter-Agency Task Force on the Roles and Missions of the Coast Guard, completed its work in 1999 and recently released

its report. As its lengthy title would suggest, this august body—comprised primarily at the cabinet under-secretary level—was tasked with reviewing, revalidating and possibly reconfiguring the docket of roles and missions currently performed by the USCG. Their conclusions have sent two particularly significant messages to the service and the administration: the work of the USCG is vital to US national security and poised to increase in the 21st century; and in order to meet these challenges, the service needs to recapitalise its aging deep water assets.⁶

In step with these outside reports and studies, having recognised the importance of USCG missions to America's national security and economic strength, the service has embarked on a project to ensure they can continue into the next century providing the services that the country has asked of them for more than 200 years. The Deepwater Capability Replacement Project (hereafter, the Deepwater Project) represents an innovative and comprehensive approach to meeting this need.

Deepwater missions and capabilities

The USCG categorises its operating environment into three regions⁷—inland, coastal and deepwater—and defines deepwater as the region generally extending 50 miles or more offshore, or situations/missions requiring extended on-scene presence, long distances to reach the operating area, forward deployment of forces, or a combination of these factors.

The deepwater region encompasses a vast majority of the nation's 3.36 million square mile EEZ.⁸ The US's EEZ is the world's largest and hosts a valuable array of precious natural resources—a US\$24 billion annual commercial fishing industry, substantial oil and natural gas reserves, precious minerals, and the shipping/sea lane routes that provide for the transportation of 95 per cent of America's vibrant domestic and international commerce.⁹

Fourteen of the USCG's legislatively mandated missions are performed within the deepwater region. This requires a capable USCG presence that extends from America's shores and throughout the globe. Recent examples of periodic and enduring USCG missions performed in the deepwater region include: United Nations sanctions enforcement against Iraq in the Arabian Gulf; participation in Operation Allied Force in the Mediterranean; participating in combined search and rescue and law enforcement operations with the Russians in the Bering Sea; illegal migrant interdiction operations and high seas drift net¹⁰ moratorium enforcement across vast portions of the Pacific; counter drug operations in the Caribbean; and international patrols over the North Atlantic that track and chart potentially devastating icebergs. These highlight the

relevance of a USCG that is equipped to continue working collaboratively in a complementary role with other military services and government agencies.

At the core of the USCG's ability to carry out its missions is an enduring task sequence: surveil, detect, classify, identify, and prosecute. This common functional capability is critical, but with the current slate of assets, gaps are increasing at an alarming rate.

The USCG must also be equipped with multi-mission capabilities to defend US interests—alone or in concert with other US forces and agencies, our allies, and international organisations—in home waters or in any maritime area in which the USCG can provide important benefits to America. From the Caribbean to the Arabian Gulf, the USCG carries out deepwater roles, missions, and functions. The USCG's deepwater assets must also be able to support peacetime routine, civilian emergency, crisis-response, and wartime operations, in an affordable, efficient, and effective manner, thus offering the nation the inherent, enduring, and classical attributes of maritime power.

Because the USCG's core maritime security roles, missions, and tasks clearly include military/defence operations, current and future deepwater assets must embrace the common direction for all US Armed Services outlined by *Joint Vision 2010*. New and emerging technologies must be merged with innovative operational concepts that will greatly improve the USCG's ability to conduct 'joint' and 'combined' operations across the full range of peacetime, crisis and wartime missions. Interoperability and compatibility, and the ability to 'tailor' USCG assets for the tasks at hand, will be important factors to consider as the service looks to its 21st century deepwater capabilities needs. In fact, one of the key elements of the Deepwater Project is that it will provide the USCG affordable interoperability with all US armed forces.

Also important to consider will be regaining multi-mission flexibility. Our experience with 'The Enduring Cutters'—the *Secretary* class 327s—provides insight into what is needed. Built to a modified US Navy (USN) *Erie* class gunboat design, seven 327s were completed in 1936–37, with a design requirement to carry amphibious aircraft and missions that included hydrographic research, general law enforcement, and search and rescue (SAR). An example of USN-USCG standardisation, the machinery plant and hull below the waterline were identical in the *Secretary* and *Erie* classes.

During World War II they served alongside USN warships as ocean escorts, protecting Allied convoys from German U-boats, and also served as amphibious command ships. At the height of the Battle of the Atlantic in mid-1943, USN warships had sunk only 11 U-boats, 6 of these by USCG cutters—three by *Secretary* class cutters.

Post-World War II, the 327s returned to peacetime missions, including ocean station patrols for weather and SAR. During Vietnam, they conducted naval gunfire support tasks in support of forces ashore and maritime interdiction operations aimed at Vietcong coastal movements. With the end of the war in 1975 and until the decommissioning of the last cutter of the class, the *Ingham* in May 1988, they enforced maritime laws, interdicted alien migrants and illegal drugs, and protected living marine resources. For more than 50 years, these highly versatile, flexible, and enduring cutters supported a broad spectrum of missions and tasks in peace and war.

Deepwater legacy assets

The Deepwater Project encompasses the entire portfolio of USCG assets¹¹ that currently operate in the deepwater region, and the greatest challenge confronting the USCG is the advanced age and technological obsolescence of its deepwater cutters and aircraft. The average age of the USCG's high and medium endurance cutters is 27 years, and the overall deepwater cutter fleet is older than 39 of the world's 41 major naval fleets. USCG aircraft, meanwhile, operate in a rigorous, highly corrosive, and often dangerous environment at a demanding operational tempo, which poses severe challenges to a service already facing a twenty-thousand-hour shortfall in available flight hours.¹² As a result of these obsolescences, the USCG is experiencing increasing operating and maintenance costs for its ships and aircraft.¹³

Existing USCG deepwater assets lack fundamental capabilities—e.g. sensors, speed, and interoperability—necessary for effective and efficient performance of today's missions, let alone for confronting the threats likely to emerge in the first decades of the 21st century. For example, most cutters lack the sensors and speed necessary to detect and intercept smuggler 'go-fast' boats. Consequently, during 1998, the USCG was able to seize just 10.1 per cent of the non-commercial maritime cocaine flowing into the US, while the nation's drug control strategy calls for an increase in this rate to 18.7 per cent by the year 2002 and 28.7 per cent by the year 2007.¹⁴ No high-endurance cutters and only a few medium-endurance cutters are certified for embarking the service's HH-60J medium range helicopter, and some medium endurance cutters lack any flight deck, greatly limiting their capability. Perhaps most restricting in today's information age is the fact that deployed cutters and aircraft have a very limited ability to share tactical information and lack real-time or near real-time access to essential operational databases.

Operating with antiquated systems manifests itself in three fundamental ways: the USCG's ability to carry out its missions is substantially hindered; its operating and maintenance costs are driven up substantially; and there is a negative

impact on availability and readiness. A particular challenge to the USCG's mission capability is antiquated sensors. The concomitantly poor ability to detect and identify targets results in more time spent searching and less time engaging.

One compelling indicator of the technology gap between the USCG's surface fleet and today's more modern fleets is that personnel costs account for approximately two thirds of the operating costs of a major USCG deepwater cutter.¹⁵ In the thirty to forty years since most of the deepwater cutters were designed, great strides have been made in automating shipboard systems and minimising maintenance.¹⁶ But the challenge of filling large crewing requirements is not just expensive; it also creates serious readiness vulnerabilities. Recruiting and retention are serious challenges for all US armed forces. In the USCG's case, for example, this means cutters deploy short-crewed or with critical positions augmented from experienced sailors who have just rotated to shore assignments following three- and four-year tours at sea. This has already been identified as a critical and deleterious agent on retention.

Compounding the effects of decreasing capability is a concurrent decrease in availability. As USCG deepwater assets continue to age, they place greater demands on the existing logistics infrastructure. For example, the main engines on one class of cutters are used only by the USCG and a South African railroad. Similarly, many system or component manufacturers have or will soon cancel production and support for old equipment and parts. The turbine engines on another cutter class are no longer in production and available support is dwindling. Engines on the USCG's medium range patrol aircraft are antiquated, unsupported and failing at an alarming rate. As a result of age-driven challenges like these, the overall logistics effort demands more labor hours, leading to increased maintenance costs and decreased cutter and aircraft operational availability.

After thoroughly identifying its significant asset deficiencies,¹⁷ the USCG began the process of finding solutions by establishing the Deepwater Project. The project's expansive scope of asset consideration and innovative system of systems approach are unique in the realm of US federal acquisition projects.

Traditionally, major acquisition projects are focused on purchasing a single type of asset or specific kind of service. With the Deepwater Project, the USCG departs from the traditional federal acquisition paradigm by implementing a mission-based performance acquisition strategy. Rather than focusing on specific hardware—like a class of cutter or aircraft—the USCG has developed a set of performance specifications that describe the fundamental capabilities the service needs to perform all of its crucial missions in the deepwater regions—today and into the future.

As part of this mission-based performance acquisition strategy, the USCG decided to pursue an integrated system of systems approach. Several key factors leading to this conclusion were: the approaching block obsolescence of most deepwater legacy assets (see Table 17.1); the understanding that an integrated system of systems approach enables a more realistic and encompassing mission analysis; the realisation that the disaggregate acquisition of major deepwater assets creates and perpetuates chronic intra- and interoperability limitations; and the practical challenge posed by implementing several interrelated major acquisition projects in a constrained fiscal environment. This was a bold and insightful decision.

Asset Type	Year First Commissioned	Expiration of Planned Service Life
210' medium endurance cutter	1964	2007
378' high endurance cutter	1965	2007
HC-130 patrol aircraft	1972	1997
270' medium endurance cutter	1982	2013
HU-25 patrol aircraft	1983	2002
HH-65 short range helicopter	1984	2004
110' patrol boat	1985	2005
HH-60 medium range helicopter	1990	2005

Table 17.1. USCG Deepwater legacy assets

In consideration of the recognised soundness of the project's acquisition strategy, it received a strong positive endorsement from the Office of Federal Procurement Policy. And because of the innovations already incorporated into the project, it has been designated a Reinvention Lab under Vice President Gore's National Partnership for Reinventing Government. As such, it is empowered to test new ways of doing the government's business and share the lessons-learned with other government agencies. In particular, the Deepwater Project was recognised for planning the entire deepwater acquisition as a single coordinated *system* rather than a series of distinct procurements.

An integrated deepwater system

Design concepts and project acquisition strategy

Commandant of the USCG, Admiral James Loy, has determined that the most effective and efficient way for the service to meet its deepwater mission needs in the future is through an aggregate consideration of all legacy assets in one project instead of the traditional approach of separate projects for each major asset type.¹⁸ The resulting challenge for the USCG's major acquisition force was how best to structure a major capital acquisition program that enabled the flexible consideration and trade-off of: surface; air; command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR); and logistics assets and infrastructure, to maximise the USCG's deepwater operational effectiveness and minimise the service's total cost of ownership.

By including all deepwater assets, the USCG was able to determine its fundamental capability requirements in a manner that would not bias the analysis through limiting the scope to the capabilities inherent in a particular asset type (i.e. ship or aircraft). Additionally, the USCG pursued the Deepwater integrated system of systems approach due to the continuing barriers to effective and efficient interoperability among assets. The source of these chronic interoperability problems was the disaggregate acquisition of assets in past years. The current portfolio of deepwater legacy assets was acquired, and in some cases subsequently modernised, via distinct, independent major acquisition projects executed over the past thirty-five years. Although interoperability with extant USCG assets was a requirement when these disparate projects were undertaken, practical cost/performance trade-offs and fiscal limitations ultimately degraded their functional interoperability. By including all legacy asset classes within the scope of the Deepwater Project, interoperability is designed into a USCG integrated deepwater system of systems right from the start. Furthermore, a single project enables better management and mitigation of practical cost/performance and fiscal limitations without compromising interoperability. As mentioned above, interoperability with US Department of Defence is also mandated.¹⁹

Project flexibility

Central to the USCG's Deepwater Project acquisition strategy is flexibility. The requisite flexibility is designed into the USCG's Deepwater Project via an acquisition strategy firmly grounded upon four strategic cornerstones: the overarching objective is to maximise operational effectiveness while minimising total ownership costs; a comprehensive modeling and simulation program will

be utilised to assess various proposals; an innovative mission-based performance acquisition approach will be used; and a system performance specification will keep industry firmly focused on fundamental mission capabilities. The first two are fairly self-explanatory and will not be discussed, however the last two, are not so obvious and need some explanation.

