Operational and Technological Developments in Maritime Warfare:

Implications for the Western Pacific

Dick Sherwood
Editor

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ABSTRACT

There is a growing emphasis on maritime capabilities in the development of military forces in the Western Pacific region, particularly in Northeast and Southeast Asia. This reflects both the relative economic prosperity of the region and a growing concern over maritime security issues. Regional countries are seeking to take advantage of the technological developments which have occurred in recent decades in the field of maritime warfare; some are taking steps towards defining their force structures in terms of what can be built locally and what benefits can be gained for their economic development as a whole from transfers of technology.

For all regional navies new issues have arisen. There is the thorny question of balancing resources as well as the risk of opting for too high a military capability and being left with the wrong weapon in the wrong fight. Much of the new equipment entering regional force structures is based on state-of-the-art technology and it is necessary to develop the ability both to operate and to maintain it. New problems are faced: of training and management, of shore-side support, and of testing and evaluation. Technologies which lead to force structuring to suit the unique environment of the region also lead to increased rigour in defining missions, tasks and requirements, and ultimately to the refinement of doctrine and tactics.

This monograph is based on papers delivered at a seminar jointly hosted by the Royal Australian Navy's Maritime Studies Program and the Australian Naval Institute at HMAS *Watson*. It explores recent operational and technological developments in all aspects of maritime warfare - air, surface and sub-surface - and touches on many of the issues facing force planners in respect to the future of maritime security.

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Commander Dick Sherwood, RAN is the Director of Maritime Studies, RAN Maritime Studies Program, Canberra and the editor of *Maritime Studies* and *The Journal of the Australian Naval Institute*. He holds a BA and MDefStd from the University of New South Wales. He has served much of his twenty years in the RAN at sea and in the latter part of 1994 will assume command of a major Fleet Unit, after a brief sojourn as the inaugural visiting naval fellow at the Centre for Maritime Policy, Wollongong University.

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Dr Stan Weeks is a Senior Scientist with Science Applications International Corporation in McLean Virginia. Dr Weeks is a 1970 graduate of the US Naval Academy, who during his time in the US Navy served as Staff Operations Officer to STANAVFORLANT, Commanding Officer of USS *Hayler* (DD-997), CDE officer in the State Department Politico-Military Bureau and on the staff of the strategy faculty at the Naval War College, Newport RI. Dr Weeks has a PhD and MA in international studies from the American University, and is a member of the United Nations Maritime Experts Group.

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CONTENTS

FIGURES

ACRONYMS AND ABBREVIATIONS

2D	Two-Dimensional
3D	Three-Dimensional
AAA	Anti-Aircraft Artillery
AAW	Anti-Air Warfare
ADI	Australian Defence Industries Ltd
AEW&C	Airborne Early Warning and Control
AMASS	Australian Minesweeping And Surveillance System
ARM	Anti-Radiation Missile
ASS	Acoustic Signature Spectrum
ASuW	Anti-Surface (Shipping) Warfare
ASW	Anti-Submarine Warfare
ATE	Automated Test Equipment
AUP	Avionics Update Programme
AUSSYS	Australian Sonar Systems
BFC	Battle Force Combatants
BVD	Buoyant Vehicle Dyad
C^2	Command and Control
C^3	Command, Control and Communications
C^3I	Command, Control, Communications and Intelligence
CBU	Cluster Bomb Unit
CIWS	Close-In Weapon System
CODOG	Combined Diesel Or Gas turbine propulsion
CSBM	Confidence- and Security-Building Measure
DDG	Guided-missile destroyer
DEG	Guided-missile escort ship
DLM	Depot-Level Maintenance
DSTO	Defence Science and Technology Organisation
EC	Electronic Combat
ECCM	Electronic Counter Countermeasure
ECM	Electronic Countermeasure
EEZ	Exclusive Economic Zone
ELPHI	Electric potential field
EO	Electro-Optic
ESM	Electronic Support Measure

ETC	Electro-Thermal Combustion
ETOPS	Extended-range Operations
EW	Electronic Warfare
FFG	Frigate, guided-missile
FLIR	Forward-Looking Infra-Red
FSED	Full-Scale Engineering Development
GaAs	Gallium Arsenide
GDP	Gross Domestic Product
GMLS	Guided Missile Launch System
GMS	GEC-Marconi Systems
GNP	Gross National Product
GP	General-Purpose
GPS	Global Positioning System
HMAS	Her Majesty's Australian Ship
HME	Hull, Mechanical and Electrical
IR	Infra-Red
JORN	Jindalee Operational Radar Network
KDX	Korean destroyer development programme
LAN	Local Area Network
LANTIRN	Low-Altitude Navigation and Targeting Infra-Red system for Night
LASH	Lighter Aboard Ship
LCAC	Landing Craft, Air-Cushion
LFA	Low-Frequency Active
LGB	Laser-Guided Bomb
LLAD	Low-Level Air Defence
LPI	Low Probability of Intercept
LSM	Landing Ship, Medium
LST	Landing Ship, Tank
MAD	Magnetic Anomaly Detection
MAGR	Miniaturised Airborne GPS Receiver
MCM	Mine Countermeasure
MCMV	Mine Countermeasure Vessel
MOP	Magnetic Orange Pipe
MPA	Maritime Patrol Aircraft
MSDF	Maritime Self-Defense Force (Japan)
NAD	Non-Acoustic Detection
OPC	Offshore Patrol Combatant
OPV	Offshore Patrol Vessel
OTH	Over-The-Horizon

OTHR	Over-The-Horizon Radar
OTHT	Over-The-Horizon Targeting
PFG	Guided-missile patrol boat
Pk	Probability of kill
PLA-N	People's Liberation Army - Navy
PMC	Post-Ministerial Council
PRC	People's Republic of China
PRF	Pulse Repetition Frequency
PTF	Patrol torpedo boat, fast
PTFG	Large guided-missile motorboat
RAAF	Royal Australian Air Force
RAF	Royal Air Force
RAN	Royal Australian Navy
RAS	Replenishment At Sea
RCS	Radar Cross-Section
RMA	Reliability, Maintainability and Availability
RMN	Royal Malaysian Navy
RNZAF	Royal New Zealand Air Force
RO/RO	Roll On/Roll Off
ROV	Remotely Operated Vehicle
RTN	Royal Thai Navy
S&W	Space and Weight
SAM	Surface-to-Air Missile
SAR	Search And Rescue
SATCOM	Satellite Communications
SDM	Self-Defence Measure
SEAD	Suppression of Enemy Air Defences
SFC	Specific Fuel Consumption
SIGINT	Signals Intelligence
SLAM	Standoff Land Attack Missile
SLOC	Sea Lanes Of Communication
SSBN	Nuclear-powered ballistic-missile submarine
SSM	Surface-to-Surface Missile
SSN	Nuclear-powered attack submarine
STANAVFORLANT	Standing Naval Force, Atlantic
STIR	Separate Track and Illumination Radar
STOVL	Short Take-Off and Vertical Landing
SURTASS	Surveillance Towed-Array Sonar System
SUW	Surface Warfare
TARPS	Tactical Air Reconnaissance Pod System

UAV	Unmanned Aerial Vehicle
UNCLOS	United Nations Convention on the Law of the Sea
US	United States
USAAF	United States Army Air Force
USAF	United States Air Force
USN	United States Navy
USS	United States Ship
VDS	Variable-Depth Sonar
VIP	Very Important Person
VLS	Vertical Launch System
VMAO	VSTOL-type follow-on Marine Attack/Observation
VSTOL	Verticle or Short Take-Off and Landing
WSSF	Weapons System Support Facility

INTRODUCTION

Commander Dick Sherwood, RAN

There is a growing emphasis on maritime capabilities in the development of military forces in the Western Pacific region, particularly in Northeast and Southeast Asia. This reflects both the relative economic prosperity of the region and a growing concern over maritime security issues. Regional countries are seeking to take advantage of the technological developments which have occurred in recent decades in the field of maritime warfare.

While some of these developments are beyond the financial and technical capacity of some regional countries, there are others which are within reach. This has led to some closing of the technological gaps which existed previously between regional and extra-regional navies.

Additionally, some nations in the region, including Australia, are taking steps towards defining their strategic requirements and force structures in terms of what can be built locally and what benefits can be gained for their economic development as a whole by the means of transfers of technology. This is a significant shift from past practice of buying largely North Atlantic/European sensor/weapon systems, and reflects the many developments that have occurred over the last decade, especially in the fields of:

- integrated computer systems and distributed management systems;
- increasing role adaptability from primary designs;
- modular construction, allowing broader options for construction/maintenance and repair/modification;
- potent but simple-to-fit sophisticated weapon systems;
- new materials allowing common hull/airframe shapes;
- system solutions that are readily transferable between surface ships, submarines and aircraft; and

- the increased transfer of military and commercial technologies.

For all regional navies, there is the thorny question of balancing resources (time, men, money and material) as well as the risk of opting for too high a military capability and being left with the wrong weapon for the wrong fight.

Much of the new equipment entering regional force structures, including Australia's, is based on state-of-the-art technologies, and all countries are going to have to develop the skill and ability to operate and maintain those systems. In terms of developments in both surface and sub-surface combatants, the trend is increasingly towards lower manning, requiring the development of multi-skilling and improved management techniques. There are also the problems of training, of shore-side support and of testing and evaluation. Technologies which lead to force structuring to suit the unique environment of our region also lead to increased rigour in defining missions, tasks and requirements, and ultimately to the development of doctrine and tactics applicable to using the sensors and weapon systems that have been adapted to operate in that environment.

This monograph attempts to address some of these issues. It is a collection of papers delivered at a seminar on Operational and Technological Developments in Maritime Warfare - Implications for the Western Pacific, jointly hosted by the RAN's Maritime Studies Program and the Australian Naval Institute at HMAS *Watson* in May 1993. The papers explore recent operational and technological developments in all aspects of maritime warfare (air, surface and sub-surface) and touch on many of the issues facing force planners in respect to the future of maritime security. The perspective is primarily Australian, although in the fields of developments in naval aviation and submarines the two papers are by eminent US strategic thinker and naval commentator Dr Stanley Weeks, of Science Application International Corporation.

PART I

THE STRATEGIC ENVIRONMENT

CHAPTER 1

THE POST-COLD WAR MARITIME STRATEGIC ENVIRONMENT IN THE WESTERN PACIFIC

Ross Babbage

Introduction

The maritime strategic environment in the Western Pacific is changing rapidly. The Cold War has gone and with it the threat of global war and many of the deep-seated frictions of the past. This is unquestionably a positive development for international security. However, with the end of the Cold War, much of the predictability and comparative simplicity of the post-Second World War era has also gone. To the extent that the Cold War was ever the 'good guys' versus the 'bad guys', we now see many more shades of grey.

In the Western Pacific, the United States and Russia now have rather different and less central roles to play. Their military presences are reducing and changing in nature and so are their primary interests in the region. Coinciding with this changed superpower role, we are seeing the rapid rise of a number of regional powers that are demonstrating very rapid rates of economic growth and new levels of competition.

This combination of a changing power balance, greatly increased regional wealth and high levels of uncertainty is encouraging some development and modernisation of regional military forces. In the maritime environment, many countries are acquiring new-technology ships and aircraft and, despite the high prices of such systems, unit numbers are generally being maintained and, in many cases, rising.

Clearly we are witnessing the emergence of a new international order in the Western Pacific. It is characterised by increased levels of uncertainty, fluidity and, in many respects, greater complexity.

In this changing environment it would be dangerous to assume 'business as usual'. Many of the assumptions inherited from the past may no longer be valid. However, the emerging security environment in this theatre is not all bad news. Because of the fluidity of the regional security environment, many regional countries are reviewing their security positions and there are unusual opportunities to influence the shape of the new security framework that is emerging.

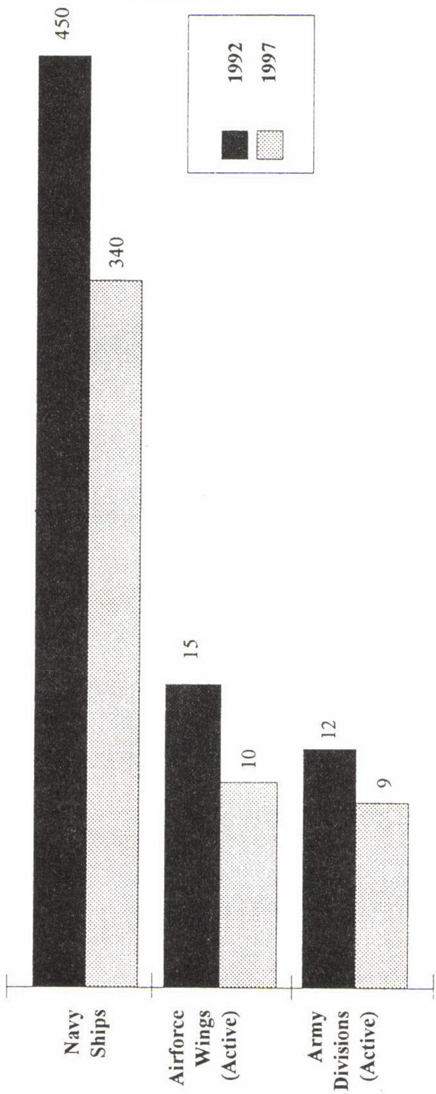
So on the one hand this is a time of change, uncertainty and potentially greater insecurity. On the other hand, however, it is also a time of opportunity; for exploring the potential to build an environment of improved security, of closer dialogue and of expanded cooperation.

Major Elements of Change

The Changed Role of the United States

The collapse of the Soviet Union, the dissolution of the Warsaw Pact and agreement between United States and Russia on several far-reaching arms reduction treaties has led to the announcement by both of those countries of massive cuts in their defence budgets and forces. Figure 1:1 gives some sense of the scale of the reductions underway in the United States' military forces. Figure 1:2 highlights the downward trend of US forces deployed in the Western Pacific. If we exclude forces that were deployed for the Vietnam War, US military personnel deployed in East Asia and Southeast Asia are now at lower levels than at any time since 1970. The trend in US naval forces in the Pacific is also in a generally downward direction, as can be seen from Figure 1:3. During the mid-to-late 1990s, this pattern of reduced US naval force deployment is likely to continue, at least for a time.

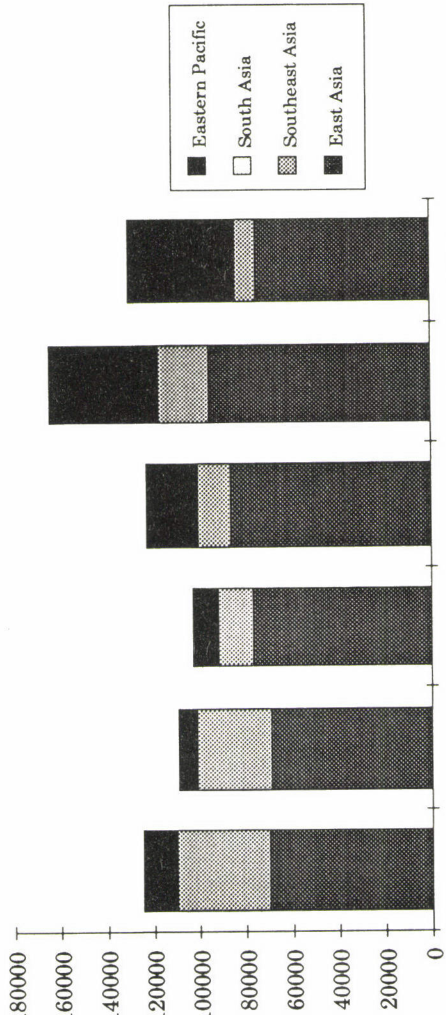
Figure 1:1
Proposed Cuts in US Military Forces
1992-1997



Source: William Matthews, 'Aspin Base Force Would Be Smaller, Lighter, and Faster', *Air Force Times*, 4 January 1993, p.3.

Figure 1:2

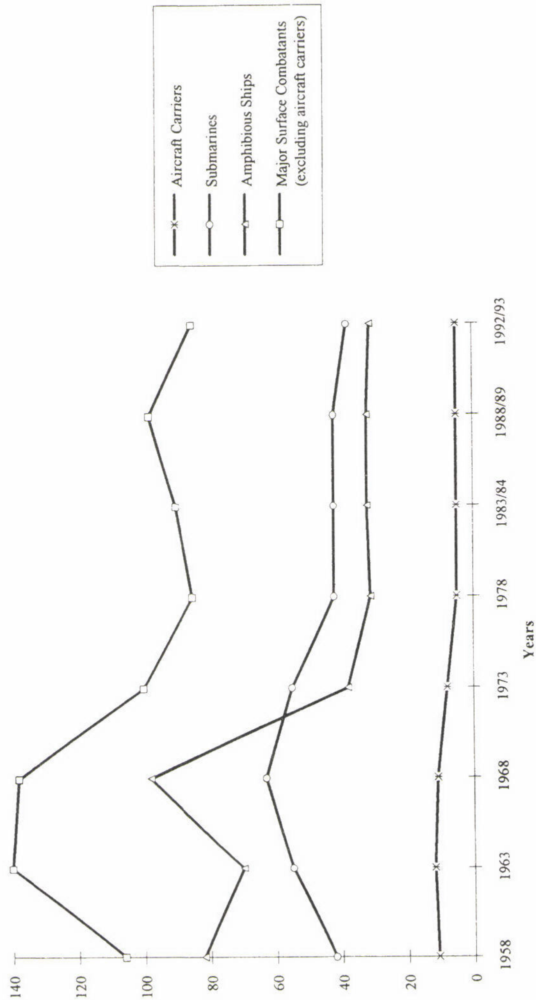
The Changing US Military Presence in the Asia-Pacific Region



Note: 1970 figures exclude 389,000 ground troops in Vietnam and 75,000 air force personnel in direct support of operations in Vietnam. Figures for Oceania are 250, 700 and 700 in 1985, 1990 and 1992 respectively.

Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1970-1992/93).

Figure 1:3
Trends in US Naval Forces in the Pacific
1958-1992



Sources: Anthony Preston, 'The Changing Balance in the Pacific', *Jane's Defence Weekly*, 20 September 1984, pp.548-550; *The Military Balance 1984-85* (The International Institute for Strategic Studies, London, 1984), pp.3,7,9; *The Military Balance 1988-89* (The International Institute for Strategic Studies, London, 1988), pp.18-29; *The Military Balance 1992-93* (The International Institute for Strategic Studies, London, 1993).

Nevertheless, the United States certainly remains the strongest military power in the Western Pacific by far, and its pattern of reduced forward basing has not eroded significantly Washington's capability to surge forces into future Western Pacific trouble spots. Forward staging facilities are, of course, readily available to US forces in Japan, South Korea, the Philippines, Singapore, Thailand, Indonesia and Australia. This concept of forward *places not bases* is very workable in operational terms and may save the US taxpayer considerable sums of money.

However, simply arguing that the United States remains the most powerful country in the Pacific overlooks several critical issues.

First, the demise of the USSR has had the effect of lifting much of the discipline for commitment on Washington that was imposed by the existence of a competing superpower. Much of the military-strategic 'glue' holding the United States to the Western Pacific has now dissolved. So the reducing US presence in the region is being reinforced by a parallel reduction in the United States' *inclination* to become involved in the future.

There are now widespread doubts throughout Asia about the preparedness of the Clinton and subsequent administrations to commit forces to this region in many circumstances of future tension or conflict. Special concerns relate to the reticence of the United States to commit forces for peacekeeping operations in Cambodia and to support regional countries in the event of increased tensions in the South China Sea. In consequence, many regional countries are reassessing the assumptions they have made in the past about the United States. Certainly the perceived value of many of the United States' alliance linkages in the Pacific has changed.

The Changed Russian Role

The Russian role in the region has changed even more radically. The rise of Russian democracy, the survival of President Yeltsin, and the growth of genuine cooperation and even partnership between Moscow and the West, have diminished greatly regional perceptions of a Russian military threat.

The trend in Russia's Pacific Fleet is also downwards, as can be seen from Figure 1:4. These numerical projections do, however, understate the real reduction in Russian operational capability over the last five years. Many elements of the Pacific Fleet are unmaintained and training levels for most units are low. Unless there is a dramatic change in Moscow, the role of Russian maritime power in the Western Pacific is likely to be greatly reduced for at least the next twenty years.

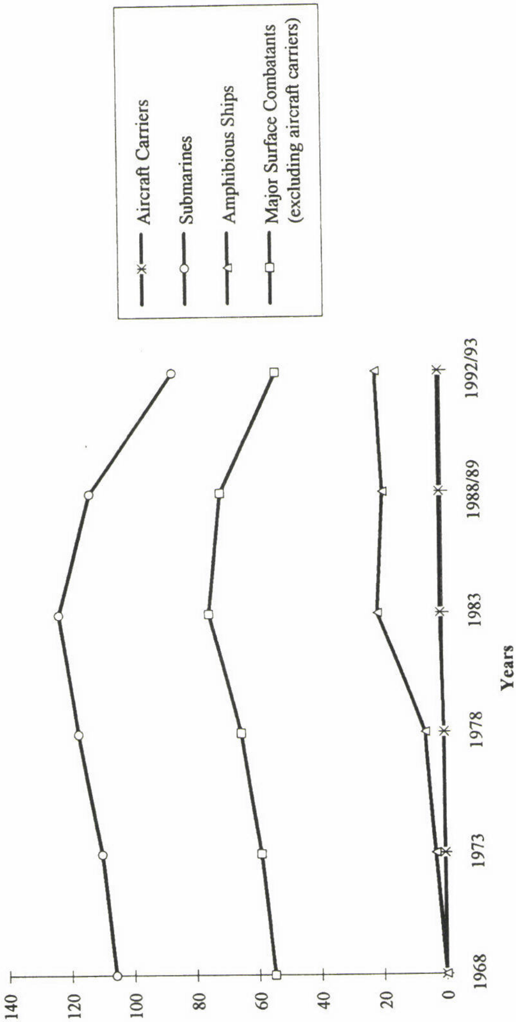
The Rising Role of Regional States

While the role of the superpowers in the Western Pacific is changing, and in most respects reducing, many regional countries are rising to much greater prominence. This is largely a consequence of the spectacular rates of economic growth that many of the countries in this region have been able to sustain over the last twenty years. Figure 1:5 shows that during the last quarter-century several of these countries have maintained growth rates of over 6 per cent per annum. Moreover, Figure 1:6 shows that this economic growth has not merely been a consequence of rapid population increases. GNP per capita grew strongly in most of these countries. An examination of international bank reserves reinforces this trend. In 1980, Asian banks held one-sixth of world central bank reserves. They now hold two-fifths and are rapidly approaching one-half. Significantly, the Asian region now holds the largest single reserve of international investment funds.

It is not just these countries' economic growth and the rapid rise of their foreign currency holdings that has been remarkable. Also noteworthy has been the dramatic modernisation and technological development of most of these countries' industries. Their manufacturing, transport, communications and other infrastructures have been developed very substantially. Several of their research institutes and sectors of industry are now operating at the forefront of technology. Most of them possess industrial sectors that are extremely competitive and have very good prospects for the future.

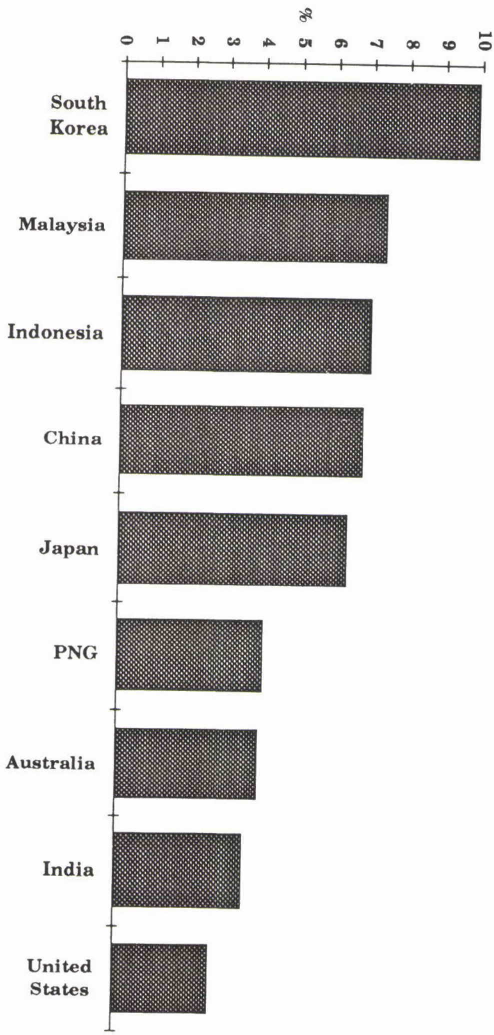
In the analogy of human growth, Asia could be said to be young, still at school, saving diligently and investing and building for tomorrow. By contrast, the economies of the United States and Australia have matured, taken on debt and are ageing rapidly.

Figure 1:4
Trends in the Russian Pacific Fleet



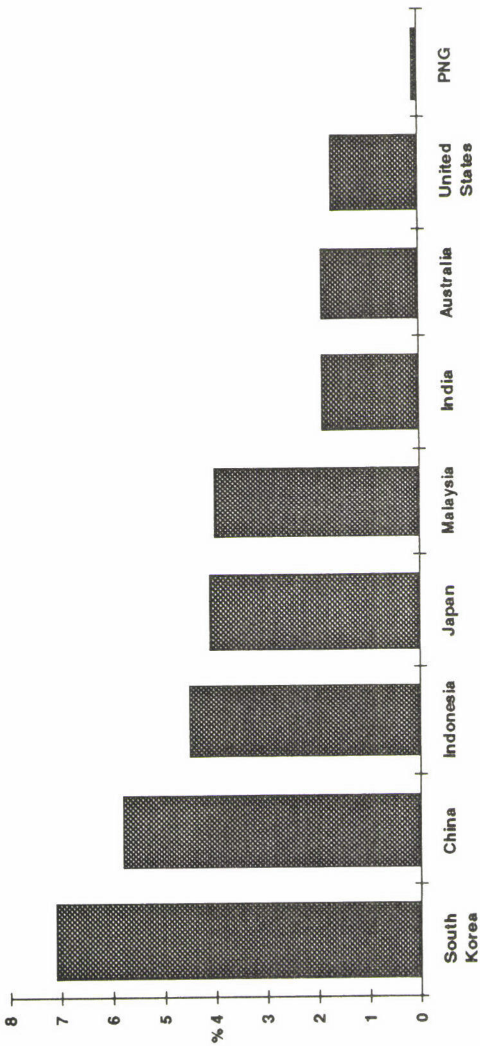
Sources: Anthony Preston, 'The Changing Balance in the Pacific', *Jane's Defence Weekly*, 20 September 1984, pp.548-550; *The Military Balance 1984-85* (The International Institute for Strategic Studies, London, 1984), pp.3,7,9; *The Military Balance 1988-89* (The International Institute for Strategic Studies, London, 1988), pp.43-44; *The Military Balance 1992-93* (The International Institute for Strategic Studies, London, 1993).

Figure 1:5
GDP Growth in the Asia-Pacific Region
(average annual percentage rate, 1965-1990)



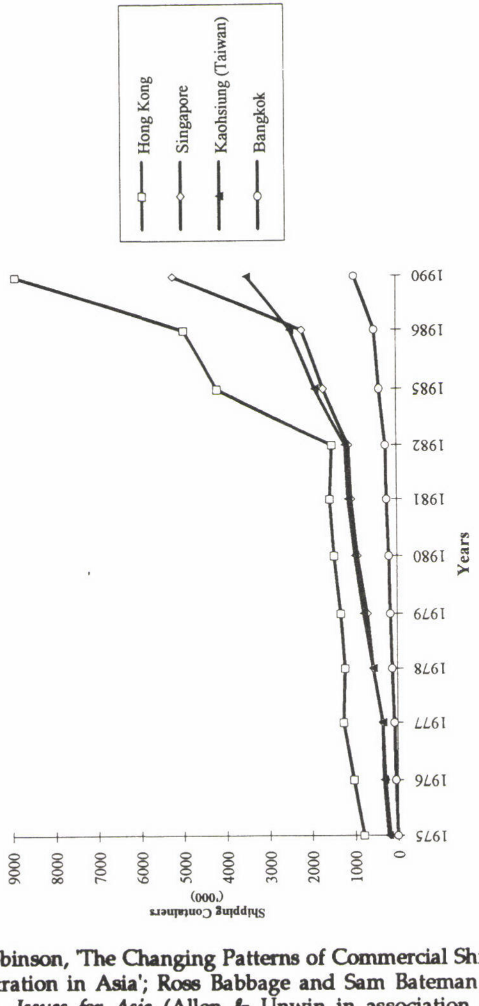
Source: World Bank, *World Development Report 1992* (Oxford University Press, New York, 1992), pp.220-221.

Figure 1:6
GNP Per Capita Growth in the Asia-Pacific Region
(average annual percentage rate, 1965-1990)



Sources: World Bank, *World Development Report 1992* (Oxford University Press, New York, 1992), pp.218-219.

Figure 1:7
Growth in Container Traffic in Selected Asian Ports
1975-1990



Sources: Ross Robinson, 'The Changing Patterns of Commercial Shipping and Port Concentration in Asia'; Ross Babbage and Sam Bateman (eds), *Maritime Change: Issues for Asia* (Allen & Unwin in association with the Royal Australian Navy and Australian Defence Industries Ltd, Sydney, 1993), p.77; and 'Containerisation in Parts of Third-World China: An Overview of Present Patterns and the Direction of Future Growth', *Maritime Policy and Management*, Vol.12, No.4, 1985, p.264.

The extraordinary economic dynamism of the Western Pacific has numerous maritime dimensions. In terms of commercial shipping, the so-called 'iron highway' through the Malacca Straits now carries over 600 ships per day and several other major shipping routes in the region display comparable congestion.

Figure 1:7 shows the growth of container traffic through several Western Pacific ports in the period from 1975-1990. Hong Kong and Singapore are now the world's two largest container ports. In 1990 this region handled a total of about 28 million containers. This compares to the US west coast's 7 million containers and the combined total for all Australian ports of only 1.7 million containers.

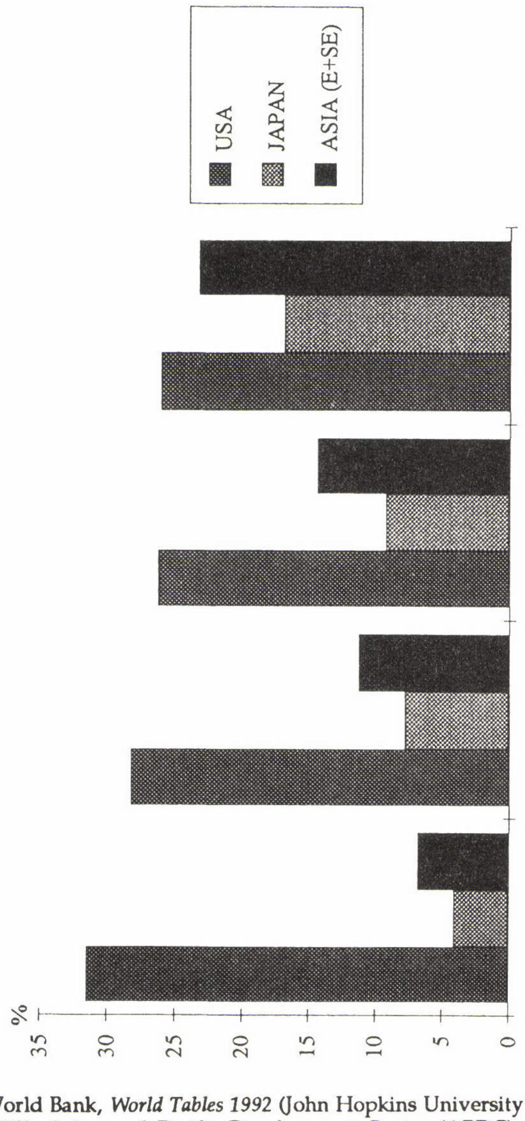
Moreover, this region seems likely to continue its world-leading rates of economic growth well into the next century. Some speculative projections suggest that, should present trends persist, the economies of the United States, Japan and China may be of roughly equal size by the year 2020. Whether these projections prove accurate or not, the balance is clearly shifting rapidly, as can be seen in Figure 1:8. In an era when economic power is becoming the predominant currency of global power, the Western Pacific could be said to be in the 'box seat'.

The Pattern of Western Pacific Defence Expenditures

The growing strength of regional countries and their concerns about the increased uncertainties and greater fluidity in the international environment are apparent from their substantial military investments. In the Western Pacific region there is currently little thought of paying peace dividends. The general trend is for defence expenditures to be maintained or increased in real terms, as can be seen in Figure 1:9.

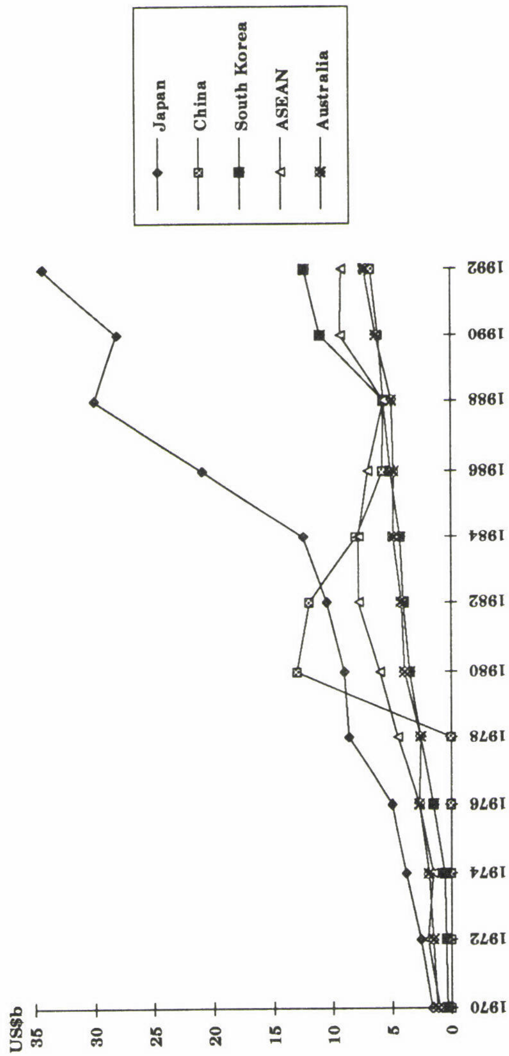
The increasing strength and influence of these rising Asian powers, when combined with the falling regional influence of the two superpowers, is creating a very different strategic environment from the 1960s and 1970s. Regional power is much less concentrated, there are more countries with a substantial capacity to influence regional security and there is a rising sense that many regional governments now have more freedom to exert pressure, including military pressure, in their immediate regions. As we shall see, these trends are starting

Figure 1:8
Relative Percentage Shares of World GDP



Sources: World Bank, *World Tables 1992* (John Hopkins University Press, Baltimore, 1992); Asian and Pacific Development Centre (APDC), *Asian and Pacific Economy Toward the Year 2000* (APDC, Kuala Lumpur, 1987).

Figure 1:9
Trends in Regional Defence Expenditure in Selected Countries 1970-1992 (in current $USb)



Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

to be reflected in the size and nature of the naval forces that are being deployed here.

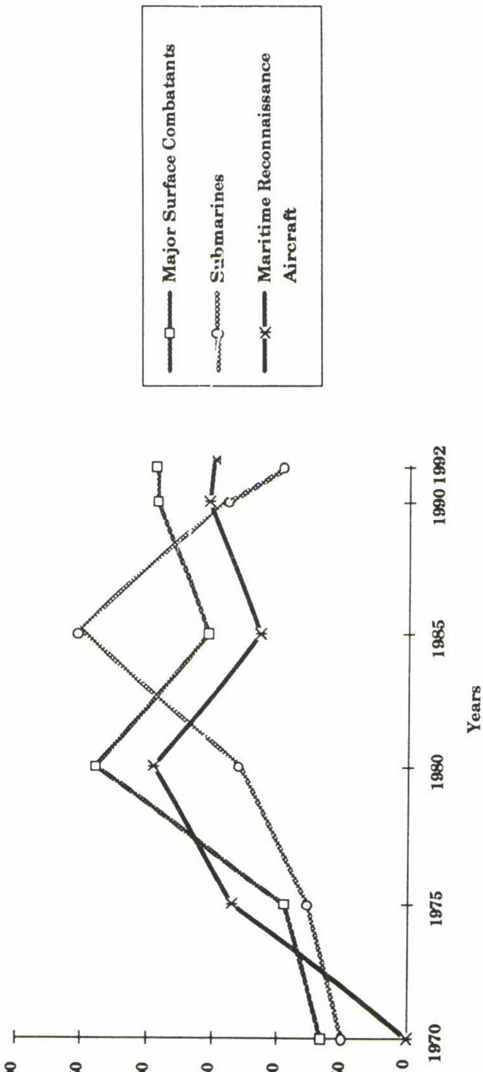
Trends in Regional Maritime Forces

Figures 1:10 and 1:11 show the long-term trends in naval forces deployed by the states of East and Southeast Asia. Figures 1:12 to 1:19 show the country holdings of major surface combatants, submarines, maritime reconnaissance aircraft and combat aircraft in East Asia and Southeast Asia in 1992. Figures 1:20-1:27 show the trends in the holdings of major surface combatants, submarines and maritime reconnaissance aircraft in Japan, China, North Korea, South Korea, Taiwan, Vietnam, the member countries of ASEAN combined, and in Australia.