As mentioned, the Deepwater Project is pioneering new ground in federal acquisition reform with its *mission-based performance acquisition* approach. Under a typical performance-based acquisition, the government defines its basic requirements in terms of operational performance parameters—such as speed, endurance, and reduced radar cross-section for a ship or aircraft. The government may then issue several competitive contracts for the engineering design of the desired asset and subsequently award the final construction contract based upon the proposal that meets the stated performance requirements at the lowest acquisition cost.

Rather than focusing on the performance requirements to acquire a predetermined asset-type, however, the Deepwater Project's mission-based performance acquisition approach focuses instead on acquiring an integrated system of systems that provides the fundamental capabilities to perform the entire range of deepwater missions. The key difference is that the USCG does not limit its concept exploration by presupposing a desired solution. Instead, industry is empowered with substantial design flexibility to consider the realm of innovative new technologies and processes in integrating the operations and support of ships, aircraft, C4ISR and logistics.²⁰

The Deepwater Project's *system performance specification* is the formal requirements document that implements the deepwater mission-based performance acquisition and goes right to the heart of the operational commander's concerns. In essence, it describes the core capabilities required to perform the entire range of deepwater missions. By emphasising fundamental mission capabilities instead of specific asset requirements, the Deepwater Project's system performance specification empowers industry with tremendous design latitude. Consequently, industry may consider unmanned aerial vehicles, automated propulsion and auxiliary systems, advanced new multi-hull ship designs, multiple-crewing concepts, and a host of other proven, non-developmental technologies and processes—as long as they meet the system performance specification.

The project's system performance specification is structured around ten principal elements to specify an integrated, knowledge-centric, mobile, and sustainable integrated deepwater system that collects and prioritises information, then rapidly and effectively responds. Each of the ten elements has sub-requirements

to fully accomplish the USCG's core deepwater mission sequence of surveillance, detection, classification, identification, and prosecution. The USCG's system performance specification requirements are also consistent with key aspects²¹ of the Defense Department's doctrine for network-centric warfare.

The fundamental mission capability requirements in the deepwater system performance specification evolved from the project's initial mission analysis and underwent internal review and validation at several levels within the USCG as well as external review and comment by industry and other government agencies. The end result is a system performance specification that clearly defines the USCG's mission requirements without compromising the ingenuity and creativity of the deepwater industry teams.

Funding: past, present, future

The final consideration that led to the project's integrated system of systems approach was the practical challenge of efficiently implementing several interrelated major acquisition projects within constrained and fluctuating USCG budgets. The type of funding required to implement this modernisation is not unprecedented. During the early 1960s and continuing into the 1980s, the USCG received comparable funding to that expected to be required for the *integrated deepwater system*. *Essentially, this period during the 60s, 70s and 80s was the procurement phase of the USCG's current deepwater fleet.*

The fiscal environment of the past, however, is not indicative of the prevailing federal budget climate. The project's necessary funding stream has the potential to exceed the current capacity of the entire USCG acquisition, construction and improvement budget. In addition, the Project's long duration (perhaps fifteen to twenty years) poses capital planning challenges to ensure a stable and reliable funding stream in a year-to-year fiscal appropriations process.

The affordability of deepwater asset recapitalisation is a challenge that must be addressed regardless of whether the USCG should pursue several separate major acquisition projects or just one project. The USCG concluded that one project offered several practical advantages. With an integrated deepwater system, the USCG obtains greater flexibility in structuring contracts to obtain economic order quantity discounts. The project enables determination of the optimum mix of deepwater assets. During concept exploration and beyond, the USCG can accurately determine the proper balance between numbers of assets and the corresponding operational effectiveness benefits and total ownership cost impacts. Hence, inefficient operational capability overlap/redundancy is minimised. Lastly, one project provides broad management flexibility to structure the acquisition of specific system assets in a scalable

manner that can be tailored to meet administration priorities and a dynamic funding stream.

The bottom line is that America needs a coast guard that can effectively and efficiently carry out its full slate of missions. Due to a variety of factors, the service is struggling to do that. Its deepwater assets are old and technologically obsolete, while maritime threats to US national security are on the rise.

But the USCG is on the right track. The Government Accounting Office final audit report published in October 1998 acknowledged that 'the Coast Guard is correct in starting now to explore how best to modernise or replace its deepwater ships and aircraft' and that 'the Coast Guard's acquisition approach seems an appropriate way to avoid a costly one-for-one replacement of ships and aircraft'.²² The Deepwater Capabilities Replacement Project is moving forward, employing a thorough and innovative approach to designing, testing and acquiring a system of systems that will provide the service with maximum operational effectiveness in prosecution of its vital—and enduring—missions at a minimum total ownership cost.

Notes

- 1 The five roles of the USCG are national defence, maritime security, maritime safety, mobility, and protection of natural resources.
- 2 Henry H. Shelton, 'Translating Concepts into Capabilities,' *Proceedings*, US Naval Institute, September 1998, p. 29.
- 3 Quoted in Office of Naval Intelligence, *Worldwide Maritime Challenges 1997*, March 1977, p. 2.
- 4 See especially *Threats and Challenges to Maritime Security 2020* and *Worldwide Maritime Challenges 1997*, both published by the Office of Naval Intelligence.
- 5 The United States Commission on National Security/21st Century. *New World Coming: American Security in the 21st Century, Supporting Research and Analysis. The Phase I Report on the Emerging Global Security Environment for the First Quarter of the 21st Century*, 15 September, 1999, p. 144.
- 6 The final report states clearly that recapitalisation is a near-term national priority and endorses the Deepwater Capability Replacement Project as the right vehicle for effecting this vital process.
- 7 The USCG also operates in the polar regions. Arctic/Antarctic missions include support of US scientific research projects, escort of supply vessels supporting installations and bases, and support of Antarctic Treaty inspection teams.
- 8 'Exclusive Economic Zone and the US Insular Areas: A Case for Shared Sovereignty', *Ocean Development and International Law*, vol. 25, 1994.

- 9 US Bureau of Census
- 10 The use of these nets, indiscriminate killers of marine life and sometimes more than ten miles long, was banned by United Nations agreement.
- 11 These assets are ships, aircraft, C4ISR and their associated logistics infrastructure.
- 12 *Deepwater Mission Analysis Report*, November, 1995.
- 13 *Deepwater Legacy Asset Baseline—2002 Report*, 12 February 1999. *Deepwater Maintenance and Supportability Report*, 9 June 1998. *Fleet Condition and Remaining Service Life Report for 378' High Endurance Cutters*, draft report February 1999. *Fleet Condition and Remaining Service Life Report for 270' Medium Endurance Cutters*, draft report June 1999. *Coast Guard Aviation Near Term Support Strategy*, 28 October 1998.
- 14 *National Drug Control Strategy 1999*
- 15 *Deepwater Legacy Asset Baseline—2002 Report*, 12 February 1999.
- 16 Technology almost certainly will lead to crewing reductions, but the USCG still will need crews large enough to conduct boardings, handle hundreds of migrants, replenish supplies while underway, etc.—all of which tend to be manpower intensive. The crewing of future deepwater cutters needs to be driven by sound analysis of the work that is required to be done.
- 17 The USCG completed a *Deepwater Mission Analysis Report* in November 1995, and the Department of Transportation Systems Acquisition Review Council approved the *Deepwater Mission Needs Statement* in August 1996.
- 18 The deepwater acquisition strategy is also based on research of past USCG acquisitions, thorough review of lessons learned from Department of Defence and other agency acquisitions, and specific advice from federal acquisition experts, including the faculty at the Defence Systems Management College.
- 19 This will extend well beyond hardware commonality and interoperability (e.g. ensuring that Deepwater cutter flight decks are designed to accommodate USN helicopters) to full compliance with USN C4ISR architecture requirements and network centrality.
- 20 A potential benefit here is that the total number of assets required by the USCG to accomplish its essential missions could decrease, assuming design, interoperability and technological improvements lead to increased unit capability.
- 21 Specifically: (1) C4ISR is the capability driver for queuing missions for prosecution; (2) the USCG must have a suite of capable prosecution assets to 'close the deal' for its missions (i.e. there must be an effective on-scene presence); and (3) there must be a strong focus on cost effective logistics (to include an expansive integrated logistics system concept encompassing logistics, maintenance, personnel, training, etc.) to sustain mission performance.
- 22 *Coast Guard's Acquisition Management: Deepwater Project's Justification and Affordability Need to Be Addressed More Thoroughly*, GAO Report B-280862 of 26 Oct. 1998.

Part | 6

Undersea warfare

2015: will the submarine continue to be relevant?

18

Graeme Dunk

From the point of view of society at large it simply makes no sense to produce weapons that are too expensive, too fast, too indiscriminate, too big, too unmanoeuvrable and too powerful to use in real-life war.¹

Martin L. Van Creveld, 1991

This chapter looks at the relevance of the submarine in the year 2015 and what the likely impact of developments in submarine warfare may be for small to medium navies. The main focus is on the conventional submarine, although the same broad trends should also be applicable to nuclear-powered boats. In the non-acoustic realm the Canadian Navy considers that ‘developments in...non-acoustic detection systems such as MAD [magnetic anomaly detector]—enhanced by new superconducting technology—provide possible means of countering the stealthy submarine’,² however acoustics are used to provide examples throughout this chapter. Either way, whether through acoustics or not, the end result should be the same.

Although precursors to the modern submarine were used with some success as early as the American Civil War, it is since the early part of the twentieth century that the platform has dominated maritime warfare, research directions and operational planning. In recent years advances in submarine-related technologies have far outstripped any similar advances in the anti-submarine warfare (ASW) sphere, despite the best endeavours of scientific communities and the expenditure of a great deal of money. The question to be answered therefore is will this continue, or will the trend be reversed?

The fundamental strength of the submarine is stealth. In fact, it could be argued that without stealth the conventional submarine is nothing more than a slow, incompletely armed and equipped submersible corvette with poor endurance. For the submarine, stealth is not only the main game, it is the only game! The French maritime strategist Admiral Raoul Castex noted this as early as 1937 when he wrote:

Though it [the submarine] is no more able than any other ship to cover the entire sea, it will, however, do so in the mind of the enemy, in whose imagination the submarine’s invisibility confers the gift of omnipresence.

Fear therefore leads the enemy to take constant anti-submarine measures, just as if there were one to be found in every mile of sea.³

This chapter focuses on three inter-related key aspects of submarine warfare in the future; namely stealth, information technology (IT) and cost. It will be seen that IT developments will drive stealth requirements, which in turn will drive cost. The end result will be a marked reduction in affordability of the submarine for small to medium navies. Those countries that can afford the means to maintain the stealth characteristics so vital to submarine operations will continue to reap benefits in sea control and covert operations.