These numerical comparisons do not, of course, tell the complete story. In particular, the quality of the capabilities maintained by these countries varies greatly. For instance, if we compare the submarine forces operated by China and Japan we can see a stark contrast. China's submarine force is almost three times the size of that operated by Japan, but 33 of its 46 boats are ageing 1950s-vintage Romeo-class vessels with very limited capabilities. By contrast, Japan's submarines rate amongst the most advanced conventionally powered boats in the world.

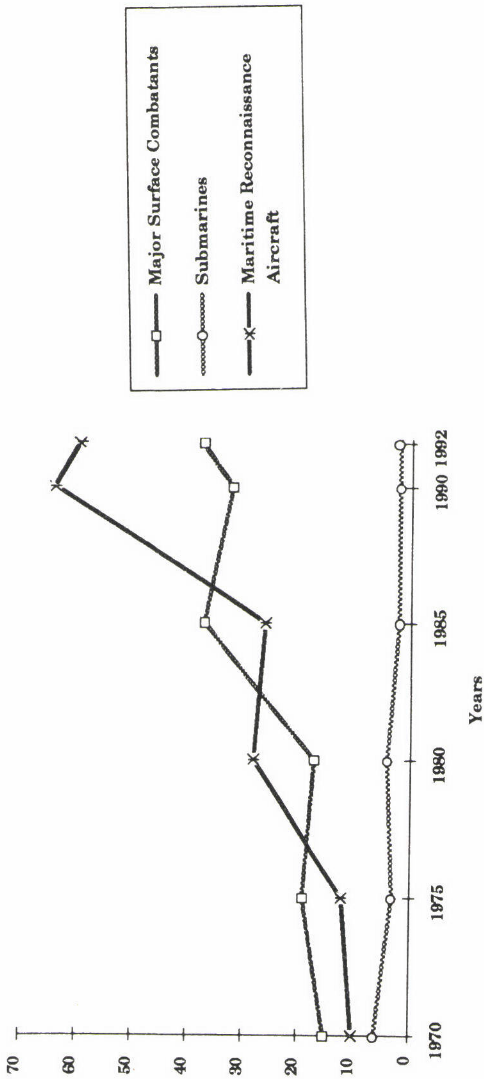
In general, however, most of the new naval combatants now being deployed in the Western Pacific are at, or close to, the state of the art for their generic type. The Japanese Kongo-class Aegis destroyers have combat capabilities comparable to those of the United States' Arleigh Burke-class Aegis destroyers. The new conventional submarines being brought into service by Australia, South Korea, Taiwan and Japan all have advanced sensor suites and long-range torpedo and anti-ship missile launching capabilities. Even many of the smaller patrol craft being introduced into regional navies carry anti-ship missiles and relatively sophisticated command and control systems. Moreover, the simple numerical comparisons in the figures do not display the very substantial advances many regional countries have made in areas such as maritime intelligence collection and assessment, wide-area surveillance, maritime command and control and in local supply, repair, refit and broader logistic support.

Figure 1:10
Trends in East Asian Naval Forces
1970-1992



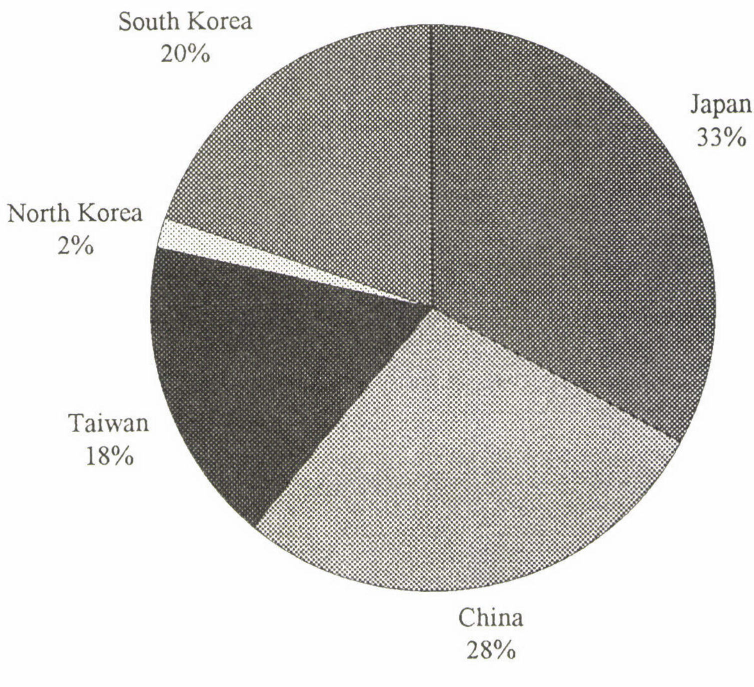
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:11
Trends in Southeast Asian Naval Forces
1970-1992



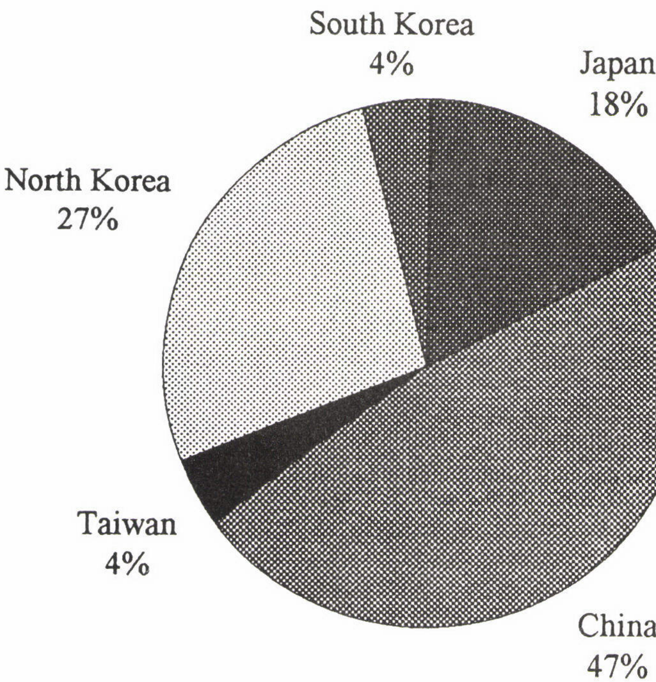
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:12
Distribution of Major Surface Combatants in East Asia
1992



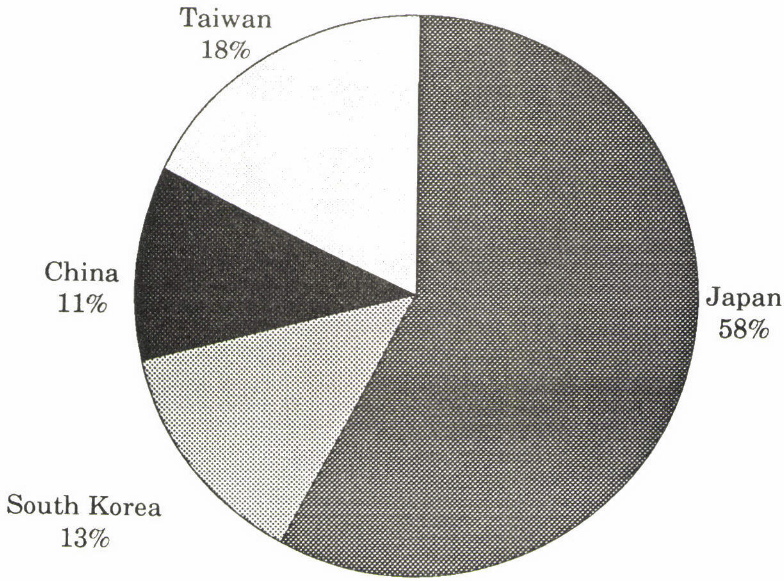
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:13
Distribution of Submarines in East Asia
1992



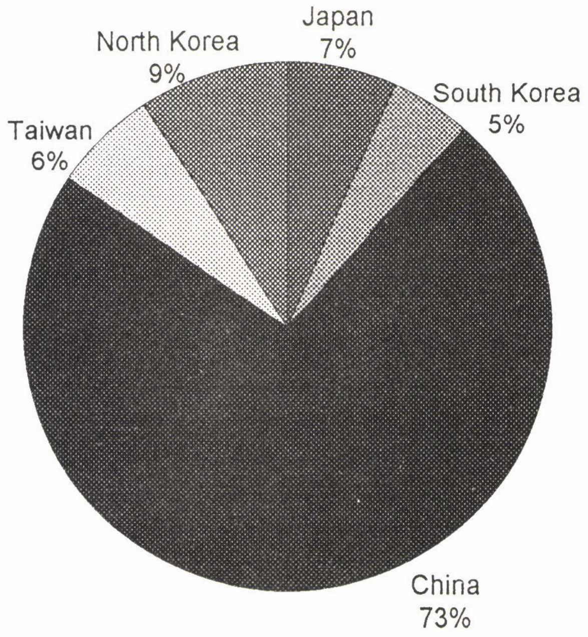
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:14
Distribution of Maritime Reconnaissance Aircraft in East Asia
1992



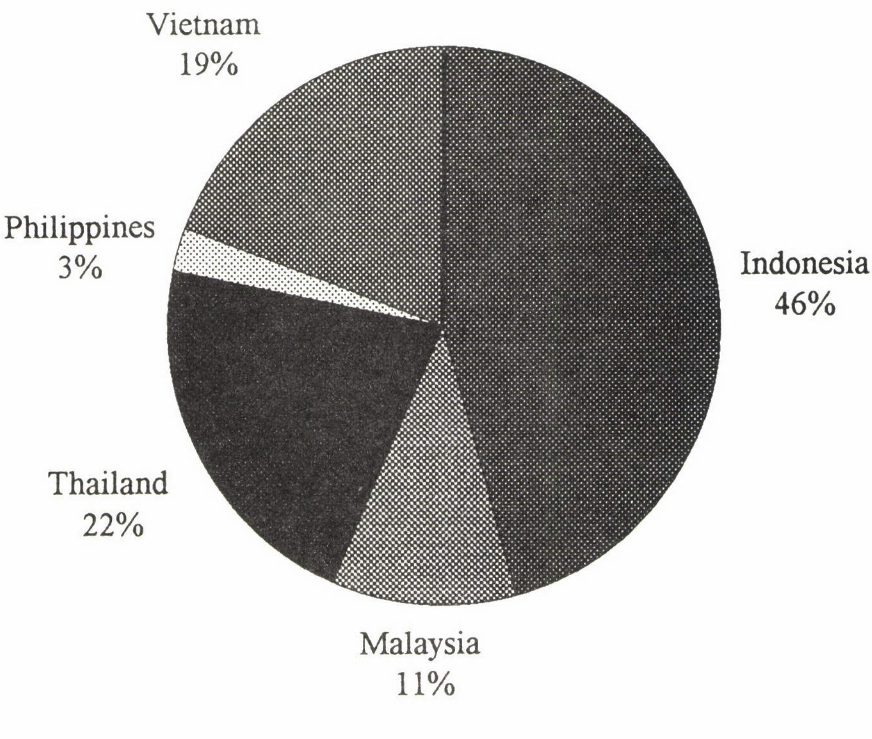
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:15
Distribution of Combat Aircraft in East Asia
1992



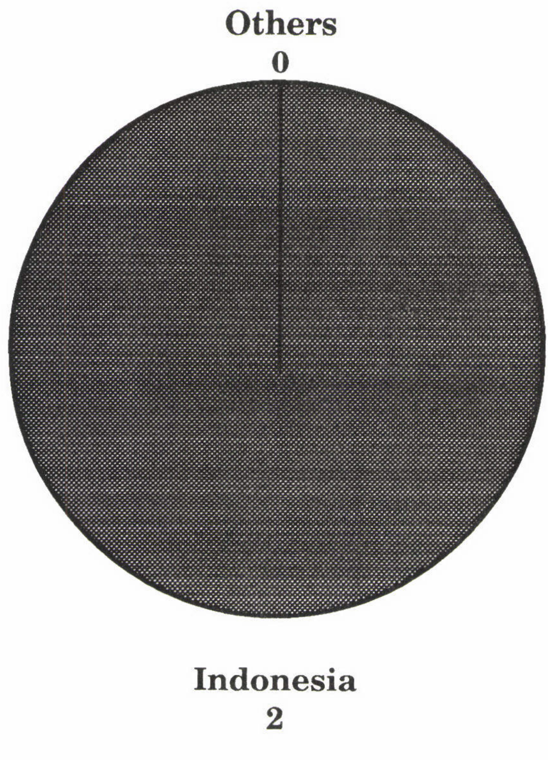
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:16
Distribution of Major Surface Combatants in Southeast Asia
1992



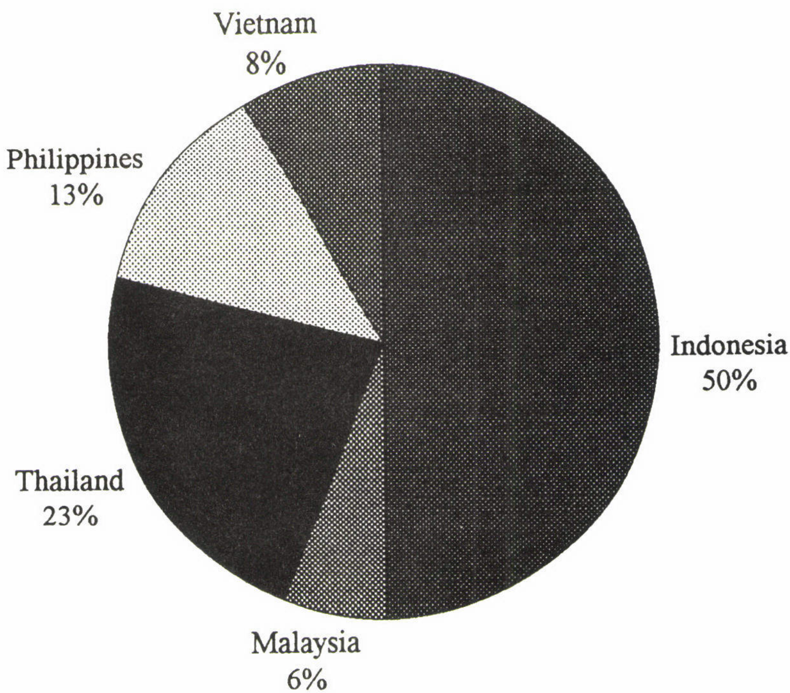
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:17
Distribution of Submarines in Southeast Asia
1992



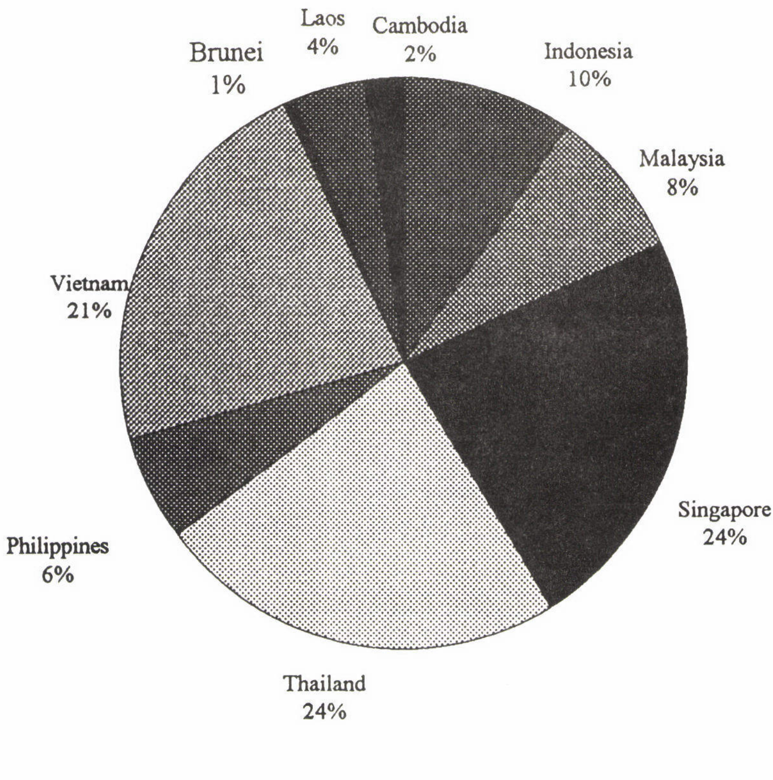
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:18
Distribution of Maritime Reconnaissance Aircraft in Southeast Asia
1992



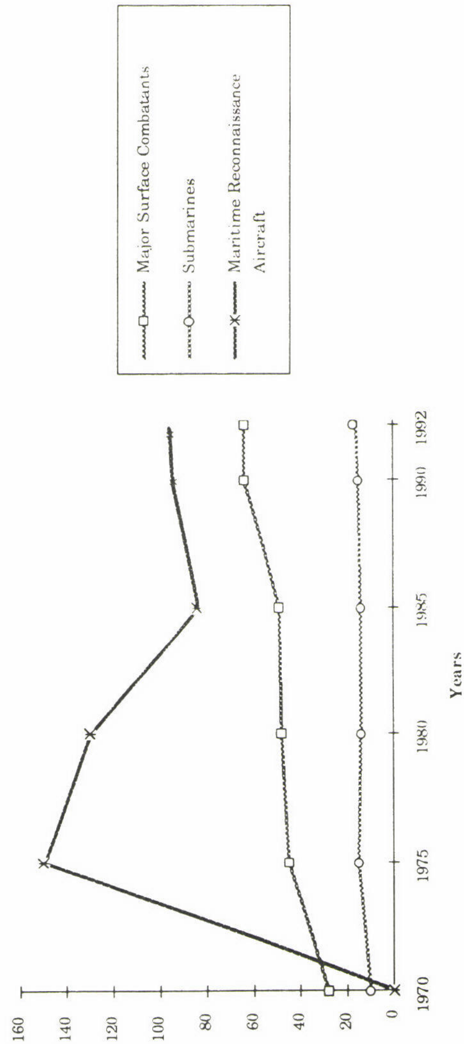
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:19
Distribution of Combat Aircraft in Southeast Asia
1992



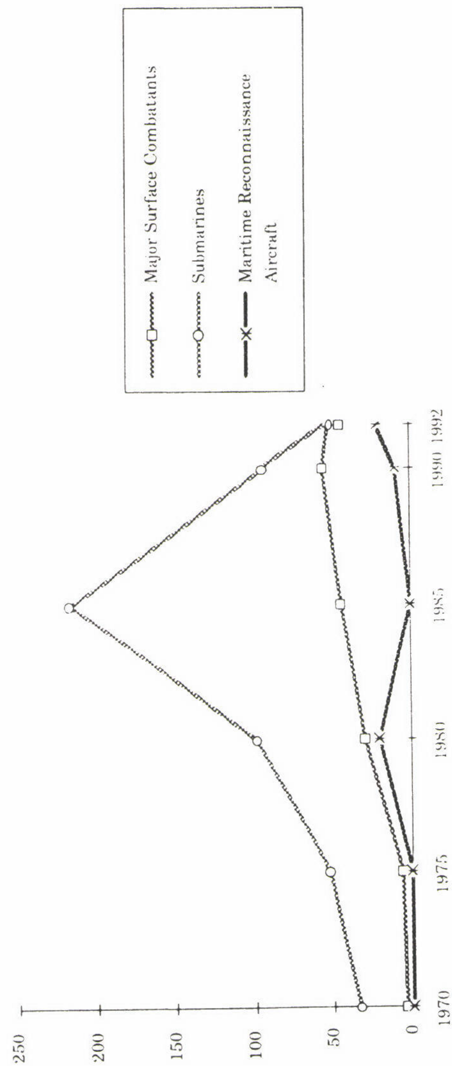
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:20
Trends in Japanese Naval Forces
1970-1992



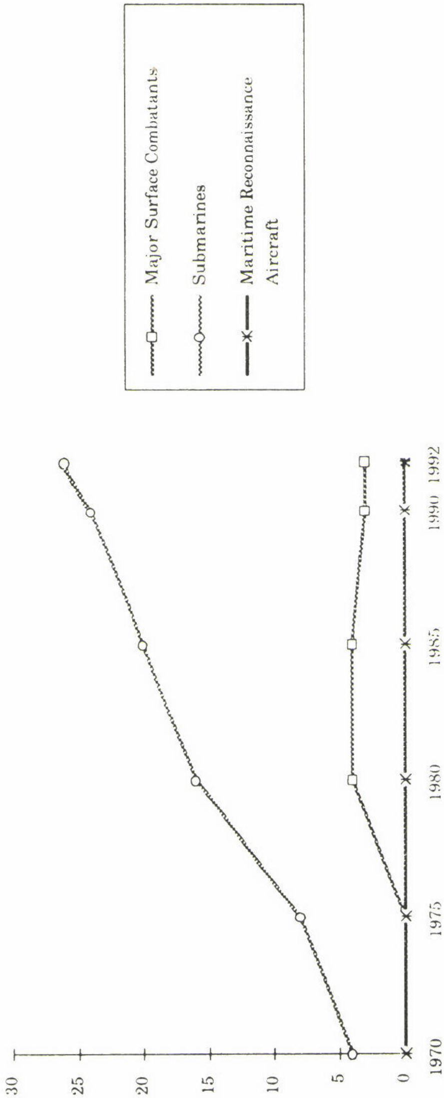
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:21
Trends in Chinese Naval Forces
1970-1992



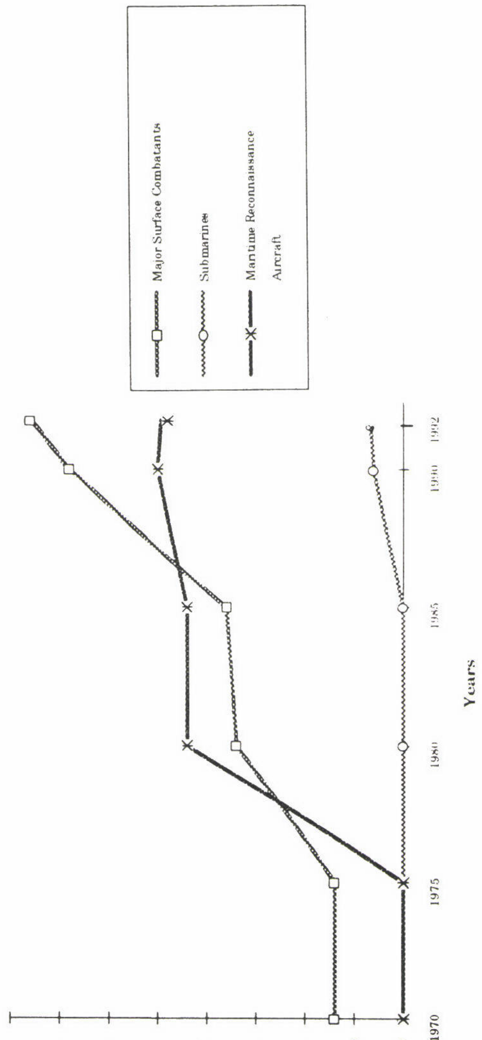
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:22
Trends in North Korean Naval Forces
1970-1992



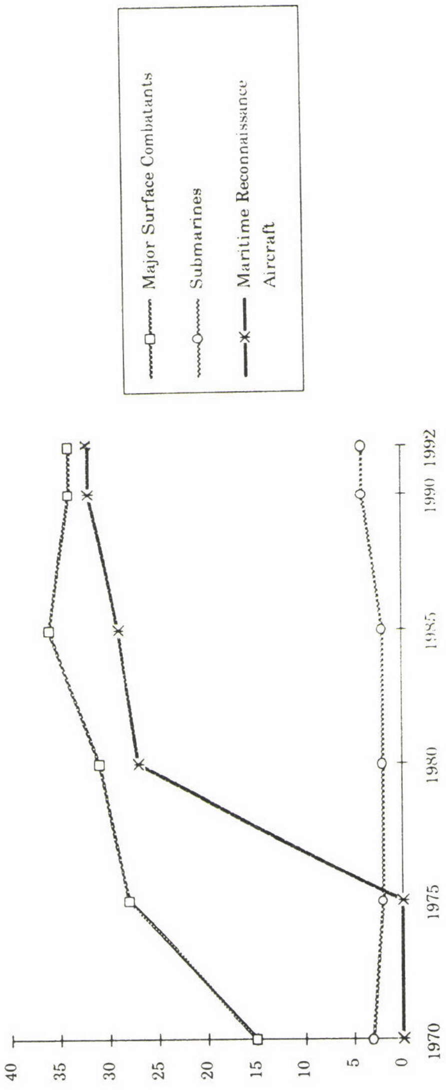
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:23
Trends in South Korean Naval Forces
1970-1992



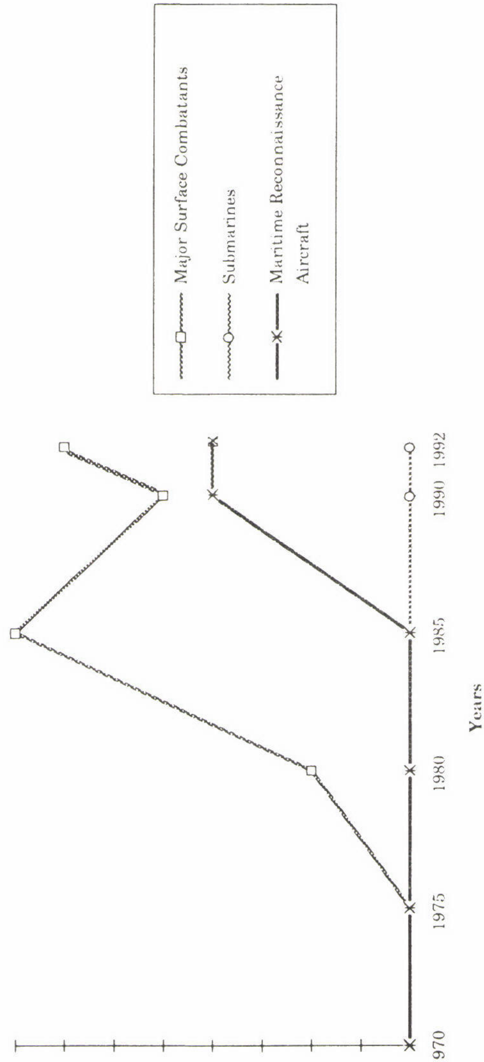
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:24
Trends in Taiwanese Naval Forces
1970-1992



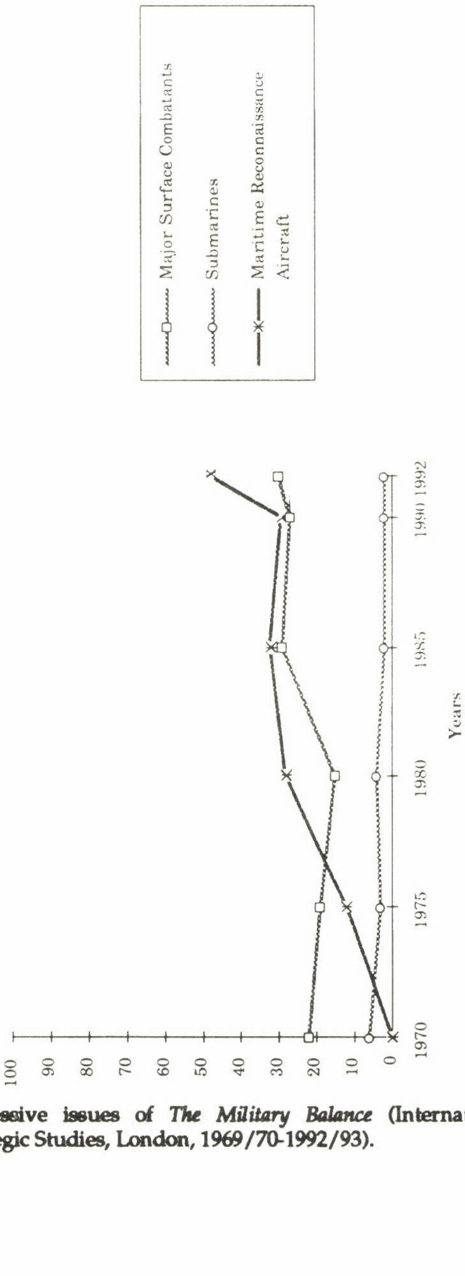
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:25
Trends in Vietnamese Naval Forces
1970-1992



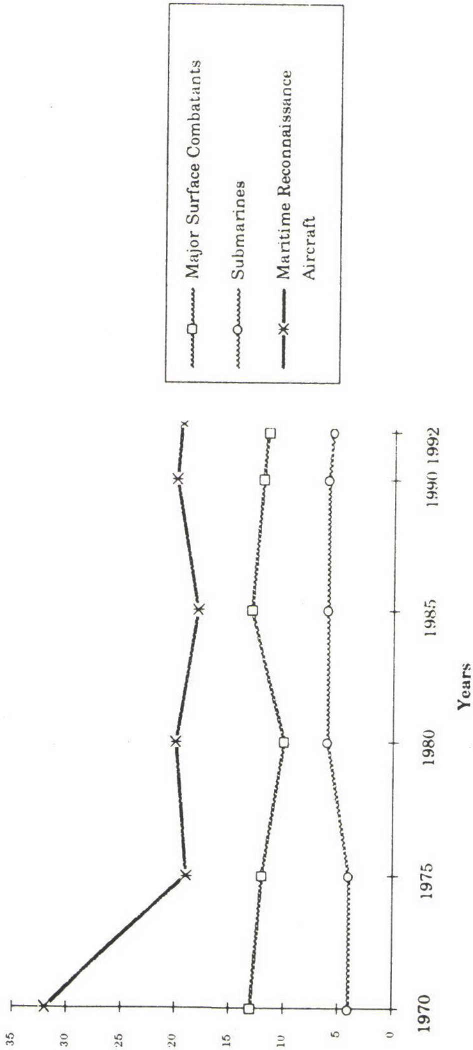
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:26
Trends in ASEAN Naval Forces
1970-1992



Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

Figure 1:27
Trends in Australian Naval Forces
1970-1992



Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1969/70-1992/93).

These developments are contributing to the development by any Western Pacific countries of maritime forces that are far more capable than those of the 1980s.

The Maritime Strategic Environment in the late 1990s

In combination, these factors suggest that the Western Pacific maritime environment of the late 1990s will be significantly different to that of the 1970s and 1980s. The superpowers, while still powerful, will clearly be less central to regional strategic concerns. This coincides with a general increase in security uncertainty and a growth in the scale and quality of most regional defence forces. It is perhaps salutary to note that Japan now has more frigates and destroyers in the Pacific than the United States, twice as many combat aircraft and twice as many regular army and marine corps personnel. Force relativities are clearly changing, and the Clinton administration's planned further cuts to US forces appear likely to exacerbate this disparity.

While there is general unease in the region about many of these trends, there is no sign at present that Japan, China or any other major player plans to use its maritime forces to dominate the region. Most countries are carefully tailoring their forces to their specific maritime circumstances. Nearly all are focusing on short-to-medium-range maritime denial capabilities, combining a mix of surface and air assets and, in some cases, submarines as well.

No Western Pacific country currently possesses the maritime capabilities that would be required to project and sustain substantial military power over long distances. In particular, none has the capabilities to project independently and sustain major surface combatants into a heavily defended environment beyond the range of supporting land-based aircraft.

While these observations suggest that major conflict at sea is unlikely in this region in the late 1990s, the potential for harassments, exchanges of fire and even serious regional clashes cannot be excluded. In fact, given the numerous maritime disputes that remain unresolved in the Western Pacific, the possibility of active hostilities before the end of the decade in the South China Sea and possibly elsewhere cannot be excluded.

These circumstances certainly suggest a need to consider carefully the risks of conflict and the potential consequences of it arising. But they also highlight the importance of focusing on the potential for conflict avoidance and closer regional security cooperation.

The Scope for Maritime Cooperation and Confidence Building

One of the positive aspects of the rapid pace of change in the Western Pacific is that most, if not all, countries of the region are reassessing their security and, for the present at least, seem unusually open to new forms of dialogue and new security approaches. This provides a fertile environment for expanded maritime cooperation and confidence building.

Indeed, we have recently seen some important advances. For the first time, the ASEAN Post-Ministerial Council (PMC) included a range of security issues on its agenda at its meeting in Manila in July 1992. This wide-ranging discussion considered the security situation in the South China Sea, the changing US military role in the region, the overseas deployment of Japanese peacekeeping forces and the Cambodian situation. For an organisation that has, in the past, focused heavily on economic, social and political cooperation, and has shown a deep aversion to security issues, this was a significant advance.[1]

Many countries in the region are also taking modest steps to put more information concerning their security plans on the public record, to be more open to dialogue and to share more information. Intelligence exchanges are now more frequent, and in some cases continuous, between regional countries. Shared intelligence now covers not only military matters, but criminal, customs, immigration and other concerns.

The network of combined military exercises is also expanding. These continue to be mostly bilateral but there is a noticeable relaxation by some countries of, especially some ASEAN countries, of their previous reservations about sharing each other's sea and air space and exercise and range facilities.

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1 For a useful discussion of these and related developments, see Commodore Sam Bateman, RAN, 'Build a West Pac Naval Alliance', *United States Naval Institute Proceedings*, Vol.119/1/1079, January 1993, pp.77-82.

Several important initiatives have also been launched to foster regional discussions on maritime issues. The first biennial Western Pacific Naval Symposium was held in Sydney in 1988 bringing together senior naval officers from the ASEAN countries, China, Japan, South Korea, the United States, Australia, New Zealand and Papua New Guinea. These symposiums have fostered useful discussion and a network of personal friendships. They also promise potentially valuable spin-off activities. A subsidiary workshop was held by naval representatives in July 1992 to discuss procedures for the exchange of information on maritime activities of common concern.

A parallel very successful initiative was the conference held in Sydney in November 1991 on Maritime Change: Issues for Asia. This was jointly hosted by Vice Admiral MacDougall and Ken Harris, the Managing Director of ADI. It brought together senior naval officers from most Asian countries and leading maritime specialists for an intensive two-day exchange on a range of priority subjects.[2] The friendliness and camaraderie that began at this conference continues in various forms.

For the future, there is a healthy list of proposals for further cooperation. To use Professor Ball's phrase, there are several new 'building-block' candidates that have the potential to further foster regional security cooperation and dialogue.[3]

For instance, the Institute of Strategic and International Studies in Kuala Lumpur has suggested the concept of a Regional Maritime Surveillance and Safety Regime for Southeast Asian waters. This proposal could provide a medium for monitoring illegal activities, sharing information (including surveillance information), combating piracy, enhancing maritime safety and controlling pollution. Indeed, some of this agenda has already moved off the conference table into reality with the July 1992 signing of an anti-piracy accord between Indonesia and Singapore. These countries are now coordinating

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2 Ross Babbage and Sam Bateman (eds), *Maritime Change: Issues for Asia* (Allen & Unwin in association with the Royal Australian Navy and Australian Defence Industries Ltd, Sydney, 1993).

3 Desmond Ball, *Building Blocks for Regional Security: An Australian Perspective on Confidence and Security Building Measures (CSBMs) in the Asia/Pacific Region* (Strategic and Defence Studies Centre, Australian National University, Canberra, 1991).

surveillance and patrolling in the Malacca Straits and adjacent waters.[4]

Other potentially valuable proposals for enhanced maritime cooperation include the development in the broader Western Pacific region of a regional avoidance-of-incidents-at-sea regime. There may possibly be scope for extending this proven concept from the major powers into a locally grown variant.

There is, however, a need for patience in pursuing these initiatives. Progress in many of these fields will most likely be slow and needs to proceed within a framework of regional consensus. A key constraint is that the interests of many Western Pacific countries differ greatly. Indeed, the fact that some countries see their neighbours as the most likely source of future threat is an obvious complication. Many regional countries are hesitant to enter dialogue on complex regional security issues if this is seen to have the potential to encroach on their staunchly defended national prerogatives. In addition, most regional countries' experience of defence cooperation is limited, and most cooperation that does take place is conducted on a bilateral basis. Multilateral cooperation frequently raises political and other sensitivities that require careful handling.

Conclusion

Given these formidable obstacles to rapid progress in maritime cooperation and confidence building, can a country like Australia make a useful contribution? There is no doubt that the answer to this question is yes.

All countries in the region are now acutely aware of the rapid changes that are taking place around them. They realise that the global and regional power balance is altering significantly and many are troubled by the emergence of old tensions and the rise of new elements of competition. It is perhaps ironic that this environment of increased fluidity and uncertainty is encouraging many countries in the region to be open to new security approaches and avenues of dialogue in a way that they have not been since at least the Second World War. How long this period of fluidity and ccomparative openness will last is difficult to predict.

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4 For details, see Michael Richardson, 'Crackdown on Piracy', *Asia-Pacific Defence Reporter*, October-November 1992, p.34.

However, for a country like Australia the opportunities for enhanced maritime dialogue and cooperation are too good to be missed. Throughout the Western Pacific, Australia is generally seen as benign and friendly, and having no outstanding border disputes with its neighbours. Moreover, Australia possesses naval forces and naval personnel that are highly professional and widely respected.

The new structures and patterns of Western Pacific security are being put in place now. By working actively to encourage greater dialogue and closer maritime cooperation we have a unique chance to help make the future.