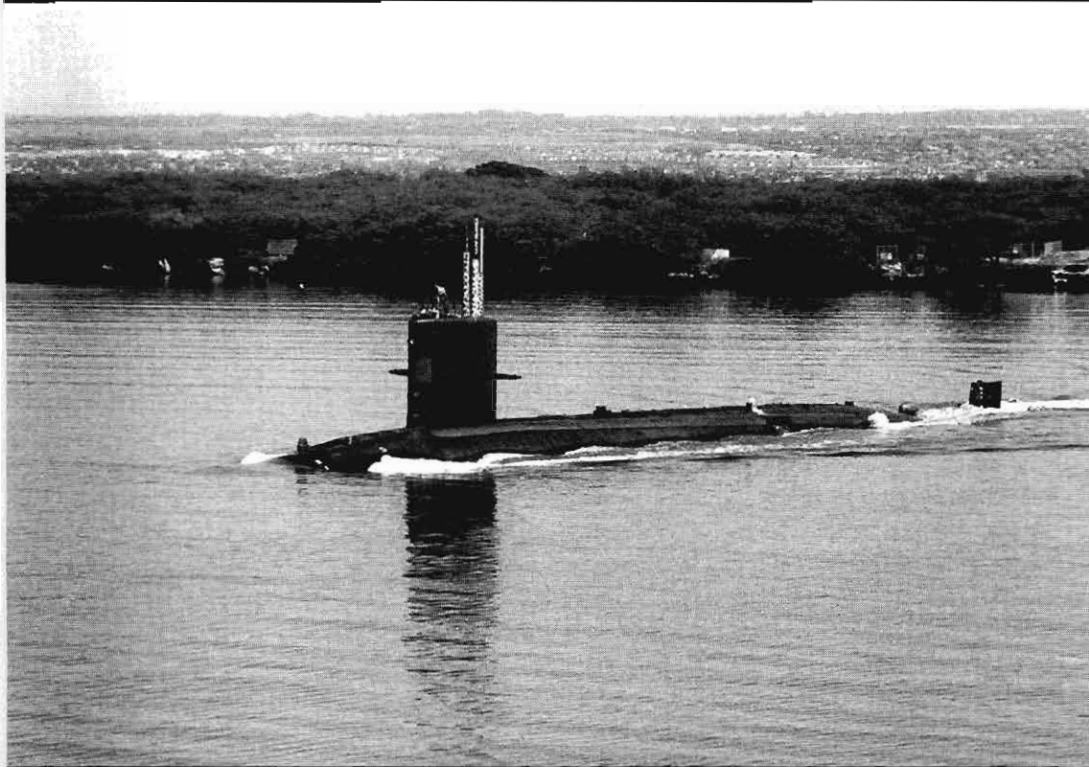
Background issues

Before moving on to the main part of this thesis, it is first necessary to briefly discuss a number of other issues. The first is the crucial issue of vulnerability. For the submarine, more than for any other platform, vulnerability is inextricably linked to stealth.

The first comment is that vulnerability is a relative rather than an absolute measure. This means that a platform cannot unilaterally address its vulnerability but must take into account the capabilities of the threat. Moreover, a platform will have differing levels of vulnerability to different threats. It can be seen therefore that vulnerability to detection depends upon three factors; the nature of the detector (ie. the detector's systems used to achieve detection); the nature of the detectee (ie. characteristics used to achieve detection, such as the radiated signature or reflective characteristics of the hull); and the nature of what lies in between; the environment.

A full understanding of one's vulnerability can only be possible with this information. What this means as far as the argument presented herein is concerned is that it could be possible to improve the characteristics and systems of one's own platform and yet have a reduction in overall vulnerability should there be a corresponding greater improvement in the adversary.

The second issue is that of contra-indicating trends. In the short term, say out to about five years, there will be a number of developments that will run counter to the position advanced here, and which will serve to further decrease the overall vulnerability of the submarine. The first of these will be due to exposure, or rather the lack of it. The advent of air independent propulsion on a wider scale, and improvements in these and battery technologies, coupled with improvements in electro-optical periscopes, will necessitate fewer mast exposures, and consequently less detection opportunities⁴. This will serve to reduce the detection vulnerability to airborne platforms⁵.



The United States *Los Angeles* class nuclear attack submarine USS *William H. Bates*.
The fundamental strength of a submarine is its stealth.

Submarine launched anti-air missiles will reduce the vulnerability to attack by providing the submarine with a fight-back option whilst submerged, and by forcing ASW forces to conduct operations from a distance. This will require the development of a completely new set of tactics. The major impact of this capability is likely to be fairly short term as air assets adapt to a more stand-off posture. Our interest, however, is on the longer term out to 15 years.

Longer term trends

As discussed previously the submarine has achieved its pre-eminent position due to stealth, and it is only stealth that will keep it there. Frank Uhlig of the United States Naval War College has argued that the submarine is a real

revolution in naval affairs as it introduced the hitherto unknown 'fear of being ambushed by an unseen attacker'⁶. Unfortunately, the submarine does not have other characteristics which would compensate should it suffer any significant loss of stealth.

To date, developments in ASW have progressed with a platform-centric focus. That is, the capability of each platform has been viewed, and addressed, individually. In this race the submarine has been the victor, as it has the distinct advantage of being able to immerse itself totally in the operating medium, and its capabilities have outstripped those of surface and air vehicles. This has had the effect of reducing vulnerability.

If one considers the 'data/information/knowledge' hierarchy shown in Figure 18.1 it can be seen that whilst surface and air platforms have operated together for ASW actions, this has been achieved by each unit individually acquiring and processing data, and by sharing the derived knowledge to achieve a coordinated tactical outcome.

Advances in communications and information technologies will allow vehicles at sea not only to share operational knowledge, but also to share and jointly process down to the data level. This will be a significant development, and one for which the submarine does not have an obvious counter. Submarine capabilities must always be developed with stealth as a primary consideration, and for that reason they will continue to be undertaken at the individual platform level.

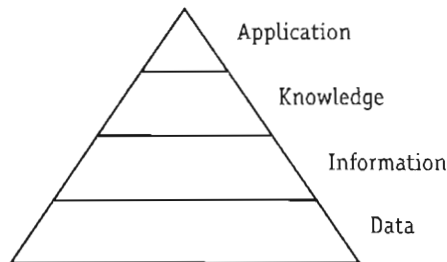


Figure 18.1. Data/information/knowledge hierarchy

What follows is one possible example of such a combined capability. Other solutions involving non-acoustics, or the blending of acoustic and non-acoustic data streams, may also serve to achieve the same overall result. It is however the future ability of ASW forces to develop a combined capability that will serve to redress the imbalance between submarines and those who hunt them.

The combined capability example presented here is based on the creation of an extremely large virtual array for submarine detection. It is perhaps the underwater equivalent of the astronomical technique called very long baseline interferometry where the individual outputs from a number of fixed terrestrial and orbiting antennae are processed (although not currently in real time) to form a single, large virtual array. The technique has markedly increased sensitivity over any of the arrays working individually and delivers the capability to look further into space (ie. to see more distant, fainter, objects); or to see closer, more bright objects in greater detail.

A similar approach could be adopted with a task group to create a large virtual array to improve both submarine detection (enabling higher probability detection at a greater range) and classification (to be able to classify a submarine from a non-submarine object; and to classify between submarine types).

The creation of this virtual array will be made possible by connecting units into a wide area network and by conducting distributed processing of the data in the same way as distributed computers can process any large computational problem. Sonar and associated data (such as environmental data) would be used as a group resource, and a combined sonar product would be developed.

Unlike the astronomical application of the same concept, the virtual array created in the maritime environment will be continuously moving, and may be comprised of a variety of different sensors. Moreover, the characteristics of the virtual array will be changing as ships routinely manoeuvre, as task group evolutions such as replenishment take place, and as units join or leave. The virtual array will therefore be dynamically changing, and must be able to automatically adapt to these continual alterations in its components. Timing and positional accuracies will be sufficient for this to occur.

The technique will also require a more precise understanding of the environment. For an active application of the array it may be necessary to conduct real time environmental modelling on a pulse by pulse basis, and to adapt each transmitted pulse for optimum performance in the prevailing environmental conditions. Research into such evolutionary algorithms is currently being progressed, including those that learn from environmental interaction⁷.

None of this will be possible without improvements in data storage techniques, such as dynamic distributed data warehousing⁸. Real time update of data storage will be required, as will techniques to automatically add and remove distributed data users and the synchronisation of data holdings across all linked vehicles.

Impact on submarine warfare

The impact of improved submarine detection and classification capabilities by virtue of the virtual array will be significant. Faced with a serious increase in vulnerability, the submarine's response must be to improve its stealth characteristics. How will it do this?

In order to address the problem, the submarine must do two fundamental things (neither of which are new, but both of which must be pursued with renewed vigour). The first is to monitor, manage and negate, in real time, the radiated signature. The second is to negate, in real time, active sonars employed against it. Neither of these tasks is trivial. The former will require the extensive



HMAS Collins. In the constant pursuit of stealth will submarines price themselves out of the force structures of all except the major navies?

use of onboard sensors to monitor hull and other vibrations, and to actively counteract these as the platform state alters. Given the sensitivity that may be achieved with the virtual array, detections may be possible, not on radiated noise, but on the lack of it. That is, should the active noise cancellation be totally successful by the submarine there may exist an area in the water column where there is an acoustic hole. The submarine would therefore have to match its signature to the surrounding background noise, and alter this as conditions changed around it, a sort of 'acoustic cloaking device'.

In the event that the virtual array was used actively, the noise cancellation would need to cater for these pulses, possibly over a wide spectrum; whilst continuing to maintain the background noise signature noted previously. As noted earlier the active pulses may alter from pulse to pulse as the virtual array adapts to the environment.

Can these capabilities be developed? Maybe; maybe not; but for the submarine they will be vital. With an increase in detectability comes a decrease in stealth. With a decrease in stealth comes an increase in vulnerability. With an increase in vulnerability comes a decrease in relevance. The size of the decrease in relevance therefore is fundamentally linked to any increase in detectability.

Implications for navies

This chapter is concerned with the implications of these developments for small and medium navies. If we augment the descriptions of medium maritime power advanced by Rear Admiral Richard Hill⁹ and by Sam Bateman¹⁰ to include the broad power categories of:

- maritime superpower—can maintain a continuous global maritime presence;
- major maritime power—can maintain a continuous, significant regional maritime presence;
- medium maritime power—can maintain a limited regional maritime presence; and
- small maritime power—cannot maintain a regional maritime presence,

then we are considering navies such as those in Australia, Singapore, Malaysia, Indonesia and Thailand.

The difficulties to be faced by these countries with respect to submarine forces, or plans for submarine forces, are fundamentally no different to those for larger navies; only the scale of the effect will be different. As for any other force element, the development and maintenance of submarine forces comes at a cost. The question is whether the costs can be justified in terms of capability, strategic advantage, national pride or whatever measure may be used.

The difficulty for the submarine is that the pursuit of stealth (and hence a favourable vulnerability position) will only come with the expenditure of increasingly greater funds. Already, the new French *Triomphant* class nuclear ballistic missile submarine has installed a real time signature monitoring system which costs more than the combat system. The impact of the exponential growth in information and knowledge technologies over the next 15 years will exacerbate this situation by the ability of ASW forces to develop combined capabilities.

The result will be therefore that, in the pursuit of stealth to maintain relevance as a maritime platform, the submarine will price itself out of the force structures of all except the major navies. For those countries that can afford the investment, the submarine will continue to have operational and strategic benefits. As for many military vehicles and technologies before it, the submarine is likely to become a niche capability, powerful in its own right, before perhaps disappearing from the scene altogether.

Notes

- 1 M.L. Van Creveld, *The Transformation of War*, The Free Press, New York, 1991, p. 7.
- 2 See <http://www.dnd.ca/navy/marcom/acp1fut.html#n89>
- 3 R.V.P Castex, *Strategic Theories*, Naval Institute Press, Annapolis, MD; 1994; p. 13
- 4 See also T.S. Joergensen, 'US Navy Operations in Littoral Waters', *Naval War College Review*, Spring 1998; <http://www.nwc.navy.mil/press/Review/1998/spring/art2-sp8.htm>
- 5 A contradictory view is put in P. Stevens, 'Can Radar Help Defeat the Diesel-Electric Sub?', *Proceedings*, US Naval Institute, August 1999, p. 56-59.
- 6 F. Uhlig Jr; 'A Real Revolution in Naval Affairs and What it Achieved', *US Naval War College Review*, Spring 1999; <http://www.nwc.navy.mil/press/Review/1999/spring/s&d-sp9.htm>
- 7 See <http://pc143d.dcs.napier.ac.uk/roadmap/articleT10.html>
- 8 For coverage of data warehousing, including distributed data warehousing see for example K. Orr, *Data Warehousing Techniques*, The Ken Orr Institute, 1996-97; <http://www.kenorinst.com/dwpaper.html>. Dynamic distributed data warehousing refers to the need to dynamically add and remove users and their individual warehouses, and to ensure that the combined warehouse is dynamically updated to reflect the different data holdings as users join.
- 9 See J.R. Hill, *Maritime Strategy for Medium Powers*, Croom Helm, London, 1986, pp. 22-25 for 'Some Examples of Medium Power Perceptions and Strategy'.
- 10 S. Bateman, 'Naval Roles and Maritime Power', *Maritime Studies*, No.84, September/October 1995, pp. 13-24.

Submarines: | 19 an Australian view

Lieutenant Commander Horden Wiltshire, RAN

Naval strategists have argued convincingly of the need for versatility in navies and their warships to achieve a nation's strategic aims. Faced with a strategic assessment that 'short of global war almost anything can happen'¹, the flexibility of the Royal Australian Navy (RAN) and its major combatants is crucial. A flexible submarine capability has an important contribution to make.

During the Cold War, particularly in the United States (US), the submarine evolved into a specialist anti-submarine warfare platform. The hunter-killer submarine was designed to neutralise the Soviet submarine armada. Lacking a clearly defined threat and operating within the constraints of a small force, Australian submarines could not afford the luxury of such focus and have always trained for a variety of missions.

History provides countless examples of the versatility of the submarine. Japanese operations against Australia during World War II demonstrate a few. The submarine I-25 launched and recovered a seaplane to conduct reconnaissance missions over Sydney. Similar reconnaissance missions were also flown over Melbourne and Hobart. I-24 shelled Sydney's eastern suburbs and three midget submarines were launched from 'mother ships' for the attack on the warships in the harbour.²

This chapter explores ways the inherent flexibility of the submarine can be further exploited to improve both the tactical and strategic value of the asset. The tactical value of the submarine can be enhanced by improving the core skills of the submariner and maximising the advantage derived from the submarine's distinguishing attribute—stealth. The tactical flexibility and effectiveness of the submarine can be also be enhanced by exploiting technological advances in weapons and sensors. These developments will be explored within the context of the core missions performed by the submarine to support national defence priorities. Capitalising on the strategic value of the submarine can be achieved by employing the submarine in other roles and missions.

Core skills and attributes

Fighting the submarine

The essence of the war fighter is the ability to make decisions under conditions of uncertainty. The skill of the submariner is the ability to weave together enough pieces of information, by listening acoustically and electronically, to develop a 'good enough' picture of the world around the submarine. The speed and accuracy with which this picture is painted directly affects the submarine's ability to achieve the operational aim.

Originally manual methods were used to compile the tactical picture and control the weapons system. However, with the development of fire control systems and more recently combat systems, the relationship between man and machine has become ever more entwined.

Traditionally the combat system was linked to the platform. Often upgrades were associated with platform refits and purchase of new combat systems linked to new acquisitions. Now, as the development cycles for software decrease dramatically and the trend towards commercial-off-the-shelf equipment continues, the nexus between combat system and platform will weaken and eventually be broken. The relationship between man and combat system will become far more important. This relationship will capture the essence of how to fight the submarine, the Australian way, and become part of the wider navy's war fighting knowledge and the service's most important asset.

The major advantage of reduced software development times is the ability of the combat system to adapt incrementally as improved methods for compiling the tactical picture are developed and the operators discover better ways to optimise the system's performance. The successor to the *Collins* class should sail with the latest version of the combat system, that incorporates the advances achieved and experiences gained over the next 20 years. It should not take a completely new combat system to sea.

The RAN is rapidly approaching the decision point for a new combat system. It is crucial that any future system allows the service to retain control of the system architecture and interfaces. To acquire and maintain the technology edge, the combat system should be capable of incorporating improvements quickly, including any uniquely Australian developments. It should also be capable of evolving to meet any new mission requirements.

Training

The only way to fight and win at sea is to train to fight as effectively and realistically as possible. Under the current social and economic pressures to

reduce sea time the best way to improve our performance in this area is to conduct more effective training when the submarine is alongside and better quality training when the submarine is at sea. High fidelity simulation provides a solution.

Modern navies have been using simulators for many years to develop their core skills and the usefulness of this training cannot be underestimated. By way of example, almost half of the current submarine command course is conducted in a simulator. The combat and platform system simulators are often booked 24 hours a day, for basic and advanced training. Nevertheless, there remains substantial room for improving the way we train using developments in technology.



HMAS Waller. Modern conventional diesel submarines are not easy to detect.

In particular, there is significant scope for on board training systems that combine simulated visual, sonar and electronic information. This would provide the Commanding Officer with greater flexibility in training his team either alongside, in a completely synthetic environment, or at sea with artificial contacts superimposed upon a real scenario. While basic single sensor simulation is available now, an integrated training system would allow the submarine to engage a hostile task group without leaving the wharf.

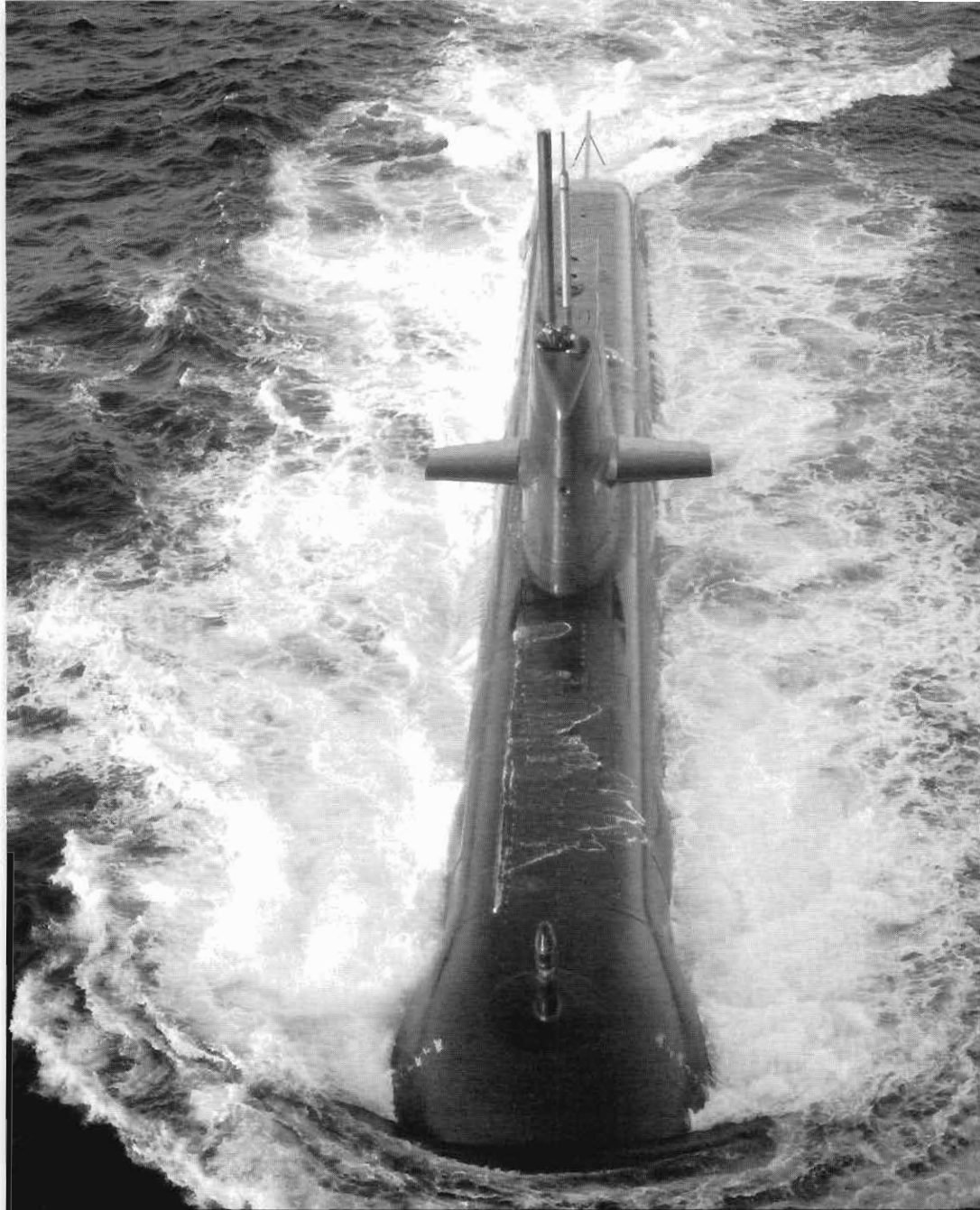
The reduced software development times that maintain the submarine's technological fighting edge will also place greater training demands on the crew into the future. Considerable benefit would be gained from training the command team, using the latest release of combat system software, alongside in a foreign port prior to conducting a major international exercise.

Further developments are already under way in the US where rather than firing practice weapons, virtual torpedoes are fired by the submarine with weapon preset and control data passed to the range via a high bandwidth acoustic transducer. Weapon and target information is then passed back to the combat system.³ These firings are not restricted by sea state, the weapons do not have to be recovered and firings are not interrupted by passing merchant vessel traffic. Importantly, the firings would not be constrained by the limitations of peacetime safety firing rules used to protect the submarine and target.

Stealth

The strategic and tactical value of submarine stealth is likely to grow in the future as surface ships become increasingly vulnerable to the widespread availability of visual satellite data.⁴ Most professionals agree that even today, the modern diesel submarine is not easy to detect.⁵ The continued reduction in both broad band and narrow band acoustic signatures will make the task of passively tracking the conventional submarine very difficult. While it is acknowledged that increases in processing power may improve the performance of the opponent's sensors these would be offset by continued advances in acoustic stealth such as advanced hull coatings, polymer ejection systems and active mounts.⁶

Without doubt the weakness of the conventional submarine lies in its requirement to snort. The need to re-charge the submarine's battery forces the conventional submarine to increase its vulnerability to passive acoustic detection and, often more importantly, to visual detection. One of the biggest improvements of the *Collins* class over the older *Oberon* was the improvement in indiscretion ratio, or the amount of time it needs to snort to re-charge the battery. Nevertheless, further advances in the area of air independent propulsion



HMAS *Collins*. Even with self defence developments such as anti-aircraft missiles and countermeasures the priority should remain improvement of a submarine's stealth qualities.

(AIP) will improve indiscretion ratios further. Depending on the operation, AIP may reduce the requirement to snort from a once a day to once every 14 days⁷, significantly reducing the vulnerability to visual and acoustic counter detection.

Although self defence developments such as anti-aircraft missiles and countermeasures will continue, the priority should remain the improvement of the submarine's stealth qualities. Despite the widely publicised 'noise problems' of the *Collins* class, the issues are being effectively dealt with. Facing the challenges of signature reduction, however, is not a single event. It has always required an ongoing, systems based approach. The structures now in place to deal with these noise issues augur well for the future continuous improvement in the submarine's stealth characteristics.

Core missions

Improved core skills and attributes will enhance the ability of the submarine to conduct its core missions. Core missions are defined as those current missions of the submarine that support defence's priorities of maintaining the knowledge edge, as an able intelligence collection platform, and defeating threats in the maritime approaches.⁸ Submarines play a key role in supporting the highest defence priorities and will continue to do so.

Defeating ships

Submarines are the nation's longest range and most potent anti-shipping capability in a wide range of strategic circumstances.⁹ The cloak of stealth provides the submarine with the ability to sink warships in hostile waters or preferably to mine enemy harbours defeating those ships before they become a threat. Improvements in both anti-ship torpedoes and mines would continue to make the submarine a formidable threat in this role.