PART II

DEVELOPMENTS IN UNDERWATER WARFARE

CHAPTER 2

SUBMARINES

Stan Weeks

The end of the Cold War has altered the strategic environment in many ways, and submarine warfare is no exception. Consideration today of the future of submarines might have as a theme 'Back to the Future', since the most significant developments will involve broadening submarine roles to a variety of missions like in the pre-Cold War era. A common maxim holds that 'the best anti-submarine warfare (ASW) asset against one submarine is another submarine'. During the Cold War, the overwhelming priority to counter the Soviet submarine threat largely transformed submarines into platforms from which to attack other submarines. Since the demise of the Soviet Union, however, developments in underwater warfare have expanded the roles of submarines to include more varied missions. This multi-mission focus harkens back to the pre-Cold War era, and also conforms well to the new littoral emphasis delineated in the United States Navy's White Paper, *From the Sea.*[1]

Beyond the anti-submarine mission, current developments in submarine warfare include other missions such as covert surveillance and reconnaissance. The surveillance/reconnaissance roles were, of course, very important (although seldom publicised) during the Cold War. With modern technological advances, and a variety of potential adversaries of less technological prowess, submarines have now become a particularly effective platform from which to execute such operations. Signals, electronic, and acoustic intelligence-collection capabilities continue to be valued.

Another new/old mission for submarines is the covert insertion and extraction of Special Operations Forces or intelligence agents. Again, this mission harkens back to the pre-Cold War era.

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1 US Department of the Navy and US Marine Corps White Paper, ... *From the Sea: Preparing the Naval Service for the 21st Century*, Washington DC, September 1992.

Another traditional role gaining new currency in the present refocusing of submarine roles and missions is strike/land attack. The concept is certainly not new: during the Second World War, Japanese submarines had guns for attacking shore targets. The difference between then and now, though, is the extended reach now available. In fact, there has been much discussion of a *conventional strategic role* (that is, use of a conventional weapon with strategic range/effect) for the Tomahawk land-attack cruise missile on all newer US nuclear attack submarines.

Covert mining of harbours, straits, and coastal waters has always been a classic submarine role. Without the exclusive focus on anti-submarine warfare prevalent during the Cold War, this mission is receiving more attention. Similarly, US concentration on ASW against the Soviets also precluded the optimisation of any torpedo for anti-surface warfare. The Soviet Navy, as well as others, maintained this anti-surface torpedo capacity. Now, with the submarine-launched Harpoon, anti-surface attack range has been extended, and is also autonomous after launch.

United States nuclear attack submarine forces are changing in force structure and force employment to reflect the new littoral, multi-mission emphasis of US strategy. With respect to the force structure, in the 1990-98 time period, ten Los Angeles-class submarines currently under construction in addition to up to three newer Seawolf submarines will enter the force. But almost forty other submarines, including early Los Angeles-class attack submarines, will be retired by the year 2000. This is necessary to reduce the planned nuclear-powered attack submarine (SSN) force from the Cold War number of 100 to the new figure of 55 by the year 2000.

US Navy submarine force employment has also changed. There are now two SSNs assigned to every carrier battle group. In 1992, a total of nineteen Pacific attack submarines operated in battle group support operations. A new *Submarine Support Manual* with doctrine for surface force employment of attack submarines, as well as improved communications, are helping US Navy surface and submarine forces operate better together. Moreover, the US nuclear attack submarine force has a new shallow-water anti-diesel emphasis, although the diesel submarine still poses difficult challenges. SSNs are also increasingly being integrated into US amphibious task forces for strike, anti-diesel operations and surveillance missions. In 1992, US nuclear attack submarines even played a greater role in regional presence - there were twenty-eight US attack submarines that conducted exercises with twenty other countries, twelve of which were in the Pacific.

During the Cold War, nuclear-powered ballistic missile submarines (SSBNs) served a vital strategic role for the United States, as one leg of the strategic triad. These submarines continue to serve this strategic function today. The United States currently deploys 55 per cent of its strategic nuclear deterrent force on SSBNs. The former Soviet Union deployed 30 per cent of its strategic force on submarines, but under START II, the Russians will increase this percentage by almost half, to 53 per cent. A recent two-year US Government Accounting Office study gave the highest marks to the US ballistic missile submarine force. Of a total of twenty-two US ballistic missile submarines, ten are stationed in the Pacific.

Looking to the future, the US Navy will continue to emphasise the littoral environment, with its shorter reaction time and increasingly complex battle-space. Submarines will be the 'point of the spear' in the surging forward of the primary battle or amphibious group forces and provide the covert reconnaissance and surveillance that define the battle-space. The US Navy is still designing its next-generation, post-2000 attack submarine. The initial Centurion design alternatives reveal a continuing US preference for nuclear propulsion, in view of the distance US attack submarines must deploy, as well as on-station endurance. One area that is likely to see a greater US Navy nuclear attack submarine role is mine warfare, with additional minelaying capability now added to the Los Angeles-class submarines, and possible future mine countermeasures roles for SSNs, through onboard sensors and deployment of unmanned underwater vehicles.

All of these changes in the US submarine forces will eventually influence the role of submarines globally, including in the Pacific region. Moreover, in the Pacific, the Russian submarine fleet will continue to influence the naval environment. The new Russian naval plans, for example, still emphasise nuclear attack submarines. (One difference, however, is that the Russians plan to build these submarines in European Russia, as opposed to Pacific Russia.) According to the Australian defence analyst Desmond Ball, approximately three dozen nuclear attack submarines are in the Russian Pacific Fleet,[2] manned at 90 per cent. Despite this relatively high manning level, overall readiness and maintenance are chronic problems. In spite of these issues, though, the Russians are still using SSNs to protect their ballistic missile submarines in their Pacific and Atlantic bastions.

The People's Republic of China retains a large submarine force, but the Chinese recently acknowledged that only approximately fifty of their attack submarines were operational. This number includes five Han-class nuclear attack submarines, and one SSBN. For the most part, however, the PRC submarines are old Romeo-class diesel-powered attack boats. Operationally, there have been recent reports of a shift of some these attack submarines from the North Seas Fleet to the South Seas Fleet, for use in South China Sea patrols.

In the rest of the Pacific, Japan has fifteen very modern conventional submarines. Taiwan has two old US Guppy-class diesel submarines, two Zwardvis modern Dutch diesels, and plans for six to ten additional modern diesel submarines. In South Korea, the first modern German diesel 209-class attack submarine was delivered in October of 1992, with five more expected by 1998. North Korea reportedly still has twenty-six submarines (22 Romeo, 4 Whiskey-class), as well as 44 midget submarines for special forces insertion. On the subcontinent, India has sixteen submarines, including eight modern Russian Kilo-class diesel attack submarines, with eight more Kilos projected, as well as two German 209s under construction. Pakistan has six diesel attack submarines, four French Daphne-class and two Agosta-class.

In Southeast Asia, only Indonesia possesses submarines - two 209s were purchased in 1981. In January 1993, Indonesia ordered three additional 209s for delivery by 1996. Malaysia has decided, *in principle,* to acquire four submarines, and Singapore is considering its position. Thailand is *actively* considering whether or not to acquire submarines, making the possibility of significant submarine proliferation in Southeast Asia very real. The country with the most modern

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2 See Desmond Ball, 'The Post Cold War Maritime Strategic Environment in East Asia' in Dick Sherwood (ed.), *Maritime Power in the China Seas: Capabilities and Rationale* (Australian Defence Studies Centre, Australian Defence Force Academy, Canberra, 1994), p.4.

submarine fleet is, of course, Australia, with six Collins submarines to be commissioned in the 1995-99 time period.

With so many Pacific countries possessing at least a few submarines, the question of their potential use is of particular interest. The roles and missions of these submarines are similar to those outlined earlier including, especially, surveillance and reconnaissance. For Japan and South Korea, their submarines will primarily perform surveillance and patrol of their vital adjacent sea lines of communication. For the ASEAN states, submarines may perform the role of longer range surveillance of approaches to the critical straits. Anti-surface warfare is another potential role for submarines of all the Pacific nations. There may be a heightened submarine role in anti-surface warfare due to the vulnerabilities of coastal patrol boats demonstrated in Desert Storm. This submarine anti-surface mission might be especially important in Southeast Asia, where many countries are acquiring land-based maritime attack aircraft, which render coastal patrol boats more vulnerable. North Korea (and possibly even the People's Republic of China, in the Spratlys) have used submarines for the covert insertion of forces. And, finally, the mining of straits and approaches by submarines could be particularly critical in the Northeast and Southeast Asia region. As maritime surveillance improves, the roles and missions of submarines (which can operate covertly) will be likely to expand.

In conclusion, then, the effectiveness of submarines will continue to increase, and the roles and missions of submarines will continue to expand. There are many new technologies, including air-independent propulsion in the near future, that will contribute to the new emphasis on submarines in a full spectrum of multi-mission roles in the new global and Pacific regional strategic context.

CHAPTER 3

ANTI-SUBMARINE WARFARE

Lieutenant Commander Graeme Dunk, RAN

This chapter is about regional developments in anti-submarine warfare and their impact on the naval balance. It is a cliché to say that the aim of ASW is to deny an adversary the effective use of his submarines. What is not so commonly stressed, however, is the word *effective* rather than *use,* and that this denial can be done through a variety of measures in addition to the traditional use of ASW forces at sea to detect, classify, localise and attack submarines. Other options can include offensive action to destroy submarines in their bases or to destroy critical supporting infrastructure, the use of submarines or offensive mining outside bases to destroy an opposition's boats on exit, or to deter an opponent from putting to sea. ASW also includes supporting measures such as oceanographic research to fully understand and exploit the underwater environment, indigenous research and development (R&D) into ASW systems tailored for our own conditions, and intelligence collection to determine a potential adversary's submarine-operating patterns, capabilities and acoustic signatures. These support activities are necessary to ensure that ASW assets can be utilised most effectively when required. Anti-submarine activities may also be undertaken by national agencies other than defence, for example diplomatic efforts designed to dissuade regional countries from acquiring or enhancing a submarine capability.

Leaving that aside, this chapter will focus on the more traditional ASW measures. The use of submarines in ASW will not be addressed. The first part of the chapter concentrates on the technological developments that are occurring in ASW, as these technologies are likely, in time, to appear within our region. The second part addresses regional ASW trends and considers the implications of these trends for the regional balance. The force structures of regional navies is only lightly touched on, as it is trends that are important in the longer term, not the specifics of equipment acquisition.

General Technological Trends in ASW

The New World Order has imposed a fundamentally different rationale on ASW for the United States, and this is affecting the way ahead. No longer is the sole concern for the United States the detectability and counter-detectability of SSBNs and SSNs; a new concern is how to combat quiet conventional submarines in shallow water. This requirement has been hitherto overlooked and the problems which have been faced for some time are now being addressed.

Two common expressions in ASW are that 'the passive window is closing/has closed', and 'you cannot find conventional submarines with towed arrays'. The solutions to these problems are seen as lying in low-frequency active (LFA) sonar and alternative signal-processing strategies. Whilst LFA may be the active way to the future, the signal-processing advances may show that conventional submarines can be detectable passively; the passive window may remain open, although the information to be obtained and the way it is obtained may have changed dramatically.

Low-Frequency Active

A number of approaches have been proposed for LFA, the majority based on some type of bi-static or multi-static application.[1] In general terms, this involves transmission of low-frequency acoustic pulses from one site, with reception of the reflected signal by a separate sensor, either co-located on the same platform or at a geographically removed site, or sites. A bi-static approach could, for example, consist of transmission on a low-frequency hull-mounted sonar with reception via an array towed by the same ship, an approach being pursued by the US Navy to allow the Surveillance Towed Array Sonar System (SURTASS) ships to operate in shallow water.[2] Other bi-static and multi-static possibilities are:

- transmission by a ship-borne variable-depth sonar (VDS) with reception by a towed array;

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1 For a good unclassified description of the bi-static/ multi-static concepts see J.J. Lok, 'Active Revolution in ASW Sonars', *Jane's Defence Weekly*, 20 July 1991, p.103.

2 *Inside The Navy*, Vol.6, No.1, 4 January 1993.

- transmission by a helicopter VDS with reception by a towed-array ship, or number of ships;
- transmission by a helicopter VDS with reception via a pattern of sonobuoys; and
- transmission by a bottom-mounted transmitter with reception by towed-array ships, sonobuoy field or bottom-mounted array.

In all these approaches, with the exception of having the transmitter and receiver co-located on the same platform, accurate knowledge of the position of the transmitter or the instant of transmission is required. From this information, and using the difference in arrival times and bearings for the direct path and reflected path signals, a location for the submarine can be determined.

The accuracy of pinpointing the submarine's position suffers, however, with LFA. In some cases this accuracy is insufficient for the launch of a homing torpedo. In an operational scenario, initial long-range detection and tracking could be undertaken with LFA sonar, but fire-control solution generation and attack would require a more accurate sensor; for example, a medium-frequency sonar or a non-acoustic sensor such as magnetic anomaly detection (MAD).

Other Acoustic Developments

Other acoustic developments in ASW also feature the use of towed-array technology. For example, a bottom-array field can be integrated with a bottom-mounted sonar and weapon system to provide 'hands off' protection for focal areas. In such an arrangement the array field detects acoustic noise, passively classifies the source and obtains initial positional information. Having determined that the source is a target of interest, either through reference to an on-line signature library or by analysis from an operator ashore, the sonar, most likely a low probability of intercept (LPI) sonar, is activated, the target is tracked and a fire-control solution generated. Engagement could then be undertaken utilising the embedded weapon system. This entire process could be computer controlled, perhaps with an overriding command function positioned ashore to 'watch' developments via a fibre-optic link and orchestrate the engagement.

Totally optic arrays will become possible in the longer term, with benefits in simplified array design and reduced cost making the use of extremely large networks of arrays feasible.[3]

Signal-Processing Developments

New directions in signal processing aim to *do more with the same* rather than to *do more with less.* That is, signal-processing strategies are being developed to utilise information that already exists in the received signal but which is presently not utilised; most particularly with regard to transients. As the name implies, these transients are not permanent features of the submarine, but occur due to machinery state, or other changes - for example, opening a bow cap. Analysis of these transients can give detection, classification and tracking opportunities, but can also, if properly understood and utilised, give indications as to the operational status and intentions of the contact.

Other developments are occurring in the processing of random arrays. For example, the output of each buoy in a sonobuoy field can be processed to form a single large array thereby providing higher array gain and lower frequency detection than would have been possible from each buoy individually. The approach requires accurate positional knowledge of each buoy within the pattern. Problems experienced to date in this regard may be overcome with the use of a global positioning system (GPS) receiver in each sonobuoy.

Non-Acoustic Developments

Another area of ASW which has been of intense long-term interest, but little result, is that of non-acoustic detection (NAD). Any breakthrough in wide-area NAD systems would have significant strategic implications. Systems known to be under consideration include space-based systems, an improved magnetic anomaly detection system, the use of light for detection and ranging, and detection of the submarine through the detection of the internal disturbances its passage causes in the water column. With the exception of the latter, all would appear to have greatest

3 See D. Foxwell, 'Fibre-optic Sonars: Optical Arrays for Acoustic Detection', *International Defense Review*, 3/1992, March 1992, pp.239-242.

utility for shallow-water work, and most particularly for geographically constrained areas.

Weapons

In ASW weapons the main technology remains the torpedo, although the requirement to work in shallow waters has revived international interest in both depth charges and thrown weapons, particularly as a classification aid. For torpedo countermeasures most interest remains in the anti-torpedo torpedo and in decoys, both towed and off-board. A mortar-style system akin to the RBU 1000 fitted to ex-Soviet warships can also be an effective system against incoming torpedoes (based on modelling, it can be over 90 per cent effective), but does require three-dimensional knowledge of the torpedo's position and that engagements be conducted at short range.[4]

Australian Developments

The developments covered so far are all being considered overseas. Australian ASW activities centre on two main areas: signal processing and slim-line towed arrays. Two slim-line technologies have been developed. The first is the solid-fill Kariwara streamers currently in full-scale engineering development (FSED) by GEC-Marconi Systems (GMS), from initial work undertaken within the Defence Science and Technology Organisation (DSTO).[5] Tests and trials conducted to date have indicated that the array will meet the acoustic and mechanical specifications against which the technology has been developed.

The other technology is Narama, a slim-line fluid-filled array developed by Australian Sonar Systems (AUSSYS). A sea trial of a Narama array was conducted in March this year utilising an Oberon submarine. It would appear that the trial was successful and that the array showed low levels of self-noise.

Both array technologies will have utility for surface ship, submarine and bottom-mounted applications.

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4 G.A. Dunk, An Investigation of the Effectiveness of a Hard Kill Torpedo Counter Measure System, Royal Naval Engineering College, Manadon, 1988 (unpublished).

5 For coverage of the Kariwara technology and applications see G.A. Dunk, 'KARIWARA - Australia at the Leading Edge of Towed Array Development', *Maritime Studies*, No.68, January/February 1993.

Implications for the Regional Maritime Balance

It is well documented that regional countries are showing a heightened interest in all maritime aspects of warfare; and this includes submarine and anti-submarine capabilities.[6] It is not unreasonable to expect, therefore, that increasingly advanced systems will be progressively introduced.[7] The driving forces for these maritime development are:

- The requirement to maintain the security of the regional sea lanes of communication (SLOC) for ongoing economic performance and development. This includes any perceived vulnerability of traffic in these lanes to submarine interdiction.[8]
- The requirement to maintain the security of maritime claims made under the 1982 United Nations Convention on the Law of the Sea (UNCLOS), particularly noting that China, a major player in any final determination of boundaries, possesses a large submarine force.
- The requirement to conduct surveillance of national maritime estates. Such surveillance must include the underwater environment if it is to be complete.

In addition to improvements in its surface ASW capability, Indonesia is known to be particularly interested in bottom-mounted arrays for focal area and archipelagic surveillance. For an archipelagic

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6 *Australia's Strategic Planning in the 1990s* (Departmental Publications, Department of Defence, Canberra, 27 November 1989); paragraph 5.4, for example, states:

> Whereas, traditionally, regional countries have concentrated on land forces, and continue to retain significant capabilities in this area, there are clear trends in regional force structure development which indicate increasing emphasis on naval and air forces, especially for maritime operations.

7 For coverage of more general trends in the defence spending of Southeast Asian nations, see Chin Kin Wah (ed.), *Defence Spending in Southeast Asia* (Institute of Southeast Asian Studies, Singapore, 1989).

8 For a (now somewhat dated with the demise of the Soviet Union) discussion on the security of the sea lanes of communication in Asia, from the perspective of the individual countries, see L.T. Soon and L.L. To (eds), *The Security of the Sea Lanes of Communication in the Asia-Pacific Region* (Centre for Advanced Studies, Singapore Institute of International Affairs and Heinemann Publishers Asia, Singapore, 1988).

nation with a vast number of potential transit routes, the use of bottom-mounted arrays is an understandable and cost-effective solution. It allows continuous surveillance to be undertaken, for both surface and sub-surface traffic. This is not to imply that fixed arrays will be a total solution for Indonesia, only that they can fulfil a significant part of the total surveillance requirement in a cost-effective way.