A program of continual improvement in anti-ship weapons, including the heavy weight torpedo replacement, would allow the submarine to attack hostile ships at longer ranges and with increasing kill probabilities. While surface ships will improve their ability to survive a missiles attack, their vulnerability to complete destruction from a successful torpedo attack continues to be an Achilles heel.

Mobile mines will improve the ability of the submarine to restrict warships to their harbours. The ability to control a mine after discharge would enable the mine to be positioned in water depths shallower than the submarine is capable of entering. This would improve the effectiveness of the submarine's mining capability while reducing the risk to the submarine.

Research under way to reduce the size of missiles, torpedoes and mines may result in a significant improvement in the payload of the platform. By halving the length of any weapons the payload can effectively be doubled.

The effectiveness and flexibility to conduct anti-shipping operations will continue to improve in the future in line with developments in weapon technology.

Intelligence collection

The submarine is a valuable intelligence collection platform. When satellite information is not available and other collection platforms would be placed at risk, the submarine's contribution is unique. Future improvements in connectivity will improve the quantity and quality of information that would be passed to the tactical or operational commander depending on the situation, including real time video and tactical communications.

In the past, the submarine risked counter detection when making any transmissions. The development of more covert methods of communicating including improvements in acoustic communications methods and buoyant wire antennas capable of two way communications with satellites will decrease the risk to the submarine of such activities. Looking further to the future, laser communications with satellites may provide the bandwidth and covertness required by the submarine.

The development of off-board sensors would also improve the effectiveness of the submarine to gather intelligence. Unmanned underwater vehicles and unmanned aerial vehicles launched from the submarine would improve the submarine's ability to gather both strategic and tactical intelligence. The unmanned sensors would allow the submarine to extend its area of operations. Areas previously difficult to penetrate because of geographical or threat limitations would be accessible to the unmanned vehicle.

Alternative missions

While it is impossible to determine which of these technologies will be successful, history has shown the tactical value of the submarine, or its ability to carry out the core missions, will probably continue to improve incrementally. Considerations of other roles such as supporting United Nations (UN) activities or by providing the submarine with a land strike capability will increase the strategic value of the asset.

UN activities

Australian submarines have not been involved in any UN activities in the past. In purely peacekeeping scenarios the submarines would be a useful intelligence collection platform. In peace enforcement operations more active use of the submarine may be required.

During the recent Kosovo conflict, Dutch media reported that a conventional *Walrus* class submarine was stationed off Kotor, tasked to engage any submarines

of the Federation of Yugoslavia, which posed a threat to the assembled allied warships. Other conventional submarines were also employed, probably in intelligence collection roles.

Submarines regularly exercise with forces from other nations and, provided interoperability is maintained with nations such as the US, they are capable of supporting international operations. One of the greatest advantages of the submarine is that whilst capable of making a significant contribution to any UN effort, Australian personnel would be placed at minimal risk.

Strike

While the current policy has ruled out the use of long range strategic strike weapons such as *Tomahawk*¹⁰, the requirement for such a capability may well be warranted in the future. The ability to conduct precision strike, however, is not limited to *Tomahawk* and there are other weapons available that provide more flexibility and would require minimum modification to current systems. *Harpoon* Block II, for example, while possessing a shorter range, is capable of attacking a land target. It would allow the submarine to retain the ability to conduct an anti-ship missile strike while adding the flexibility to conduct precision land strike if the situation required.

The submarine is well suited to the employment of such a weapon. The shorter the range of any missile selected for strategic strike the greater the value of the submarine as a launch platform. The ability to achieve surprise by positioning the submarine relatively close to the target while remaining undetected provides considerable leverage compared with other platforms such as surface ships and even F-111 aircraft. Another advantage of an upgrade to existing capability is that relatively little additional training would be necessary for the crew to develop the required expertise.

While not arguing in favour of *Harpoon II* specifically, this type of weapon would allow the submarine to strike warships in harbour as well as other military installations. Used as part of a coordinated strike with other assets, the weapon provides a substantial force multiplying effect. Special forces have long held the role of conducting strategic strike and it is possible to see the opportunity for the submarine and special forces to act in unison to conduct highly intrusive operations. The ability of special forces to coordinate a significant strategic strike from a submarine would dramatically increase the impact of any attack.

Assigning the submarine the role of strategic strike allows it to make a significant contribution to each of Australia's top three defence priorities and maximises the strategic value of the asset.

Conclusion

Australia has invested a large amount of time, money and effort into the construction of the *Collins* class submarine. The media smoke screen has disguised the full potential of the platform which, in an uncertain strategic environment, remains one of the most versatile and potent in the Australian Defence Force. Improved training, a responsive and adaptive combat system and ongoing stealth enhancements will improve the way the submarine conducts its core missions of collecting intelligence and defending the maritime approaches. Providing alternative tasking and new roles will maximise the strategic value of the submarine.

Notes

- 1 P. Dibb, *Defence Strategy in the Contemporary Era*, Strategic and Defence Studies Centre, Canberra, 1999, p. 12.
- 2 D. Jenkins, *Battle Surface*, Random House Australia, Sydney, 1992, pp. 126, 201–23, 243.
- 3 For a detailed description of these developments see W. Canto, 'Virtual Reality Under the Sea', *Undersea Warfare 1998/1999*, vol. 1, no. 2, Washington, 1998.
- 4 National Research Council (US), *Technology for the US Navy and Marine Corps 2000-2035*, Naval Studies Board, Washington, 1997, p. 5.
- 5 D. Snider, *Attack Submarines in the Post-Cold War Era*, The Centre for Strategic and International Studies, Washington, 1993, p. 4.
- 6 For a detailed description of stealth developments see National Research Council (US), *Technology for the US Navy and Marine Corps 2000-2035*.
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- 8 Commonwealth of Australia, *Australia's Strategic Policy*, Australian Government Publishing Service, Canberra, 1997, pp. 56-63.
- 9 *ibid.*, p. 62.
- 10 *ibid.*, p. 63.

Royal Navy submarines | 20 in the 21st century

Commodore Jonathan Lyall, MBE, RN

This chapter addresses the topic of Royal Navy (RN) submarines in the 21st century describing the intermeshed doctrinal, operational and political arguments. It also touches on some related issues that may be the subject of future debate.

Firstly the RN and submarines in the 21st century. To posit this appreciation it should be recognised that the shape of the future RN, as with any other military service, can only exist within the context of broader security and fiscal policies. At this grand strategic level I take as my example not the oft-quoted playing fields of Eton, nor even any other hallowed institution of learning. Instead take an expatriate Englishman, of limited academic achievement, based in Singapore where he operated as a broker dealing throughout the Far East. Single handedly he was responsible for the fall of one of the United Kingdom's oldest and, until then, most blue chip of banking houses (Baring Brothers) just a few years ago. The point, obtuse though it may seem, is that the speed of communications, the vulnerability of institutions, and the common links between nations across the globe, tell a great deal about the shrinking size of the world that we live in. At the grand strategic level the UK will be obliged to pitch its economic goals—and thus unavoidably its political aims and military capabilities—at a global scale. This is not, however, a nostalgic search for a new world role; it is simply a hard-nosed realisation that with its trade based economy and investment culture, the UK must maintain military capabilities and force structures that are coherent with its geostrategic position.

Pursuit of this argument, completed in the UK's *Strategic Defence Review (SDR)* two years ago, leads inexorably to forces with flexibility, reach and utility—in other words maritime forces. The capacity to deploy affordable, integrated, potent military force quickly and decisively, in concert with a range of allies, will have an enduring place in fostering and preserving international security. Expeditionary warfare of the classic type, in fact. The balance of capabilities that the future fleet will require to meet these objectives stem from the requirement to operate, project and sustain force up to littoral waters, and beyond into sustained operations ashore. The intellectual basis for this is laid down in *British Maritime Doctrine* (republished in 1999). The supporting concept of operations is provided by the UK *Maritime Contribution to Joint Operations*,

also published in 1999. Hopefully that background sets the intellectual basis for the ensuing illustration of the unique utility of the submarine in supporting the UK's defence policy and concept of operations.

Let's first recap the attributes, or seven deadly virtues as some call them, of submarines:

- *Flexibility*—capable of role changing almost instantaneously without equipment reconfiguration or changing personnel. No requirement for external or host nation support. Arguably the greatest potential constraint on this attribute is communications limitations which may extend the time to change roles.
- *Mobility*—sustained high speeds, independent of the weather, allowing a speed of advance in excess of 500 nautical miles per day indefinitely. Clearly this refers to nuclear submarines (SSN) and this particular attribute will be less essential for nations closer to likely problem areas. In other words a conventional submarine may well fit the bill.
- *Stealth*—independent of the surface, able to operate up threat regardless of who exercises sea control or has air superiority. Is a submarine there or not? Can the threat nation take that chance? (For example, *Dreadnought* in 1977 off the Falklands or *Conqueror* sinking *Belgrano* in 1982.)
- *Endurance*—again no dependence on external or host nation support. The only limitations are food and/or weapons expenditure.
- *Reach*—the ability to deliver ordnance, selectively targeted, if needs be from within the enemy's backyard, regardless of who controls the battle space.
- *Autonomy*—the ability to operate alone and without support at the direction of whoever exercises overall command as a complete and self contained unit of force.
- *Punch*—ranging from the *Tomahawk* land attack missile (TLAM) up to 1,000 nautical miles with Cable News Network demonstrated accuracy, to RN *Sub-Harpoon*, *Spearfish* and *Tigerfish* at more tactical ranges.

That is a quick recap of the inherent strengths of an SSN. How are they, or more importantly how will they, be best used?

During the Cold War SSNs conducted mainly independent operations. There will be a continuing requirement for these, not least in support of the nuclear deterrent deployed in the new *Vanguard* class nuclear ballistic missile submarines. But the new operational environment and advent of new weapons, opens up a number of opportunities for these versatile platforms in support of more diverse naval task forces:

- Deploying early, covertly or overtly as appropriate.

- Intelligence gathering/surveillance, including indicators and warnings.
- Precursor and advance force operations.
- Surface and sub-surface interdiction.
- And of course with TLAM, demonstrating and exerting political will through coercion or, if needs be, execution of long range precision land attack.

In what is seen as the new strategic circumstances, the use of military force is based principally on the concept of manoeuvre warfare. In quick and easy terms, rather than the Cold War concept of destroying an enemy by incremental attrition, the UK will now seek to defeat an enemy by shattering his ability to fight as an effective and coordinated whole. This requires the determination of his centre of gravity (the characteristic or capability from which he derives his freedom to operate) and the application of overwhelming force to deprive him of this advantage. The use of force will be four dimensional—integrating air, land, sea, and political aims and tools—and will draw upon the immutable qualities of maritime assets:

- flexibility,
- low political risk,
- access,
- reach,
- mobility, and
- sustainability.

thus allowing maritime power to be employed across the range of crisis and political activity and conferring the ability to give an almost infinite range of carefully and clearly graduated signals. While referring generally to maritime forces here, the key functions and roles of submarines within this broader picture should be recognisable.

Hopefully this demonstrates—albeit only in brief and very superficially—the political, doctrinal and operational imperatives for submarines within balanced forces. Their flexibility, utility across the spectrum of strategic and tactical needs, and not forgetting the important political attraction of their use in many of the purposes. That is why the RN has—and will for the foreseeable future maintain—a sizeable force of SSNs. Currently 12 *Trafalgar* and *Swiftsure* class, the number will drop to 10 as the *Astute* class is phased in from 2005 and the *Swiftsure* class is phased out.

Let's now consider a few broader issues which may give rise to further discussion. The obvious sceptic's reaction to the above is, 'So what. The oceans will soon become transparent and that will herald the demise of submarines!' This may

be right, just as the predicted demise of the Dreadnoughts was, eventually, right. Nothing is forever and certainly not weapons of war. Opinions have always been polarised when discussing submarines.

In 1900 the then First Sea Lord, Admiral Lord Charles Beresford stated 'submarines are underhand, underwater and damned un-English'. He may well have been correct but a more pragmatic approach was adopted by his successor Admiral of the Fleet Lord Jacky Fisher who said: 'My beloved submarines. If I had twice as many, the Chancellor of the Exchequer could reduce income tax to threepence in the pound'.

Clearly Fisher recognised the political as well as the military imperatives of his time! I wonder if the Chief of the Royal Australian Navy has considered pursuing this line with Federal Treasurer Mr Peter Costello. But historical allegory can hardly be a sustinment for todays discussion. The farsighted will look to the distant future and tell of what they see—but is that a basis on which to not only plan but actually build our future defences? We are attempting to look 15 plus years ahead, about the time that it takes to plan, design, build and bring into operational service any major new weapon system. 15 years ago there was a young man—unkindly described as a nerd—called Bill Gates, who was fortunate enough to inherit \$1 million. At the same time there were about 500 subscribers to a niche information exchange system called the internet. The rest as they say is history—but not even Nostradamus predicted it. The exponential advances in technology are such that anyone who is prepared to state now what the key emerging factors will be in that timeframe risks being dubbed the proverbial emperor with no clothes.

Precisely what the capabilities and roles of submarines will be, let alone their sensor fits, weapons and propulsion modes, no one can be certain. What new threats they will have to overcome in order to retain their essential utility also lies ahead. Each nation has differing requirements, different geostrategic imperatives, and different aspirations—peaceful or otherwise—which will colour their perceptions. Who knows how different the conduct of the maritime phase of *Operation Desert Storm* would have been if Saddam Hussein had possessed one operational 206 class submarine roaming dangerously inside the Gulf?

Unless the oceans become transparent (and that has been imminent for the past 20 plus years according to some self styled cognoscenti) there is a very positive, vital role for submarines for the foreseeable future. Particular reference has been made to SSNs, primarily because that is what the RN operates—for very good reasons. But it is perhaps the uncertainties and intangibles as much as the beautifully crafted doctrine which suggest that—for the foreseeable future—submarines will have a crucial and cost effective role to play in small, medium and large navies around the world.

The future of mine warfare: a small to medium navy perspective | 21

Captain Allan Du Toit, RAN and
Lieutenant Commander Matt Brown, RAN

Mines have variously been described as the 'hidden menace', 'weapons that wait' and the 'silent unseen killer' all of which conjure up connotations of a sinister albeit highly lethal and effective undersea weapon, the presence of which may not be evident until the first ship falls prey to a mine.

Mine technology can range from very basic mines to highly sophisticated weapons, proliferation is rampant, and nations or organisations can acquire a capability commensurate with their objectives and available funds. Modern mines are highly advanced weapons capable of targeting not only particular classes of ship, but have been developed to the point where they are capable of selecting particular ships. Mining, however, is unique amongst all disciplines of maritime warfare, in that it also employs weapons developed and used in mining over one hundred years ago, which continue to remain potent and effective weapons today.

It is difficult to imagine a canvas biplane or a coal powered warship equipped with visually sighted guns striking fear into the heart of a modern day naval commander. Older generation mines, which are still in use today, however, do. They continue to require specialised equipment to counter and, with the spiralling cost of high technology warfare, are increasingly cost effective weapons.

Mines are versatile and powerful weapons that can be employed either offensively or defensively, to attack an enemy's vessels in areas where they are expected to operate or to protect a nation's own waters and installations from interference by enemy ships or submarines. They may be laid overtly or covertly from a variety of anonymous or non-attributable platforms including ships, small boats, submarines or aircraft, and not only possess the capability to inflict damage, but also the capacity to exert a significant psychological effect. Even if no mines have actually been laid, the mere claim to have done so constitutes a substantial and very real threat.

Mines have long played a significant, often devastating role in maritime warfare, out of all proportion to the measures needed to counter them. History abounds

with examples of the decisive impact of mining on naval operations and its capacity to negate the strategic impact of numerically and technologically superior forces. Furthermore, in a disconcertingly high proportion of these examples, the impact and effectiveness of the naval mine is further multiplied by the inability of otherwise well equipped and prepared navies to deal effectively with the mine threat.

Poignant examples from recent history, which emphasise the power and impact of the naval mine, include Korea and the recent Gulf War, where numerically and technologically superior forces were prevented from achieving their aim by the use of mines. In Korea, in an effort to break out of the defensive perimeter around Pusan, United Nations (UN) forces planned a decisive two-headed amphibious strike with landings at Inchon and Wonsan. The strategic aim of the landings was to sever North Korean supply lines and isolate the bulk of the North Korean Army. Whilst the Inchon landing was successful, the vital second half of the operation was delayed for 14 days through mining by the North Koreans, using a makeshift force of junks. As a result the bulk of the North Korean Army were able to retreat, regroup and eventually force back the UN Forces to the current border between North and South Korea. The strategic aim was not achieved, and it can be argued that the action that had the greatest bearing on the outcome of the entire Korean campaign was the defensive mining of Wonsan. Similarly, during the Gulf War in 1991, planned amphibious landings could not be carried out because of the extensive Iraqi mining threat off the coast of Kuwait and the fact that mine clearance operations could not match the pace and tempo of the campaign.

There is perhaps no better 'David versus Goliath' example of the impact and cost effectiveness of the low cost mine in modern times, than the significant structural and mission abort damage sustained by the recently commissioned state-of-the-art *Aegis* class cruiser USS *Princeton*, after actuating a small modern anti-invasion ground mine during the Gulf War. The total repair cost of the mine damage is estimated to have cost some US\$20 million—all from a weapon costing about US\$35,000.

Recent technological advances, have consequently, not robbed the mine of its traditional cost-effectiveness. As a result, the naval mine remains an extremely cost effective and powerful tool in the hands of small to medium navies. On the other hand, the disproportionate effort required to counter mines is vastly more complex, considerably more costly and significantly more dangerous than the effort required to lay the minefields in the first place. In mine warfare the disparity between weapon and countermeasure, characteristic of many aspects of warfare, is particularly marked. Mine warfare is consequently a constant

and never-ending battle of wits between tacticians and scientists on both sides of the mine warfare spectrum.

Mine countermeasures (MCM) forces, which often tend to be more neglected than other more glamorous naval forces, are universally regarded as one of the most important constituents of all types of littoral maritime operations. Mine countermeasures is a highly specialised business, assets are highly sophisticated and expensive and crews highly trained. The Royal Australian Navy employs what is euphemistically known as an MCM toolbox. There are a number of versions of this in the world's small to medium navies. Essentially, a good MCM toolbox provides a mix of techniques to enable a flexible, balanced and, most importantly, layered approach to the conduct of mine countermeasures to be pursued.

The first tool in an MCM toolbox is a thorough knowledge of the environment in which the MCM force is required to operate. This includes such tools as route survey, which is a detailed survey tailored specifically to the requirements of MCM. It is usually conducted with side scan sonar and may be overlaid with sub-bottom profile and magnetic anomaly data. It features data collected by clearance divers specifically detailing seabed material and the likelihood of mine burial. It also includes oceanographic and hydrographic data to predict currents, turbidity, temperature and salinity layers, biological noise and other effects on sonar propagation, and may include additional data gleaned from local fishermen, professional mariners and other sources.

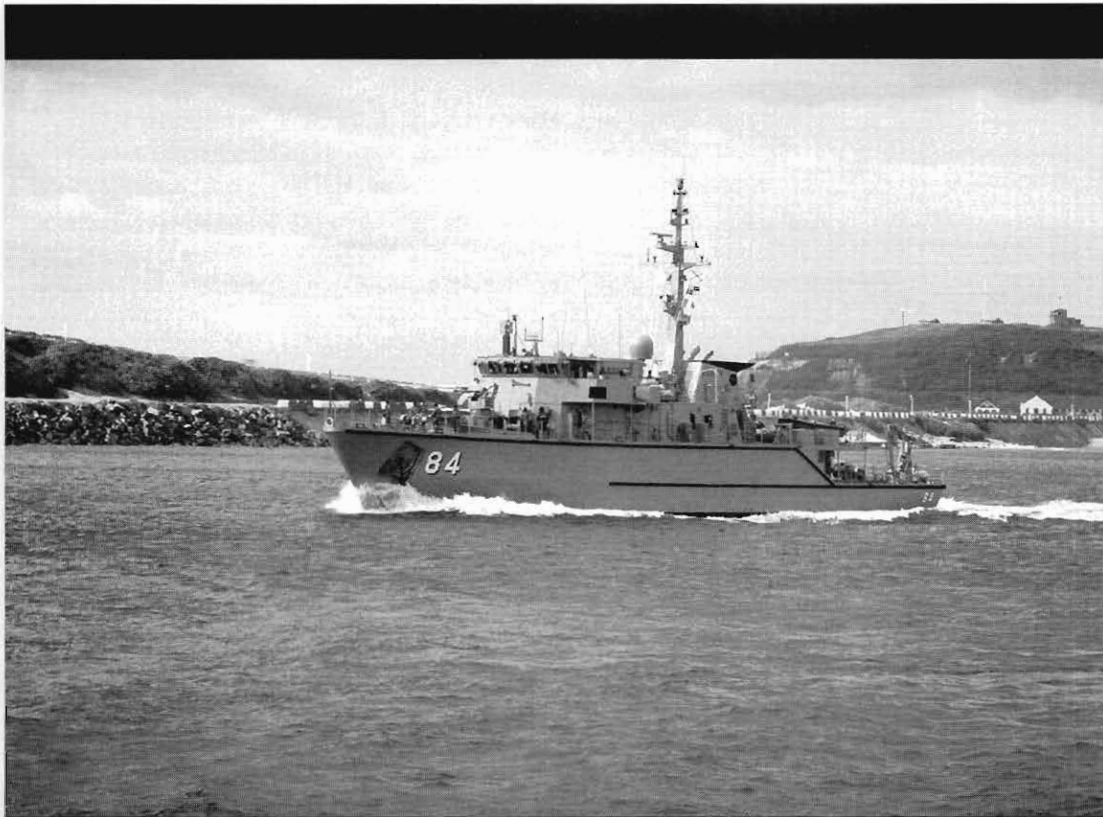
The fundamental importance of route survey is that whilst an MCM commander is unlikely to have much say in where an adversary may lay mines, at least he can determine which piece of ocean he will attempt to punch a clear channel through. Route survey enables him to achieve this and is, therefore, a vital key tool in his toolbox.

As the MCM commander will have limited knowledge of the number, location and settings of mines, the entire operation will, by necessity, be based on assumptions. Noting the critical nature of these assumptions, computerised mine threat analysis and decision making aids are crucial.

The conduct of MCM is an increasingly complex business, and often conducted with insufficient resources and significant time constraints. This dictates that the MCM commander must optimise the employment of his three primary active MCM tools (minehunters, minesweepers and clearance divers) to achieve the highest possible clearance levels as safely and as quickly as possible within these timing constraints. Computerised planning tools are therefore a necessity. Furthermore, as the MCM operation progresses, the MCM commander will not

only need the ability to evaluate progressive clearance levels, but will also require the flexibility to review planning for the completion of the operation.

The first of the active MCM tools is the minesweeper, which tows through the water a variety of sweeps to counter mines. These range from the wire sweeps which are used to cut the mooring wires of buoyant mines, which have not changed significantly since their introduction early last century, through to the most modern influence sweeps. Wire sweeps, of course, are of no use against a mine lying on the seabed. The MCM toolbox, therefore, contains sweeps which simulate or emulate the magnetic and acoustic signature of a vessel and defeat the mine logic by deceit. The theory is that the mine sensors will believe that a ship satisfying the miners requirements is in its direct vicinity



The RAN's *Huon* class coastal minehunter HMAS *Norman*. MCM forces are universally regarded as one of the most important constituents of littoral maritime operators.

and detonate. The obvious disadvantage with minesweeping is that the sweeper must pass over the mine first. It is, therefore, considerably more dangerous than minehunting and modern day MCM commanders will look to a number of techniques to reduce this risk—or seriously consider not using it at all. Having said that, if faced with unhuntable mines (stealth) or a rocky seabed where effective hunting is not possible, the MCM commander will have little option but to employ minesweepers. Sweeping is therefore, and will remain, an important MCM tool.