Singapore has recently acquired an ASW capability through the VDS fitted to its new class of missile corvettes. An ASW capability is considered by the Singapore Navy to be a critical factor in the fulfilment of its role to safeguard the freedom of navigation through the adjacent SLOC.[9] Noting the limited extent of its maritime estate, and that the platforms have tasks other than ASW to perform, the utilisation of relatively short-range, ship-borne sensors for the underwater surveillance task is considered a cost-effective option as it avoids the high capital cost of dedicated ASW infrastructure.

Malaysia and Thailand are also in the process of upgrading their maritime capabilities. Malaysia has acquired two new frigates with an ASW capability and helicopters with dipping sonar are under consideration. Thailand is also believed to be in the market for ship-borne ASW helicopters and additional frigates.

For these countries the choice of surveillance platforms is not so clear-cut. Malaysia in particular could face a number of different ASW scenarios, which may affect the choice of capability. Malaysia is a geographically separated country with three main coastlines along which to conduct surveillance. Over 90 per cent of its external trade is seaborne.[10] It has a requirement to maintain the lines of communication between East and West Malaysia. It also, along with China, Taiwan, Vietnam, the Philippines and Brunei, is a claimant for part of the Spratly Islands in the South China Sea.[11] In order to fully meet all requirements, Malaysia will need a range of ASW capabilities,

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9 Interview with the Chief of the Navy, Royal Singapore Navy, Commodore Teo Chee Teo, as reported in G. Toremans, 'The Republic of Singapore Navy', *Naval Forces*, Vol.XIII, No.1/1992, January 1992, pp.10-14.

10 B.A. Hamzah, 'Sea Lanes of Communication Security: A Malaysian Perspective' in Soon and To (eds), *The Security of the Sea Lanes of Communication in the Asia-Pacific Region*, p.119.

11 For a good description of the status of the overlapping sovereignty claims in the South China Sea, see K. Conboy, 'The Future Southeast Asian Security

including ship-borne sensors and ASW helicopters for SLOC protection and for a presence in the Spratly Islands, and maritime patrol aircraft for surveillance of the Indian Ocean approaches and the South China Sea.

Whilst the strategic rationale for the interest in ASW by Indonesia, Singapore and Malaysia is readily apparent, the same cannot be said for Thailand.[12] Thailand's economy is not heavily dependant upon sea transport (as are those of Singapore and Malaysia),[13] Thailand does not have concerns over archipelagic security and SLOC surveillance (as does Indonesia), Thailand does not have maritime sovereignty claims, nor internal communication lines, to consider (as does Malaysia). It does, however, have two separate coastlines over which to conduct surveillance.

It has been stated by a Thai commentator on defence issues that, due to the conflicting demands of the political and military roles played by the Thai military, exacerbated by inter-service rivalry and competition for budget allocations, 'where defence spending in general and arms procurement in particular are concerned, there is no priority-setting based on security requirements or threat perceptions'.[14] Interest in ASW by the Royal Thai Navy (RTN) may therefore only be a continuation of a wider interest in the acquisition of submarines.

How are these improvements in ASW capabilities likely to change the regional maritime balance? Are these changes threatening to regional stability, or are they beneficial in some way? Can they be used to further regional cooperation and confidence building?

Environment', *Strategic Review*, Vol.XX, No.3, Summer 1992, pp.34-39.

12 For further detail of the strategic perceptions of these countries see the relevant sections of Chin Kin Wah (ed.), *Defence Spending in Southeast Asia:* Sukhumbrand Paribatra, 'Thailand: Defence Spending and Threat Perceptions', pp.75-108; Dorodjatun Kuntjoronjakti and T.A.M. Simtupang, 'Indonesia: Defence Expenditure in the Period of the New Order, 1967-1985', pp.109-132; Muthiah Alagappa, 'Malaysia: From the Commonwealth Umbrella to Self-reliance', pp.165-193; Chin Kin Wah, 'Singapore: Threat Perceptions and Defence Spending in the City State', p.194.

13 For detail on the relativities of Thai and other ASEAN nations' seaborne trade and other trading information, see Dhawon Sukhakanya, 'The Security of the Sea Lanes in Southeast Asia'; and Hamzah, 'Sea Lanes of Communication Security', pp.21-44 and 118-125. See also A. Tyabji, 'The Six Asian Economies: 1980-88' in A. Broinowski (ed.), *ASEAN into the 1990s* (Macmillan Press, London, 1990), pp.32-57.

14 Sukhumbrand Paribatra, 'Thailand: Defence Spending and Threat Perceptions', p.104.

The remainder of this paper deals with these questions.

ASW is a reactionary and inherently defensive business. That is, actions are generally taken to defend national assets in reaction to a perceived threat posed through the use of submarines by another party. Such usage can include surveillance and intelligence gathering, the interdiction of commercial and military shipping, the landing of special forces, the mining of harbour entrances and other focal areas, and the application of pressure during periods of tension through threatened use or posturing. Such posturing will obviously have more effect if the other party feels insecure and has no real means of countering this pressure.

Success in ASW depends upon the ability to detect submarines, all other activities being dependant in turn upon this ability. This detection is notoriously difficult: not only must the type of equipment being employed be suitable and operated correctly, but the operator must have an understanding of the environment and the way in which an adversary is likely to use submarines.

Regional countries are in the early stages of building an ASW capability; numbers are small and expertise limited. The implication of this is that, in the short term, the regional balance is unlikely to be affected. The probability of submarine detection will therefore not rise markedly and, consequently, little pressure will be placed upon countries with submarines to alter operating patterns. This view reflects the fact that 'the necessary skills are difficult to acquire and the lead times for adapting and developing ASW technology ... are long'.[15]

In the longer term, however, if ASW capabilities continue to develop and include the introduction of more advanced technologies, particularly LFA, there may be other, more wide-ranging, implications.

The most obvious of these is that the probability of submarine detection will increase for any submarine operating within the area, be it American, Chinese, Japanese, Russian, Indonesian, or Australian. The question then becomes that of how the countries that have submarines within Asia-Pacific waters will alter the operating profile

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15 *The Defence of Australia 1987*, Presented to Parliament by the Minister for Defence, the Honourable Kim C. Beazley, MP, March 1987 (Australian Government Publishing Service, Canberra, 1987), paragraph 4.20.

of their boats to cater for the increased ASW capability; and whether they will bother to do this. After all, submarine activities can only be attributed to any one country if the submarine can be positively identified, and the difficulties in making such positive identification are well known.

The major impact of further development in the ASW capabilities of regional countries will be felt in the South China Sea. A number of overlapping claims for territorial and maritime sovereignty have been made in this area, the most visible and contentious being the Spratly Islands. The passing of legislation by China in February 1992 legalising and further stressing China's claim to the entire disputed area around the Spratly Islands has made a number of countries nervous with respect to Chinese intentions in this area.

The capability of the Spratly Islands claimants to conduct ASW operations within the area (in addition to Malaysia, Taiwan is also developing its ASW capabilities) may reduce China's ability to influence the course of events in this dispute through the use (implied, threatened or actual) of its submarine force. Should Chinese submarine activity towards Malaysia and Taiwan be inhibited, it would most likely be re-directed towards those areas in which the claimants do not possess an ASW capability.

The South China Sea also contains vital sea lanes of communication. These SLOC are crucial to the economic performance of Northeast Asia,[16] as well as regional countries. An increased ASW capability would add to SLOC security by inhibiting the unrestricted use of submarines along these routes. The option of escorting selected shipping through focal areas, provided suitable weapons are also possessed, also becomes available.

An increased ability of regional countries to conduct ASW must therefore be beneficial for regional stability, as it may inhibit the use or movement of an offensive weapon system, the submarine. Any future acquisition of more advanced ASW technologies by regional countries, bi-static or multi-static LFA for example, should similarly be considered as a regional stabilising factor; undersea surveillance

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16 K. Conboy, 'The Future Southeast Asian Security Environment', states that 90 per cent of the oil destined for Japan/South Korea passes through the South China Sea.

capabilities would be further enhanced, and submarine activities would become more 'transparent'.

The increasing numbers of modern submarines being operated by Asian nations, and in particular moves by Malaysia, Thailand and possibly Singapore to acquire a submarine force, coupled with the trend toward increasing regional ASW capabilities, makes more onerous the already difficult task of identification, and increases the risk of engagement due to mistaken identity. This problem provides an opportunity to highlight water space management as a confidence- and security-building measure (CSBM) and an opportunity for further regional cooperation.

In Europe, water space management is achieved for Western countries under the framework of the NATO alliance. In the Asia-Pacific region such an approach is not possible as no comparable treaty framework exists; nor is one likely or even required to exist. Notification of submarine movements could be addressed as a declaratory CSBM, perhaps initially on a bilateral basis.

The declaration of such information does not necessarily need to be conducted between two countries that both have submarine forces, nor need the information cover the submarine's location at all points. An agreement could focus on the provision of submarine positional data only when the submarine is within certain negotiated areas for a number of individual countries. Submarine movement data could be exchanged with Indonesia, for example, on a different basis to the exchange with Malaysia, or Singapore, or Thailand. Such a declaratory agreement would provide complementarity with other surveillance CSBMs. Australia, being in possession of a submarine force, is in the position of being able to take some action in this regard. This would lessen the water space management problem that will become increasingly more important and provide another step on the ladder to regional common security.

In conclusion, the regional trend is toward the introduction of new systems and the improvement of ASW capabilities; in some cases, with direct Australian assistance and encouragement. More advanced systems will inevitably be introduced as maritime force structures mature and regional countries gain more experience and expertise in the utilisation of these assets.

These increasing regional ASW capabilities are considered to be beneficial for stability and should continue to be encouraged. Australia should therefore continue to expend resources on developing the ASW expertise of regional countries. The further introduction of the more advanced ASW technologies and capabilities is similarly considered to have a stabilising effect, as it has the potential to inhibit the use of an offensive weapon system within the region.

These developing capabilities present additional opportunities for a cooperative approach to security. Such opportunities must be seized if we are committed, in the words of Bob Hawke in 1991, to 'seek[ing] security in and with Asia [rather than] seeking security from Asia'.[17]

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17 R.L. Hawke, 'The Asia Lecture', delivered on 24 May 1991 at the Asia-Australia Institute, University of New South Wales, by the Prime Minister, Mr Bob Hawke, as reproduced in *The Monthly Record*, Australian Foreign Affairs and Trade, Vol.62, No.5, May 1991, p.200.

CHAPTER 4

MINE WARFARE AND MINE COUNTERMEASURES

Lieutenant Commander Alan Hinge, RAN

> ... A ghost is walking the corridors of defence departments all over the world - [that ghost is] the fear of military impotence, even irrelevance.[1]

So says eminent historian and strategic analyst Martin van Creveld in his controversial book, *The Transformation of War*, where he argues that small-scale military eruptions around the globe have demonstrated new forms of warfare conducted by a different cast of characters - guerrillas, terrorists, pirates, tribes, religious sects and bandits - pursuing diverse goals with the most primitive *and* sophisticated means. He suggests that the tactics of low-intensity conflict mark the beginning of the end for conventional warfare between states as we know it - that submarines, missiles, aircraft and towed arrays will become increasingly irrelevant instruments of conflict and will simply rust away.

Van Creveld sometimes 'draws a long bow', but one thing is sure: the humble, not too glamorous, stodgy old sea mine - that Cinderella of our naval warfare arsenal - will remain in use throughout the whole conflict spectrum from terrorism to general war. Indeed, the sea mine is and will remain important simply *because it is used*. During the Gulf War, for example, the maritime threat came not from Saddam Hussein's Exocets but from sea mines. Hussein deployed 2,500 sea mines, including 1300 laid in waterways. Along with ubiquitous Russian mines of varying sophistication there were quite sophisticated Italian Mantas and Misars upgraded with Russian help. Unconfirmed reports claim Iraq brought mines from Chile, which incorporated West German and South African technology. Similarly, in 1987 it was mines

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1 Martin van Creveld, *The Transformation of War* (Free Press, New York, 1991), p.1.

that posed the real threat to naval forces in the Middle East. The US$96 million damage bill for the FFG USS *Samuel B. Roberts* testifies to this; it was one of five large vessels incurring major damage as a result of Iranian mines.[2] In 1984 minelaying had become the new tactic of international terrorism, with modern mines laid in the Gulf of Suez and Central America.[3]

The aim of this chapter is to look at recent operational and technological developments in the use of the sea mine and in mine countermeasures (MCM), and the implications for the Western Pacific. It firstly covers the increasing utility and threat of sea mines generally, and relates this back to the region. Secondly, the chapter looks at developments in mine countermeasures and ways and means of countering the mine menace in the region.

The Increasing Utility and Threat of Mines

The sea mine is an underwater explosive device that waits to sink or damage targets or deter them from entering an area. It should be remembered that the sea mine has succeeded in its mission if the opponent refuses to challenge it. The opponent has failed to bring hostile forces to bear at a chosen time and place and so a measure of control over the opponent's ability to seize the initiative has been achieved. Control over the actions and deployment of an adversary at sea is the essential mission of the sea mine. Importantly, the mine, as 'the weapon that waits', enables one who deploys it to avoid escalatory confrontation. It is the only weapon that can be actually used without killing or injuring people or damaging property, and can be aimed at attacking people with shortages and loss of income rather than with bullets and missiles. Mines lie at the critical interface between military and political action, and this is the key to their utility in modern and future warfare.

The mining of the Vietnamese harbours at Cam Pha, Haiphong and Hon Gai in 1972 marked the turnaround. Mine deployments, instead of being considered highly escalatory acts almost

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2 For an outline of the mining of the USS *Samuel B. Roberts*, see Norman Friedmann, 'US Frigate Mined in the Gulf', *United States Naval Institute Proceedings*, June 1988, p.119.

3 See S. Truver, 'The Mines of August: An International Who Dunnit', *United States Naval Institute Proceedings*, Naval Review Issue, May 1985, p.109.

by definition, were now seen as acts which, if implemented cleverly, could be pitched at the minimum level of violence. Operations against the North Vietnamese also revealed to all countries in the region the absolute helplessness of a country with no MCM capability to speak of. Twenty-seven ships were trapped in harbour for 300 days, costing the Soviets US$146,000,000 or almost one billion dollars in today's figures. It only took 75 Mk 52 bottom mines to seal Haiphong's main channel.[4]

Technical Developments

Mine effectiveness depends largely on the ability of mine sensors to detect 'signatures' and localise the right target. Research into several signature types has been conducted and these signatures include distortions in the local magnetic field, change in cosmic ray and white light transmission to the seabed due to the opacity of a ship's hull and also the redistribution of sea mass per unit volume and variation of fluid velocity flow around a ship. However, the most promising and reliable new method of target localisation is using the ELPHI signature. ELPHI stands for 'electric potential field' and this signature derives from a number of causes, a major one being the modulated magnetic field derived from a simple battery circuit formed between the steel hull and bronze propellers of a vessel. These dissimilar metals are linked by the seawater electrolyte of very high and stable conductivity and the propeller shaft bearings, which complete the circuit. The contact resistance of the shaft bearings varies due to a number of factors, including shaft revolutions and bearing lubrication state. Varying resistance causes an alternating current flow in the circuit. This current has a correspondingly alternating or modulated magnetic field associated with it. The modulated magnetic field can be detected and usefully employed as a signature. This can lead to the mine sensing a vessel directly above at practically any depth. The perceived importance of ELPHI is increasing because getting a reliable pressure sensor to operate below a depth of 60 metres

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4 For a description of the mining of North Vietnam, see U. Luckow, 'Victory over Ignorance and Fear: The US Mine-laying Attack on North Vietnam', *Naval War College Review*, January-February 1982, p.24. See also A. Patterson, 'Mining a Naval Strategy', *Naval War College Review*, May 1971 for an insight into the rethinking of the mine's role in modern conflict which took place in the early 1970s. Patterson was involved in the Project Nimrod studies, 1968-70. See *Project Nimrod: The Present and Future Role of the Mine in Naval Warfare* (Naval Academy of Sciences, Washington, 1970).

has proven to be well-nigh impossible.[5]

Despite advances with more exotic signatures, magnetic, acoustic and pressure signatures will continue to be the mainstays of target detection and localisation in mine warfare for some time, with considerable effort currently being put into improving acoustic detection and classification of targets. Researchers are aiming for enhanced target selectivity using acoustic 'finger-printing' techniques, in which the target's acoustic signature is compared with a microprocessor-stored pattern. The acoustic signature derives from shipboard sources such as generators, pumps, hull vibrations and propeller motions. Items of equipment have their own often unique and stable frequencies of operation, which constitute spectral lines in the overall acoustic signature spectrum (ASS) of the vessel. Such acoustic finger-prints can be surreptitiously recorded during peacetime for various ships and submarine classes. By planting special recording devices on the ocean floor and recovering the information, data can be filed into the microprocessor-based target signature library of a combat mine's memory.

Two areas in mine design attracting keen interest involve the development of *sleeper mines* and *self-burying anti-hunter mines.* Sleeper mines can be laid in peacetime and maintain station for years. They are designed to be virtually undetectable, using sonar-absorbent coatings and irregular shape. They are safe until armed on command by coded sonar signals and can be remotely instructed, interrogated and detonated. Self-burying anti-hunter mines are designed to hide on deployment and kill MCM vessels (MCMVs) by locking on to minehunter sonar signatures. Some of these mines are of the bottom-mounted variety and can use torpedoes or rockets to increase radius of action to at least one nautical mile.

However, two things should be remembered when using or fighting sophisticated mine types. First, buying a sophisticated mine is one thing but programming it and collecting your local environmental and target data and then putting the information in useful form in the mine is quite another thing. In fact, it can be an especially tricky task. Second, if the mine becomes too discriminatory and highly tuned, it may never detonate at all!

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5 See G.K. Hartmann, *Weapons That Wait: Mine Warfare in the US Navy* (US Naval Institute Press, Annapolis, 1979), pp.96-97, for a description of ELPHI.

Utility of the Sea Mine in the Western Pacific

It would be hard to get a better general area to lay mines than in the Western Pacific. In fact, the nations of the Western Pacific are acutely vulnerable. Waters are shallow and confined with lots of heavily trafficked straits and seas, many of which form especially good choke points. For example, on any given day an average of 350 large vessels will be in transit through the South China Sea after coming from a variety of narrow approaches.

Submarine minelaying in these waters can be especially effective. During the Second World War the most effective operations in history occurred in Southeast Asia with a record one ship hit per eight submarine-laid mines. Aerial minelaying also proved extremely successful. All in all, cost to the United States per ton enemy casualty was 13 times more when using torpedoes than it was when using mines.[6]

Why Use Mines in the Western Pacific?