The modern minehunter is an expensive, sophisticated ship which, tonne-for-tonne, is recognised to be the most expensive warship in modern navies. Minehunters are equipped with a high frequency sonar capable of detecting and classifying minelike objects. The minehunter, and every piece of equipment fitted in them, is purpose built to withstand high shock loadings, and they have extremely low magnetic and acoustic signatures. Non-ferrous metals are used wherever possible, and degaussing coils, designed to negate the magnetic signature of individual pieces of equipment, are fitted. Even personal items belonging to the crew are subject to rigorous magnetic ranging prior to embarkation.

The minehunter carries remotely operated vehicles (ROV) and specialist mine clearance divers to neutralise mines as they are located. The forward-looking hull mounted or variable depth sonar makes the minehunter a relatively safe MCM tool. As a result, they are increasingly carrying the lions share of MCM taskings.

Small teams of divers are carried in MCM vessels (MCMV), but the majority of divers are members of specialist diving/explosive ordnance disposal teams who work in concert with other MCM assets to achieve required clearance levels wherever depths permit. They are tasked to conduct ordnance disposal and exploitation including the search for mines in shallow waters and in the vicinity of wharves and harbour installations.

The breathing apparatus worn by clearance divers is purpose built for the highly dangerous environment in which they operate and they are capable of operating to a depth of 90 meters. Their entire apparel from diving set right down to diving knife are made of non-magnetic material and have extremely low acoustic and magnetic signatures. Divers, particularly with their ability to conduct mine exploitation and ordnance disposal, are consequently an important tool in the MCM toolbox.

In dealing with the potential mine threat, few navies, in particular small to medium sized ones, have the financial resources to keep up with the pace of technological change in MCM. One option that simply must be explored, therefore, is building greater cooperation between the MCM forces of friendly

nations. In Australia's region, MCM forces are working together to build an MCM partnership by exploring potential synergies in training, logistic support as well as the conduct of mutual operations. It is arguable that MCM lends itself to international cooperation better than any other area of maritime warfare. Large multi-national MCM forces have been assembled on several recent occasions to deal with what turned out to be very small numbers of mines, for instance in the Red Sea in 1984 and during the Iran-Iraq war in 1987 when third-party tankers were the main target. During the recent Gulf War, the Iraqis laid an estimated 2,500 moored and ground mines in the eastern and northern Gulf, which required a significant multi-national effort to clear channels both during the combat phase of operations and post-conflict.

Cooperation between MCM and hydrographic services in peacetime data gathering and knowledge building is another obvious area where possible synergies must be fully exploited. Both disciplines operate in the same littoral environment, using sonars with not-dissimilar capability, to gather data focused on major ports and shipping routes.

What is clear from this discussion, is that the effort to clear mines is vastly more complex, considerably more costly and significantly more dangerous than the effort required to lay them in the first place. Also, that MCM operations require a balanced and layered approach using minehunters, minesweepers and clearance divers backed up by good route surveillance and effective planning and evaluation tools.

As we look to the future, the miner, can be expected to employ 'stealth' or 'self-burying' ground mines that will be virtually unhuntable in all but the best minehunting conditions with current technology. Furthermore, the use of passive homing mines, capable of detecting and homing in on any active sonar source, are likely to be increasing employed. They could be laid well outside shipping routes and would be equally capable of destroying minehunters, surface vessels and submarines.

Future MCM commanders may look through their inventory in ten years time and, with some justification, feel that the balance has indeed swung further in favour of the miner. The primary development in MCM will be in the field of sonar technology including the use of parametric sonars capable of penetrating mud and sand to search for buried mines. Synthetic aperture sonars may be in service to enable the MCM operator to classify mines to such a high degree of confidence that one shot torpedoes or mine disposal charges may be used for mine neutralisation. The future MCM commander will almost certainly have a workable acoustic mine imaging sonar fitted to his ROV which will enable him to identify mines even in muddy and turbid waters. The passive homing anti-

MCMV mine will cause considerable concern and spore a number of experimental sonar techniques such as sonars which will transmit a coded binary pulse at below ambient noise levels, or pseudo biological noise using an acoustic pulse modelled on whale or dolphin songs.

The push to provide safer MCM operations will continue with the development of 'swim ahead sonars' and unmanned minesweeping drones. Surface ships will also likely have a limited ability to conduct MCM surveillance operations through organic unmanned MCM assets, with all disciplines of maritime warfare undoubtedly maintaining a keen interest in multi-role autonomous unmanned submersibles such as the USN Manta project currently under development.



RAN Clearance divers deploying from a *Sea King* helicopter. Divers, along with minehunters and minesweepers, are the three primary active MCM tools available to the MCM commander.

Amidst all this conjecture, two things remain certain. Firstly a balanced and layered approach will remain the most effective method of countering the mine threat; and secondly, despite the preponderance of effort devoted to mine countermeasures, the imbalance in favour of the miner, seems unlikely to ever be redressed. Finally, there is every sign that this battle will become more rather than less intense, and will make increasing demands on the technological capabilities of both sides. Mining will consequently remain a powerful and relevant tool in the hands of small to medium navies and any navy, be it small, medium or large, that ignores mine countermeasures, will do so at its own peril.

Part | 7

Additional papers

Determination of maritime system performance: replacing perception with credible capability assessment

22

Lieutenant Commander David Finch, CF

A fighting maritime force has lived and died by the time honoured saying, 'to float (and in modern terms fly), to move, to fight'. Historically, emphasis on the 'to fight' has been placed upon the tactical inventiveness of operators to best achieve combat efficiencies and effectiveness from the weapon resources available to the maritime unit(s) against the capabilities of a threat. Theoretical modelling and generic systems component testing, in often benign multi-dimensional air, surface and sub-surface environments, have been used by tacticians to develop perceptions of overall systems performance and capabilities crucial to tactical development and effective use of weapons. In turn, these perceptions of capabilities are further used to argue for system replacement in order to improve perceived capability deficiencies. The fiscal climate restraints of the post-Cold War era 'new world order', which will, in all likelihood, continue into the 21st century, are straining the ability of small and medium sized maritime forces to justify the requirement for capability modernisation. The basic question is how best to achieve combat effectiveness within economic efficiencies in order to optimally prioritise capability improvement? The achievement of these desired enhanced effectiveness and efficiencies enhancements can only be realised from the replacement of perceived system knowledge with quantifiable system performance developed within the environments and conditions likely to be encountered by maritime forces. While this concept is readily acknowledged by those charged with tactical development and system procurement, the cost of obtaining this knowledge has been deemed too prohibitive and thus unobtainable.

All areas of traditional maritime warfare expertise, air warfare, surface warfare and undersea warfare, whether fought in the Cold War's blue water or the more modern brown water littoral environments are encapsulated within the process divisions of search, detect, classify, localise, and attack. Tactical development effort normally favours one of these divisions, requiring the sequencing of several tactics from search through to attack of a maritime threat. Of these divisions, the weapon performance of the attack sequence has been paid the most attention, in order to best determine the allocation of limited weapon

procurement dollars. Weapons are normally only fired on instrumented test ranges that quantify and qualifiedly document the performance of the weapon. The overall system performance, within realistic environments, of the search, detect and localise divisions have largely been left to imprecise theoretical models. The means to correct the search, detect, classify and localise system performance knowledge gap has, until recently, been cost prohibitive. Modern efficiencies with data collection and systems analysis now permits the achievement of a process that could potentially revolutionise maritime warfare through:

- quantifiable capability definition and determination of system performance, from cradle to grave;
- tactical development with actual capabilities figures vice theoretical or perceived performance capabilities; and
- procurement efficiencies to optimise combat effectiveness.

Lets reverse the premise that developing the required system performance knowledge is cost prohibitive and say that maritime forces can ill afford not to have this information and answer the following basic questions:

- How would this information be developed?
- Who could/would/should develop this information?
- What would development of this information support?

How would this information be developed?

The lack of definitive information on military or capability effectiveness regarding the operation of a complete system is not a recent phenomenon. Allen R. Millet and William Murray, in their 1988 book entitled *Military Effectiveness*, indicated that 'despite a sizeable theoretical literature on organizational efficiency, military effectiveness remains an ill-defined concept'.¹ They go on to say that:

The operational approach emphasizes the importance of doctrines and tactical systems and their proper utilization on the battlefield. By implication, this concept is also sensitive to companion issues such as training and leadership, but pays special attention to weapons utilisation.²

Traditionally, maritime authorities charged with developing the doctrines, tactics, training and leadership initiatives to optimise operational combat effectiveness have used whatever information was available to make determinations, to the best of their abilities, of the available data. Judgements were often based upon common sense of seamen experience. The intricacies of

modern systems requires that judgements are elevated from being reliant upon common sense of the seaman's eye to a structure which permits quantitative and qualitative assessment regarding:

- allocation of optimum resources to meet maritime operations requirements;
- identification of shortfalls in operational capability to meet these requirements; and
- accurate measurement of the performance of those resources assigned to meet the operational requirements through:
 - analysis of actual operations;
 - exercise analysis;
 - tactical development analysis;
 - system development trial analysis;
 - training development;
 - combat team (leadership) development; and
 - environmental measurement.

As previously mentioned all warfare areas require a sequence of search, detection, localisation and attack to take place within a multi-dimensional battlefield environment. The progression of the sequence, from one stage to another, may vary depending on the warfare field of choice, with undersea warfare being slow relative to air warfare which is fast. The sequence and technical definition of the applied terminology may also vary; however, the basic principle remains valid. This conceptual structure should therefore be used as the basis of any methodology used to quantify and qualify the actual performance of maritime systems and platforms. It is exactly this conceptual structure that the United States Navy (USN) has adopted for its anti-submarine warfare (ASW) platform/system/operations mosaic³, and is the cornerstone of the USN's ship ASW readiness effectiveness measurement and air effectiveness measurement programs. While the USN has been ASW centric with the application of search (surveillance & cueing/area search/local search), detect (classification), localise, and attack process methodology the same principles can be easily applied to the other maritime warfare areas. The final result would be that the performance capability of a maritime platform would be quantified and qualified removing any guesswork out of how the platform actually performs. Tacticians will have verifiable data for developing optimum tactics. Trainers will have information to determine how best to tailor training packages. Capability development organisations will have the data necessary to better prioritise system capability replacement or upgrade.

A generic system performance model can be used to illustrate what information is required to achieve the desired quantification of actual systems capability. The generic model requires information be captured to support the following sets:

- sensor operation settings (house keeping data) for sonar/radar/active or passive systems;
- signal excess—equipment detection;
- operator verifies/acknowledges—command detection;
- effort to localise to attack criteria (torpedo/missile/gun...);
- weapon fired/launched—weapon attack performance repeats generic model steps a through d above for the weapon itself; and
- environmental data.

Historically, labour intensive paper records were kept by the operators to capture the information required to highlight one or more of the above generic aspects of the search to attack systems methodology. The search aspect of the methodology is determined after the fact during analytical effort. Modern maritime combat systems now lend themselves to automated data capture. The insertion of data capture devices to automatically trap the information required to ascertain system performance outlined by the generic performance model can be achieved relatively easily and in some cases is being built into the systems themselves. The Computer Devices Corporation AN/SQS-510 hull mounted sonar is but one example of a modern combat system which has built in automated house keeping data recording and automated acoustic recording functionality. Such devices whether built into the systems or developed as add on devices are crucial to defining who did what to whom and why.

The fundamental building block to the above system performance methodology is the development of platform ground truth. Traditionally it was this aspect of event reconstruction and analysis that forced maritime platform systems testing to instrumented ranges. This information tied together with the manual records were used to determine performance requirements outlined ostensibly by the trial or test objectives. Without a verifiable ground truth track(s) it becomes impossible to determine 'who did what to whom, when, where, how and why', allowing the loudest or most persuasive voice of perception to win the day. The incorporation of global positioning system (GPS) into most modern maritime platform navigation packages makes the capture of unit ground truth as easy as connecting the GPS terminal to a recording device. This information is then played back within an analysis program designed to correlate track data with platform sensor data. Once completed, the developed picture can be

analysed in accordance with the predefined system search, detect, localise and attack, process methodology to describe actual system capability, tactical effectiveness, training effectiveness and combat team effectiveness.