Besides traditional tactical and strategic uses, there are many other potential applications for mines in the Western Pacific. The export-oriented market economies of the Western Pacific have an extraordinary dependence on trade and input of raw materials. Delays in transit, not to mention damage and sinkings due to mines, would be very costly. Holding up cargoes and interrupting important supplies dislocates a rival's industry to a measurable extent, since industry relies on the steady flow of materials. Every ship delayed represents a net cargo loss because, at the conclusion of the crisis, there is a negative balance of ship days that often cannot be made up. Charter cost of 50-100 thousand dollars per day cannot be made up easily either. Other costs associated with the mine threat include increases in marine insurance rates, refusal of crews to sail and even withdrawal of neutral tonnage from trade with a nation whose main ports are effectively mined.

Regulation of exclusive economic zones (EEZs) is also a big issue and it is getting bigger. Perhaps we may encounter mines used as

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6 R. Duncan, *America's Use of the Sea-mine* (US Government Printing Office, Washington DC, 1962), p.135; also Patterson, 'Mining a Naval Strategy', p.62.

'robot policemen' in selected areas. Territorial claims in the South China Sea, for example, could be reinforced with declared protective fields to reinforce sovereignty claims. This could avoid escalatory confrontation and may not be as far-fetched as one might at first think. When mines led to the sinking of three Vietnamese patrol boats in the late 1980s by Chinese forces, sixty Vietnamese sailors are said to have died in a very one-sided affair. Similarly, with sovereignty claims of archipelagic states, the right to lay protective minefields could be claimed and practised as a tangible exercise of sovereign power.

In addition, rogue groups comprising pirates, terrorists, dissidents and even international criminals and drug traffickers potentially have access to a wide variety of sophisticated mines. Sea mines could be used for economic or political blackmail, extortion, diversion, ambush and destruction.

Countering Mines in the Western Pacific

The sea mine is of course difficult to target. Unlike an aircraft, ship, missile or submarine, the bottom mine actually becomes part of its environment on the ocean floor. It makes no emissions and has no velocity. One must either work out some way of detonating it from a distance, or look for it, pinpoint it and counter-mine it.

There was a conspicuous absence of significant MCM forces in the region until the 1980s. Most countries in the Western Pacific now have modest MCM capabilities built around a handful of fairly capable minehunters. Some, like Japan and China, have relatively large and diversified MCM capabilities. Very importantly, most are getting hands-on experience with the operation of remotely operated vehicles (ROVs) and the use of detection and classification sonars.

Two navies in the region, that of Australia and probably that of Thailand, are moving to the next-generation minehunting sonar system, the Krupp Atlas DSQS 11M, which is capable of detecting and classifying simultaneously. The system seems very effective and this development is vital in conducting rapid mine reconnaissance and in adapting to associated technologies which are important for a very effective countermeasure known as route survey, described below.

Minesweeping

Most nations of the Western Pacific are showing some signs of having an almost exclusively minehunting focus. This is understandable, given the availability of influence-resistant sophisticated mines. Nevertheless, while minehunting is and will remain the backbone of any countermeasures force, minesweeping should not be relegated too far into the background and should not be neglected for several reasons. Tonne for tonne, minehunters are the most expensive type of warship afloat and take a very long time to do their job. A shifty opponent would be likely to use the most cost-effective fields. These are 'mixed-bag' fields comprising many relatively simple influence and sometimes contact types, with a sprinkling of more sophisticated anti-hunter and other specialty mine types. Good influence and mechanical sweeping would probably get rid of a significant proportion of the mixed field before the time-consuming and highly specialised minehunting job got underway. Sweeping followed up by selective hunting could get the MCM job done much faster and less dangerously.

The Australian Minesweeping and Surveillance System

The Australian Minesweeping and Surveillance System, or AMASS, is an integrated system which has been developed over the last decade.[7] Rather than trying to beat the mine's logic, the AMASS tries to imitate a target ship and can assist in the rapid sweeping of large areas, choke points and channels. It offers a means of extending the effectiveness of minehunting and was developed for use by craft of opportunity or civilian vessels which, with minimum adaptation, can be used in several MCM tasks. The AMASS combines four important features: a route surveillance system and a precursor influence sweep, together with new influence and mechanical sweeps.

The route surveillance system aims at creating a history of seabed data on selected routes by mapping the seabed and detecting recent changes to bottom topography. A precursor sweep then uses a remotely operated drone boat to counter coarsely set (sensitive) magnetic and/or acoustic mines.

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7 AMASS is marketed by Australian Defence Industries Ltd.

The third feature of the sweeping process involves towing various combinations of magnetic/acoustic sweep arrays to counter mines that target various kinds of ships. While improvements in acoustic effectiveness is desirable, the magnetic sweeps are effective against a wide range of magnetic setting combinations. The BVDs (buoyant vehicle dyads), as they are known, are very robust and highly manoeuvrable, being based on MOP (magnetic orange pipe) technology developed in the United States in the early 1970s and substantially improved by the Canadians in the late 1970s.

The fourth feature of the process involves the use of lightweight mechanical team and Oropesa sweeps to counter moored mines. These sweeps make use of superior, lightweight materials and are more hydrodynamically efficient than their cumbersome predecessors.

Some MCM Points to Bear in Mind

Navies of the Western Pacific could put many more millions into MCM but get very limited return. The sea mine, it seems, will probably have the upper hand unless large numbers of ships are available for the MCM task. Most MCM technologies and platforms are getting increasingly unaffordable. Consequently, one should look to ways of supplementing the effectiveness of standing MCM forces in the Western Pacific.

First, one should remember the old maxim that *deterrence deters*. Mines are the best form of MCM in inter-state conflict. Good mines can be easily acquired from a variety of European sources and probably from Russia, believed to still have 100-150 thousand useful mines in stock. Of course there are always political and financial constraints in acquisition, but the fact remains that if one has a demonstrable capability to inflict commensurate damage on one's opponent with the same weapon type, this can deter the opponent from deployment.

Second, navies and even civilian shipping agencies should relearn and redrill basic MCM *self-defence measures* (SDMs). It should be remembered that the commanding officers of the *Princeton* and *Samuel B. Roberts* came in for criticism over some of their decisions and manoeuvres in Middle Eastern minefields, which allegedly led to unnecessary damage. Basic self-defence measures can reduce the damage from mines substantially. These include maintaining maximum water-tight integrity, sailing on high tide, maintaining constant speed and bearing, cleaning hulls, reducing self-noise and cavitation, turning off all non-essential equipment, transiting high-risk areas at slow speed and regular damage-control drills. Discipline with regard to self-defence measures can have a major impact against the mine, as experiences in the Second World War clearly demonstrated. MCM standard operating procedures and damage control should continue to be taught and drilled in a serious and consistent manner.[8]

Third, *bottom conditioning* and extensive *route survey* operations conducted during peacetime offer two of the best ways of compromising the effectiveness of even the most sophisticated mines. Certain types of seabed assist mine reconnaissance and minehunting, such as seabeds where mines cannot become easily scoured or embedded, hidden amongst rocky outcrops or camouflaged. Bottom conditioning involves removing conspicuous bottom junk jettisoned by passing merchant ships to form a 'clearway', where changes to the bottom can be picked up quickly. Route survey involves compiling a database on key routes. When a route is initially surveyed, seabed data is collected and this data is stored for comparison to find anomalies when minelaying is suspected. Quick mine reconnaissance then becomes possible and this reduces the asset-to-task ratio of MCMVs markedly.[9]

Fourth, given the current and prospective shortage of dedicated MCMVs, *craft of opportunity programmes* can be set up by identifying and listing many civil sector craft best suited for MCM employment. They can be largely manned on a part-time basis by reservists and can act as auxiliary minesweepers or mine reconnaissance vessels using clip-on systems, including side-scan sonars and a variety of influence sweeps.

Fifth, *multilateral cooperation* can give rise to synergies capable of seriously degrading the mine threat. Western Pacific nations have demonstrated a generally bilateral pattern of cooperation and tend to avoid multilateral entanglements, but this could and should change

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8 For a summary of SDMs see table 4-2 in A. Hinge, *Mine Warfare in Australia's First Line of Defence* (Strategic and Defence Studies Centre, Australian National University, Canberra, 1992), p.104.

9 ibid., chapter 4.

with regard to MCM. MCM operations in the Gulf War and the Red Sea clearly indicate the force multiplier effect derived from getting as many MCM assets on the job as possible. MCM forces in the region are small and will likely remain small. Their work is dangerous and painstakingly tedious. The prospect of area pooling of MCMVs has definite advantages and attractions for the future. After all, MCM is almost invariably a purely defensive activity.

Conclusion

Modern mines demand increasingly sophisticated countermeasures, training and information/data management techniques, and it will be extremely difficult for countries in the area to keep up with advances in mine technology. Little more than a near state-of-the-art core capability of minehunters can be aimed for and maintained by most regional nations, so MCM augmentation and burden-sharing measures should be adopted. These include improved minesweeping equipment, multilateral pooling of MCMVs, use of craft of opportunity, emphasis on route survey and bottom conditioning during peacetime and perhaps acquiring mines for deterrent purposes against other states.

Nations should also be prepared for a new danger, as conventional MCM forces may increasingly come up against mines laid not by states but by rogue groups without a territorial base. The mine will, as usual, play its part and its psychological warhead as 'the weapon that waits' will be increasingly used. In such cases it is especially important to remember that war is ultimately a clash of wills - the technology used and operations employed are merely tools and manifestations of human will. It is necessary to recognise that mines may increasingly be laid not by states but by men and women with particular purposes, motives and grievances not sanctioned by any state. Efforts need to be made to find out what these purposes and motives are, and perhaps solve the problems in political ways if possible. In the long run this may be the most effective mine countermeasure in the so-called New World Order. For in concentrating entirely on technological solutions to the mine threat, our methods, to use Conrad's words, will have 'become unsound'.

PART III

DEVELOPMENTS IN ABOVE-WATER WARFARE

CHAPTER 5

AIR POWER IN THE WESTERN PACIFIC

Group Captain Gary Waters, RAAF and Wing Commander Greg Donaldson, RAAF

The conduct of sea warfare has undergone profound and fundamental change since the advent of air power; the means of waging maritime warfare now include the aeroplane. In fact the RAN stated in its Post-War Plan of 1945 that 'the master weapon of World War II has been the aeroplane'.[1]

As witnessed from 1916, land-based aircraft began to play a large part in controlling sea communications and countering the German U-boat threat. The US airman, General 'Billy' Mitchell, demonstrated another use of aircraft in 1921 when he destroyed the captured German dreadnought *Ostfriesland* with 2000 lb bombs.[2] By the beginning of the Second World War, popular opinion held that it was cheaper, quicker and more effective to protect shipping by attacking U-boats and submarines with land-based long-range aircraft than by providing escort carriers and carrier aircraft.[3]

After the loss of Norway in 1939, 'the Admiralty was forced to recognise that command of the air over the sea was as important as command of the sea itself'.[4] Furthermore, the Battle of the Atlantic proved that 'aircraft are the key to the protection of convoys'.[5] There are many examples of the susceptibility of surface ships to air attack: the vulnerability of allied troop carriers during the Crete operation in

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1 Australian Archives, CRS A5954 (Shedden Papers) Box 1841, quoted in Alan Stephens, 'Aerospace Strategy', *Australian Defence Force Journal*, No.98, January/February 1993, p.27.

2 William Mitchell, *Winged Defense* (Dover Publications, New York, 1988), pp.66-73.

3 These views are discussed in Sir Philip Joubert de la Ferté, *The Third Service: The Story behind the Royal Air Force* (Thames and Hudson, London, 1955).

4 Air Marshal Sir Robert Saundby, *Air Bombardment: The Story of its Development* (Chatto & Windus, London, 1961), p.93.

5 Asher Lee, *Air Power* (Gerald Duckworth, London, 1955), p.140.

1941,[6] the attack on naval ships at dock at Pearl Harbor in December 1941, and the disastrous allied landing off Salerno in September 1943[7] all reinforce the point.

In the Battle of the Coral Sea (7-8 May 1942), a major maritime battle occurred in which surface ships did not sight one another[8] or exchange fire. In fact, aircraft carried out all the offensive action 100 miles from their carriers.[9] Land-based aircraft participated in the battle (including B-17 Flying Fortresses, B-25 Mitchells, B-26 Marauders and RAAF Hudsons). Had the RAAF been better equipped, it could have contributed more. Indeed, it is not far-fetched to suggest that with better equipment and appropriate crew training, land-based aircraft operating from North Queensland, New Guinea or Noumea could have won the battle single-handed.

The sinking of the *Prince of Wales* and *Repulse* on 10 December 1941 re-affirmed the need for air cover over ships - whether that cover be carrier-borne or land-based. It has been suggested that a cavalier attitude to air power contributed significantly to the loss of these two ships, for they were within range of air cover but that cover was never requested.[10]

In the Battle of the Bismarck Sea (2-4 March 1943), land-based aircraft sank four destroyers and eight transport ships, thus halting the Japanese attempt to land 6,000 reinforcements in New Guinea. Here, aircraft destroyed more ships more quickly than in any other battle except Midway.[11]

The Falklands War of 1982 provided yet another example of the effectiveness of land-based aircraft in the maritime environment. The Argentinian air attacks with Exocet missiles destroyed

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6 Marshal of the Royal Air Force The Lord Tedder, G.C.B., *With Prejudice: The War Memoirs of Marshal of the Royal Air Force, Lord Tedder, G.C.B.* (Cassell, London, 1966), p.116.

7 John Terraine, *The Right of the Line* (Hodder and Stoughton, London, 1985), p.583.

8 Samuel Eliot Morison, *History of United States Naval Operations in World War II*, Vol.IV, *Coral Sea, Midway and Submarine Actions, May 1942-August 1942* (Little Brown, Boston, 1950), p.63.

9 Alan Stephens (ed.), *Defending the Air Sea Gap* (Australian Defence Studies Centre, Canberra, 1992), p.14.

10 Wing Commander A.J. Curr, 'What a Hell of a Mine', *Australian Defence Force Journal*, No.91, November/December 1991, pp.31-35.

11 Lex McAulay, *Battle of the Bismarck Sea* (St Martin's, New York, 1991), p.170.

HMS *Sheffield* and the container ship *Atlantic Conveyor*. Not one ofthe Super Etendards (which prosecuted the attacks) was lost.

At the beginning of the war, Argentina had only five air-launch Exocets and only five aircraft modified to carry them. The five missiles accounted for two British capital ships for no Argentinian aircraft losses.[12] Advances in technology provided the Argentinian pilots in 1982 with greater personal safety and greater likelihood of success than their RAAF/USAAF counterparts of 1942-43. Technological improvements have led to a marked increase today of combinations (such as F-111C or F/A-18 with Harpoon) over that afforded the Argentinians in 1982.

Geostrategic Environmental Issues

Major political factors affecting the future of the Western Pacific are the US draw-down in response to the decreased Soviet/Russian threat and the further development of China's military capabilities. Although the United States retains a major presence in Korea and Japan, reductions in the US presence in the Philippines and other parts of the region result in the need for greater self-sufficiency of regional nations. Growth in the strength of the Chinese economy, if translated into military strength, will have major implications for the defence of the region. For example, should China aggressively pursue its interests in the South China Sea, it may lead to a dangerous arms race within the region.[13]

Signs of an increase in ex-Soviet aircraft and associated weapon systems in the region are becoming apparent. This is of course a direct result of the changed geostrategic and economic environment in Eastern Europe. Malaysia is looking very closely at purchasing the MiG-29[14] for the air superiority role. China is negotiating for the

12 Stephens (ed.), *Defending the Air Sea Gap*, p.21.

13 See Michael Richardson, 'China's Build-up Rings Alarm Bells', *Asia-Pacific Defence Reporter*, February-March 1993, p.10.

14 The MiG-29 is an all-weather single-seat counter-air fighter with a ground attack capability. The export version of the MiG-29 is the MiG-29M, which has fly-by-wire controls and a glass cockpit. The aircraft is capable of carrying a range of air-to-air missiles and ground attack weapons. Malaysia is looking at purchasing the MiG-29M variant (see Michael Richardson, 'Malaysia Wants the MiG-29M', *Asia-Pacific Defence Reporter*, February-March 1993).

purchase of advanced fighters from Russia such as Su-27[15] and MiG-31[16] aircraft. They are also looking for an air-to-air refuelling capability (perhaps provided by excess Russian Il-76[17] transports) based at Zhanjiang in southern China, which would allow them to project air power into the region and, in particular, into the South China Sea.[18] China continues to produce and sell Silkworm[19] anti-ship missiles which, although dated in terms of technology, are still effective.

Nations of the Western Pacific are now taking more interest in their offshore territories and exclusive economic zones than in previous decades. Their fundamental interests are to learn the extent and value of their offshore resources, to observe and control human activities in EEZs, and to defend their sovereignty. While these nations are developing their own offshore capabilities, they are constrained in regional defence cooperation terms by:

- the limited number of multilateral defence agreements formalising close cooperation by nations in the region;
- budgetary limitations, although with rapidly expanding economies, particularly in the Southeast Asian countries, they have a capacity for more defence expenditure; and
- the fact that acquisitions are mostly designed for littoral applications. (Even China's carrier will be applied to its EEZ claims in the South China Sea.)

Foreign and defence policy emphasises that Australia's security is tied to regional security[20] and probably the most significant

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15 The Su-27 is a single-seat all-weather counter-air fighter. A two-seat combat trainer is also produced. A range of air-to-air missiles have been seen in Russian service on the Su-27.

16 The MiG-31 is a two-seat twin-engined strategic interceptor. Missile fit seen in Russian service has been AA-8 and AA-9 air-to-air missiles.

17 The Il-76 is a four-engined medium-to-long-range transport. In Russian military service, Il-76s modified as aerial refuellers are retitled as Il-78s.

18 *Aviation Week And Space Technology*, 5 October 1992, p.27.

19 The Silkworm missile is a development of the Soviet SS-N-2A 'Styx' missile technology of the 1950s. There are two operational variants, the HY-1 and -2. The HY-1 has a range of about 40 km while the HY-2 has a range of about 80 km. Guidance in the early stages on both variants is by autopilot with terminal guidance by active radar or IR seeker (on the HY-2 only).

20 See *Australia's Regional Security*, Ministerial Statement by Senator the Hon. Gareth Evans QC, Minister for Foreign Affairs and Trade, December 1989 (Department of Foreign Affairs and Trade, Canberra, 1989); and *The Defence of Australia 1987*,

contribution that Australia can make is in the maritime environment. In terms of the defence of Australia, there is unequivocal bipartisan support for the view that any hostile force could advance only in ships or aircraft. That must therefore be the focus for defence strategy. Such a view was articulated in 1988: Australia's 'military strategy for national security has to be fundamentally a maritime strategy'.[21]

Notwithstanding this, the focus of Australian defence planning and force structure deliberations remains deeply rooted in a continental strategy. As discussed by a noted defence analyst, it would have been more advantageous for Australia's national security if defence planning in recent years had been based historically on the maritime battles of the Coral Sea, Midway and the Bismarck Sea, rather than on the disastrous land battles fought on the other side of the globe in Greece, Crete, Tobruk and Gallipoli.[22]

The international move from bipolarity and the increasing focus on economic and trade issues in a multipolar trade-dependent environment carries attendant requirements to protect national trade links through areas of competing interest.[23] Such protection, in part, can be afforded to the Western Pacific through Australia's ability to provide a deterrent and to reach throughout the area to control airspace over those trade links and to apply force to protect them if necessary.[24] This ability for Australia to use land-based aircraft to expand its influence to protect its own interests and the interests of friendly nations in the Pacific contributes to regional stability: 'The thread is air power, supported by sea power, and its ability to exert influence through reach'.[25]

Presented to Parliament by the Minister for Defence the Hon. Kim C. Beazley, MP, March 1987 (Australian Government Publishing Service, Canberra, 1987).