Who could/would/should develop this information?

The availability and relatively low cost of modern computer technologies allow the introduction of computer intensive processes that previously were not achievable. The cost associated with a computer based implementation of a maritime system performance determination methodology is nominally (estimations only quoted in Australian dollars):

- GPS—to capture unit ground truth. Associated costs \$2,500–\$5,000 for the GPS and approx equivalent value for the data log computer based device, total \$5,000–\$10,000 per unit.
- System operation data capture device—to capture system configuration data. Associated costs for computer based recording devices, if not built into the sensor themselves, \$2,500–\$5,000 for the device, with a programming cost of \$10,000–\$30,000, depending upon the level of sophistication required.
- Either as a part of the system operation data capture device, or as a separate device, to capture system detection. Costs as per the system operation data capture device.
- Capture of operator/command detection and the command team effort in response of the detection. Associated costs for automated computer devices installed into combat information systems supported by video capture and command team voice recordings would be \$5,000–\$15,000 per unit.
- Weapon performance would continue to require the analytical sophistication only supported by an instrumented range, costs therefore are excluded.
- Computer based process to data correlate the unit ground truth data with the system operation and performance data to permit analytical effort by an organisation charged with implementing the developed methodology:
 - computer device—\$15,000 (personal computer based)–\$50,000 (small main frame); and
 - analytical team composition—personnel cost minimum 15 to an approximate maximum of 24 comprising:
 - command position;
 - warfare specialists (approximately 4–6) at the Lieutenant/Lieutenant Commander level;

- warfare sub-specialists (approximately 4–6) at the Senior Non-Commissioned Officer (NCO) level;
- technical expertise for the automated devices used by the team (approximately 3–5) at the Senior NCO/Lieutenant/Lieutenant Commander level;
- civilian scientific staff (approximately 1–3); and
- support staff (2)—clerical/registry.

The approximate direct a cost of implementing the above process is anywhere between \$50,000 and \$150,000 for the required equipment. It would be safe to assume that the indirect costs required for software development would be approximately double this figure. The associated dollar value is therefore somewhere between \$150,000 and \$450,000. The personnel costs would be between the range of 15 to 24 individuals, depending on anticipated work effort and knowledge fields required for an approximate cost of \$900,000 to \$1.38 million per year (based upon \$60,000 per person). The final costs would therefore be somewhere between \$1.05 million and \$1.8 million in the first year with an annual recurring cost of approximately \$1 million. This total is a relatively small infrastructure cost compared to the hundreds of millions spent on theoretical capability analysis, upgrade and replacement. While the above numbers are only approximations, they are reflective of the cost considerations that small and medium maritime powers would have to consider when deciding to adopt a system performance capability model proposed in this chapter.

It could be argued that the new process imposes another expenditure upon the theoretical capability analysis, capability upgrade and equipment replacement process already in place. However, this argument does not consider the position of empowerment that the system performance model provides the capability team to more intelligently allocate scarce resources and funding.

What would development of this information support?

Implementation of the generic system performance model, supported by the required data collection regime and by an analytical organisation could potentially turn every maritime, non-instrumented range event into the equivalent of a range event. The capture of system performance tied to unit ground truth would permit critical analysis of blue and brown water events in the actual environments that systems are likely to be operated in. Tactics, training, and combat team development would be representative of actual operations. The derived data would also enable more precise identification of system or capability shortfalls to be defined from actual operations, which

could then be used to better define or refine theoretical models attempting to anticipate future maritime capability by more precisely defining current capability(s). Improving these models would enable better refinement of system capability definition proposals to contractors permitting better test and evaluation determinations of new or introductory systems. No longer would capability assessments and tactical development be reliant upon contractor supplied glossy system performance brochures.

The way ahead!

To achieve this level of information a maritime force must first define what information it requires as sub-sections of the proposed system performance search, detect, localise and attack model. Having defined the required information sets the organisation must determine how best to capture the data and develop the corresponding procedures. This information must then be tied to unit ground truth within an analytical program to permit detailed analysis of the event in question. Finally, a report of the results is produced. This process would permit non-range events to be reconstructed to nearly the same fidelity achieved on expensive instrumented ranges themselves.

The adoption of this process is but a small fraction of the total cost of conducting theoretical capability analysis, system replacement or upgrade. Efficiencies permitted by modern combat and navigation systems and the low cost of modern portable computers make it possible to achieve a high degree of accuracy and fidelity for analytical efforts in environments of consequence. Small and medium navies should review their capability analysis and definition processes to ensure that they are not inadvertently costing themselves money through the belief that the cost of generating actual maritime system combat performance is cost prohibitive.

Notes

- 1 Allen R. Millet and William Murray, *Military Effectiveness*, Mershan Centre Series on International and Foreign Policy, Unwin Hyman Ltd., London, 1988, p. 1.
- 2 *ibid.*, p. 1.
- 3 Scott C. Truver, 'Back to the Future: A comeback for US Navy ASW', *Jane's Navy International*, vol. 102, no. 5, June 1997, pp. 12-24.

Conference dinner speech | 23

Vice Admiral David Shackleton, AO, RAN

It is always risky in after dinner speeches to take a serious approach at a time when one's audience is strenuously relaxing after a long and busy day. But I do want to take such an approach and to raise some subjects with you at what is the half way point in our conference.

Some themes are already emerging and confirm my own assessments of the issues that we must face and deal with. I want to reflect on these matters in the context of a Chief of Navy who is seeking to develop a vision of the Royal Australian Navy of 2020. How it can best contribute to national security. How it should be constituted and operated and how—not least important—we can start the RAN of 2000 on the journey that will be necessary. Let me focus on three subjects. All deal with what could be termed as *relationships*.

My first theme is the relationship of the Navy and industry. I mentioned this morning that we need to be very clear about the relationship between the two. Defence industry exists to support the defence force and national defence capability. The defence force does not exist to support defence industry.

I am not suggesting that we should be pursuing a one eyed approach to defence needs that does not recognise those of Australian industry. In fact, I am convinced that properly managed capability development and maintenance are vital tools in our national efforts to encourage technological progress and economic growth. I think that the success story of much that has been achieved over the last decade in particular outweighs the failures and I think that we need to do more to make the Australian public aware of that success. And when I say *we* to this audience, I mean *we*.

I believe, however, that some hard decisions lie ahead about the shape and form of industry and its relationship with defence. Those decisions need to be made in the context of the direction that we need to take the ADF. I certainly think that one key area needs to be the question of the balance between domestic and international effort. We need, I think, to focus on support as offering the real opportunities for the creation of robust and prosperous national industry, rather than the more visible 'one off' major projects. We need to look hard at how we can achieve a balance between 'steady state' and a properly competitive environment. I know that the Defence Department and other areas

of government are working hard with industry on such questions, but I want you to be clear that the Navy and the other services are vitally involved because so much of our future warfighting capability depends directly upon a successful resolution. *We* need to be involved. *We* want to be involved.

The second relationship issue I want to raise concerns the warfighting approach of the Australian Defence Force. 'Jointery' has been very much a theme of the 1990s for the ADF and many other nations' armed services. Well, I think we need to go a lot further than that—a great deal further. Much of our approach to 'jointery', whether we realise it or not, is founded in a paradigm of World War II allied doctrine for mass amphibious warfare. It has worked well enough for many years, but the reality is that the way in which such 'jointness' has been approached for many years accepts a degree of duplication as a price for retaining individual service systems and procedures untouched.

The theme of the 2000s must be *integration*. I stress this theme because I think that one of the fallacies appearing in some quarters is the idea that there is a silver bullet which will solve the conundrum of maintaining capability on a limited budget. Without being exclusive, I specifically refer to C3I (command, control, communications and intelligence)—it won't substitute for a balanced military force—but it sure is an important enabler. Maintaining a national defence capability will *always* be about choices, but we must make those choices with one truth in mind—that the whole is greater than the sum of the parts.

Combat power will only be maximised if we can fuse capabilities from all environments. The defence force will only be the *flexible* and versatile tool that government requires if we have worked to maintain a range of capabilities, because the fundamental truth of this is that 'the wider the range of challenges present, the more options must be present'.

We heard something today of the issues arising from the idea of maritime manoeuvre in the Australian context. The clearest lesson for me is that you cannot, in a medium or small power, seriously consider that you have a national defence capability if you haven't worked through this problem of integration. There is much more to it than fused command and control—although this is fundamental. In an Australian context, the RAN is unlikely ever to get back into the big deck carrier game, so our need to integrate with the air force—and the army—for air warfare and strike capabilities is clear. The list goes on.

When I talk about integration, I do not mean here any deliberate reduction of individual service identities and ethos—although I suggest that new technologies and new methods of operation may mean the creation of new

identities and methods and the decline of others. After all, for example, the fighter pilot type—and all that we think of as a flying warfighting culture—is very much a creation of the air campaigns of the first and second world wars. I think that we are now seeing the emergence of a new culture of computer warriors and it will be fascinating to see how they meld with the existing cultures of the three services.

What I am suggesting with integration is that we need to be encouraging a much more sophisticated understanding in our personnel of what it is that all arms of warfare offer and can achieve. We need to raise our professional standards a step further and develop new and innovative ways of working together. It is essential for medium and small maritime powers to recognise that their own power is a function of the performance of the other services. This is very different to joint concepts of thinking.

The third area of relationships concerns that between friendly and allied services. My theme here is one of mutual dependence. As warfare becomes ever more complex and difficult, so the ability of a single nation or service to find all the answers diminishes. Some analysts suggest that smaller forces should go for 'niche' capabilities so that they will be able to make a credible contribution to coalitions. Well, I do not see a force structure centered on 'niche' capabilities as being a sensible approach for any nation that wants to preserve any capacity for independent action. As I said earlier, defence forces must be about presenting government with as wide a range of options as possible. There is much more to national security than coalitions.

My view about a 'niche' approach is that there is another aspect that does have validity. I believe that smaller navies are going to have to make choices between innovation—and the heavy demand on limited intellectual, financial and industrial resources which being a 'parent' service implies—and derivation, accepting largely unaltered the systems and platforms developed by others. I believe that this is the only way in which we have any chance of maintaining the range of warfighting capabilities that will be needed. Will it be possible for nations to co-operate to the extent that they can 'piggyback' off each other's efforts? Your mine warfare for my air warfare? Your electronic warfare for my undersea capabilities? This might be possible, but not at the expense of having an independent capability which the sovereignty of nation states still demands. But the cost of that independent action is still going up—when will it become unaffordable?

I don't propose to offer any answers here. Indeed, I am only suggesting possibilities. Such an end state will not be easy to achieve. It will require some hard thinking on the part of defence forces, governments and industries.

Furthermore, it will need, I believe, very different approaches to international co-operation than those that have tended to operate to date. There have been and are many successes in international groupings, but multinational combined projects sometimes develop a complexity and an inertia which spell trouble.

It seems to me that co-operation between nations in this way needs to focus on the totality of capabilities rather than specific platforms or systems, on intellectual property rather than particular equipment. How, in other words, can we determine where 'world's best practice' is in a particular area of warfare and how can we access it? Where can we achieve 'world's best practice' so that others can take a lead from us? Here, once more, is a question that will involve defence, government, science and industry in its resolution.

If I have left you with more questions than answers, that was my intent. We live in interesting times and I think that the year 2000 represents a watershed for the Australian Defence Force and the contribution that it will make to Australia's national security in the twenty first century. We will only meet the challenges of the new century if we try now to define the hard questions and find the right answers. The longer we delay in this process, the less our room for manoeuvre will be.

Thank you very much—I look forward to seeing you all tomorrow.

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