21 Air Marshal R.G. Funnell, 'Air Power in the Defence of Australia', transcript of the Blamey Oration, Melbourne, 25 August 1988, p.7, reproduced in Gary Waters (ed.), *RAAF Air Power Doctrine: A Collection of Contemporary Essays* (Strategic and Defence Studies Centre, Australian National University, Canberra, 1990), p.74.

22 Stephens (ed.), *Defending the Air Sea Gap*, p.14.

23 Senator the Hon. Gareth Evans, 'Australia's Regional Security Environment' in Desmond Ball and David Horner (eds), *Strategic Studies in a Changing World* (Strategic and Defence Studies Centre, Australian National University, Canberra, 1992), pp.377-379.

24 This is expanded in Group Captain D.J. Schubert, 'Maritime Strike' in Stephens (ed.), *Defending the Air Sea Gap*, pp.73-74.

25 ibid., p.76.

Australia's land-based air power does provide the ability to respond quickly (to counter the large area) and to react to threats in several parts of that large area in a short time-frame (to counter small numbers of defence assets).

Common land borders in the Western Pacific are an exception, and thus external threats to regional countries would emerge principally through the maritime environment. Furthermore, these nations realise their dependence on seaborne trade and the economic significance of their respective 200-mile economic exclusion zones and offshore territories.

There are many independent nations in the area, with some having only gained their independence in the last decade or so. Each has social, economic and environmental expectations that will impact on the region as a whole. For that reason, infrastructure development of airfields and ports could be expected to increase. Moreover, as the strength of tourism increases, continued port and airfield developments throughout the Western Pacific will set in place some of the more sophisticated infrastructure needed to support the whole gamut of air and naval operations. This is certainly the case for air operations, an understanding of which can only be forthcoming through an understanding of air power doctrine.

Air Power Doctrine

Air power, in similar vein to land and sea power, has been applied historically through three distinct methods (or strategies). These are: bombardment, blockade and invasion. Bombardment is the localised attack of an enemy's armed forces or other strategic targets of national significance through the use of bombs, missiles, artillery shells and so on. Blockade or siege is the denial of resources and support for waging war or for national sustenance. Invasion is the comprehensive engagement of an enemy's armed forces and the occupation of enemy territory.[26]

RAAF doctrine argues that these methods of applying air power can be viewed at the strategic level as air campaigns (air strike,

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26 These antecedents from general warfare were postulated in an RAAF study: I. Westmore, *The Essence of Air Power Doctrine* (Department of Defence - Air Force Office, Canberra, 1989), p.7.

control of the air, and air support).[27] In this way, air strike can be seen as a means of achieving the strategic aim of bombardment. The purpose is purely offensive, with the objective to destroy the enemy's strategic capacity and will to continue conflict. Modern technology allows selective targeting and the ability to assure limited collateral damage.

Control of the air implies isolating an enemy and denying that enemy freedom of movement, akin to the strategic intention of blockade. The objective here is to assure a favourable air situation for a specified period over a specified area for a specified purpose. There is no single weapons system that allows control to be gained - indeed effective control calls for a plethora of systems and the associated doctrine for their necessary integration. Maintenance of sovereignty and protection of economic assets in the EEZ are tailor-made for control of the air and sea control operations. These two forms of *air* and *sea* control are inextricably linked as a unified *maritime* whole.

The third air campaign - air support - involves the exercise of air power to complement sea, land and other air power roles. It is this campaign which will dominate maritime warfare considerations in the Western Pacific in peacetime, particularly through the following roles and missions:

- survey (aerial photography);
- surveillance, especially over EEZs;
- light reconnaissance (for surface security forces);
- tactical transport (national tasks, ground security force mobility, logistics support of maritime deployments, etc.);
- airborne communications and liaison;
- VIP transport;
- construction work (such as erection of towers and rapid movement of equipment and personnel);
- search and rescue; and

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27 The three air campaigns are discussed in detail in AAP 1000, *Royal Australian Air Force Air Power Manual* (Air Power Studies Centre, Canberra, 1990), pp.32-35.

- as a general response to natural disasters.[28]

Notwithstanding these *support* issues, there are other important issues which need to be borne in mind. In time of conflict, aerial surveillance, anti-submarine warfare, anti-surface shipping warfare (ASuW), air defence of the fleet, and aerial minelaying may all be required.

All forms of national surveillance (air, sea, space, over-the-horizon radar (OTHR) and airborne early warning and control (AEW&C) must be coordinated. While this is accepted in military terms, there is much to be done in coordinating non-military agencies such as Coastwatch and the Australian Customs Service into the network in time of conflict. RAAF aircraft used for maritime surveillance would also have to provide ASW in time of conflict to protect vital sea lines of communication. The ASW role is a highly sophisticated one which requires constant practice to ensure effectiveness.

The greatest difficulty for aircraft in prosecuting ASuW in the past has been in penetrating an enemy's self-defence systems. However, the advent of highly accurate stand-off weapons and improved locating and targeting capabilities have swung the balance back in the aircraft's favour.

In terms of air defence of the fleet, joint planning and coordination are essential for land-based aircraft to ensure that the maritime area of operations is as free as possible of enemy aircraft and vessels. A coordinated air defence approach requires fighter aircraft to engage hostile enemy aircraft prior to weapon release, and Navy ships to defend themselves with organic self-defence weapons systems in the event of weapon release. Clearly, such air defence is not necessary if the friendly fleet restricts itself to a benign environment.

Aerial minelaying can be used in a defensive manner to protect home ports; however, the pinpoint accuracy of laying defensive mines (such that they can be located and disarmed later) means that surface vessels provide the best means for mine warfare. While aerial minelaying can be used offensively in enemy waters, especially in sea lanes and focal areas, enemy air defences tend to

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28 Air Marshal R.G. Funnell, Air Power and Smaller Pacific Nations - An Australian [Airman's] Perspective, an unpublished Chief of the Air Staff Paper presented to Asian Aerospace 90, 15 February 1990, p.8.

militate against widespread use of aircraft for such offensive minelaying operations.

Regional Cooperation and Security

Fundamental to regional security is Australia's ability to conduct surveillance of its own national interests, surveillance as part of alliance obligations, and surveillance activities on behalf of regional neighbours. For the future, the RAAF needs to pursue development of surveillance capabilities (both in aircraft and OTHR terms) and, eventually, satellite-based surveillance systems.

Irrespective of whether Australia is at peace, in transition to conflict, engaged at one of the levels of conflict postulated in *The Defence of Australia 1987*,[29] or even in a substantial conventional conflict, there will be a requirement for surveillance in the maritime approaches. Australia's geography demands a sound maritime surveillance capability that is threat-independent.

From earliest times, the ability to conduct surveillance depended on an ability to detect and track moving objects from as far away as possible and an ability to convey that information as quickly as possible to an operational commander.[30] Maritime patrol aircraft (MPA) offer a greater detection range of surface targets than ships. Their multi-sensor capability (infra-red, radar, electronic support measures) and their speed make them an inherently flexible and capable platform.

Technological developments in space-based systems have suggested such systems as a panacea for defence, albeit an expensive one. However, from a surveillance point of view, current space-based systems are of limited utility. For example, resolution requires a low earth orbit (150-1500 km) which makes satellites susceptible to poor meteorological conditions such as cloud and rain, so typical during the tropical wet season. On the other hand, emerging technologies do indicate improvements in effective resolution for satellites in

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29 *The Defence of Australia 1987*, chapter 3.

30 See Air Commodore Peter Nicholson, 'Surveillance' in Stephens (ed.), *Defending the Air Sea Gap*, p.29.

geostationary or geosynchronous orbits (above 35,786 km).[31]

In cooperating with regional air forces, the RAAF recognises that the region as a whole needs information and surveillance data to protect fishing, mineral, oil and gas resources, and to prevent drug-running and illegal immigration. A cost-effective solution for the region's surveillance requirements can be provided by sensors in land-based aircraft.

Countries throughout the region share a similar air environment, in that distances are large, air resources are limited and the threat is low. This must impact on broader air defence cooperation. Moreover, air doctrines are similar, in terms of small numbers of aircraft, attrition management and the need for reach. Long lines of communication to all nations in the region give rise to concern - it is a regional concern and requires a regional solution. An awareness of the need for a regional solution is a prerequisite for ultimate collective regional security and, through that, national security for Australia. For this reason, the RAAF is currently examining the role of land-based air power in low-level maritime threat assessments as well as providing a strong deterrent and powerful response to extra-regional aggression.

Land-based aircraft also provide a capability for graduated response. For instance, the RAAF's F/A-18s could simply fly into international airspace to indicate political resolve. In supporting a regional ally, these aircraft could be positioned over that ally's airfields. Should an indication of increase in resolve be required, F/A-18s could penetrate into an enemy's airspace, but retire prior to any engagement. At the further end of the graduated response spectrum, F-111C aircraft could prosecute land or maritime strikes.

As discussed earlier, RAAF doctrine argues that control of the air is the prime campaign in conflict. Geostrategic priorities and defence policy amplify this doctrinal tenet to indicate that control of the air over the sea/air gap is the prime campaign.

The region must be able to adapt as it responds to the changing environment. Air power is an ideal candidate for providing that adaptability. Furthermore, air power cooperation in the region

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31 Basic orbits and orbital mechanics are discussed at length in Squadron Leader A.M. Forestier, *Into the Fourth Dimension: An ADF Guide to Space* (Air Power Studies Centre, Canberra, 1991), pp.3.1-3.25.

will sharpen the focus of each nation's air force. From a sound defence posture, any lack in the ability of regional nations to react quickly throughout the Western Pacific will only encourage the potential for conflict in the area. That responsive capability is provided best through land-based air power.

Responsive air forces of the future need to maintain operational capability in all traditional roles and to maintain a minimum level of preparedness to meet operational requirements. In preparing for the future, there are some significant technological and operational developments that deserve attention.

Technological and Operational Developments

Rapid developments in high technology have had a profound effect on the utility of air power and the nature of air operations. Australia, a nation wedded to the concept of qualitative edge through technological innovation, has remained abreast of leading-edge technologies associated with land-based aircraft. As a consequence, changes in operational concepts have developed. The principal areas of technological and operational development encompass: engines, airframes, electronics and radar, infra-red (IR) and electro-optic (EO) systems, electronic combat, weapon systems, anti-submarine warfare, the Jindalee over-the-horizon radar network, and navigation and targeting systems.[32]

Engines

Increases in engine reliability have led to corresponding increases in aircraft availability, which in turn reduces the number of aircraft required to guarantee the success of a particular mission. Similarly, the reduction in fuel consumption achieved with modern engines provides longer range and on-station times.

Improvements to Pratt and Whitney 4000 series turbofan engines fitted to Boeing 767 aircraft since 1990 have resulted in specific

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32 The authors are indebted to RAAF Wing Commanders Al Curr and Bob Grey and RNZAF Squadron Leader Stu Mackenzie for contributions on these technological and operational issues.

fuel consumption (SFC)[33] improvements of 4 per cent.[34] Although these improvements are being applied to engines destined for civil airliners, the effects inevitably flow on to military engines. Examples of this osmosis between civil engines and military engines are the improvements to be made to the J52-P-408 engine fitted to the US Navy's A-6E Intruder all-weather attack aircraft. Improvements will be achieved by fitting the J52-P-409 engine, which has an improved high-pressure turbine taken from the commercial JT8D-219 fitted to the MD-80 aircraft. Engine thrust is improved by 30 per cent to 24,000 pounds and SFC is lowered by 3 per cent. Engine reliability is dramatically improved, with hot-end inspection[35] intervals increasing from every 750 hours to every 2000 hours. Overhaul life[36] increases from 1,500 hours to 4,000 hours.[37]

Other impressive improvements highlighted by the A6-E engine upgrade example are:

- an unscheduled removal rate of 20 per cent better than the J52-P-408;
- shop visit rate 20 per cent better; and
- mean time between failure rate improvement of 65 per cent.

As indicated previously, increases in engine efficiency are significantly impacting on-station times. For example, the T56-427 engine (fitted to the E-2C Hawkeye aircraft) has an increased fuel efficiency, or improved SFC, over its predecessor of approximately 15 per cent.[38] The predecessor dates from the early 1970s. The latest E-2C with Group 2 update has an on-station time of 15 per cent greater[39] than the Group 1 update, which ceased production in 1991.

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33 SFC, in engineering terms, is measured as pounds of thrust per pounds of fuel consumed per hour. In operational terms, SFC is measured as pounds of thrust per pounds of fuel consumed per nautical mile.

34 See 'Pratt Delays PW4000 Efficiency Upgrades', *Aviation Week and Space Technology*, 25 May 1993, p.33.

35 Hot-end inspections are scheduled inspections on the turbine section of turbo-fan engines.

36 Overhaul life is the period prescribed between scheduled engine overhauls.

37 Stanley W. Kandebo, 'A-6 Modifications Explored to Extend Service Life to 2015', *Aviation Week and Space Technology*, 9 November 1992, p.55.

38 Stanley W. Kandebo, 'Update Positions E-2C for 21st Century', *Aviation Week and Space Technology*, 4 January 1993, p 40.

39 ibid.

This indicates the scale of fuel efficiency improvements being realised and the impact on endurance.

Improvements in engine efficiencies combined with technological improvements in other areas, especially microprocessors (discussed below), mean that it is possible to extract greater performance from existing weapon systems. For future designs, greater fuel efficiency means that for the same range, less airframe space is required for fuel. This translates into more space being available for avionics and weapons. Alternatively, designers can take advantage of improved engine efficiencies and provide aircraft with greater range, as highlighted earlier in the E-2C Hawkeye example.

Reliability and maintainability improvements indicate potentially dramatic reductions in the cost of ownership of weapon systems. These improvements are not confined to engines; indeed they are manifest across the whole spectrum of technologies used in military equipment. To a large extent, improvements in reliability and maintainability in the aerospace industry are being driven by the need to reduce support costs, which in turn is dictated by greater pressures on commercial and defence budgets.

A by-product of increased engine reliability is the greater confidence that can be placed in the safety of over-water operations. In the civil sphere, this has led to operators exceeding the 'shut-down' rates[40] specified by regulatory bodies for extended-range operations (ETOPS) for twin-engine aircraft. This trend will probably increase the attractiveness of twin-engine airliner derivatives for use in maritime patrol (especially surveillance) and AEW&C roles.

Efforts to reduce the IR signature of engines are ongoing. This has an impact on the development of IR-capable missiles (for example, the AIM-9 Sidewinder). Cooling of engine exhaust plumes and positioning of engines within airframes are design options for reduction of IR signature and hence reduced susceptibility to IR-homing missiles. As well as being cooled, exhaust plumes can be

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40 The 'shut-down' rate for a particular engine type is a measure of the number of forced engine shut-downs recorded for a given level of flying effort in normal service. The normal measure for shut-down rate is the number of shut-downs per 1000 flying hours.

reshaped and directed through a special fairing.[41] Vertical baffles inside the air ducts can also mask engine heat. Turbofan engines, by virtue of their large rotating fans, are excellent radar reflectors for pulse-doppler radars and efforts to reduce radar signature are ongoing. Air ducts above and behind the engine can be lined with radar-absorbent material (RAM) and covered with RAM-coated grids. Additionally, engines can to some extent be physically hidden inside airframe structures so that compressor fan exposure is reduced. The B-2 bomber is an extreme example of this, as it has its engine buried in its wing structure with intake air being fed from an opening in the leading edge via an S-shaped inlet duct.

Airframes

The major issue in military airframe development is in the stealth arena. In the maritime environment, as in other environments, stealthy aircraft shorten the enemy's detection range and therefore allow friendly forces to penetrate defences o a greater depth. Stealth technology embraces:

- reduction in radar cross-section (RCS);
- radar absorption;
- reduction of IR signature; and
- reduction in active emissions.

Reduction in RCS involves the reduction of the cross-section of aircraft as presented on radar screens. The degree of reduction is dependent on the attenuation and diversion of radar waves aimed at the target aircraft. Selection of appropriate geometric aircraft forms is the main method of reducing RCS. For example, the F-117A's fuselage and wings meet in a pyramid shape, rather than as a rectangle, and the two fins are outward slanting, rather than horizontal or vertical. The aircraft's overall construction is of flat straight-edged panels, and any seams are specially machined to reduce radar signature. Wing leading edges are swept back at a 67 degree angle such that radar waves are deflected sideways and to the rear. Other flat surfaces are tilted at

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41 See 'A Radical Design for Nightmare Strikes' in *The New Face of War: Air Strikes* (Time Life Books, Alexandria Virginia, 1991), pp.69-75.

angles (approximately 30 degrees) so as to deflect radar waves upwards. The intention is always to deflect or absorb radar waves to prevent their return to the emitting radar.

The importance of reduction of RCS has been stated as follows:

> An aircraft with an RCS of one metre can be detected at a distance of 200 miles by a modern early-warning radar. If ... the RCS was reduced to one millimetre (the estimated RCS of the B-2), the aircraft would not be detected by the same radar until approximately four miles.[42]

Radar absorption and reduction of IR signature have been discussed already, Quite simply, radar absorption involves the use of radar-absorbing coatings or paint on the airframe surface and RAM in exposed airframe voids such as in engine intakes. Reduction of IR signature mainly involves reducing the energy emitted from aircraft engines. The reduction in active emissions is an electronic issue and requires further elaboration in the section below entitled 'Electronics/Radar Developments'.

Another development in airframe construction is the use of modern materials such as composites and various metal alloys to reduce weight. These materials allow the production of components which are higher in strength for a given weight. As discussed previously, reduction in weight for a given airframe size allows greater capacity to carry fuel, avionics and weapons. Finally, composite materials facilitate the production of the complex shapes required for greater stealth.

Modern airframe design techniques and materials are allowing the production of airframes with greater serviceability and longer life. This has a number of implications including:

- increased aircraft availability;
- greater resistance to corrosion, particularly in the maritime environment; and

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42 Randolph H. Brinkley, 'Future US Fighters Are at a Cost/Technology Crossroad', *Armed Forces Journal International*, January 1991, p.49.

- the availability of platforms which are suitable for upgrading a number of times during their operational life.

Use of active control systems in aircraft is now almost universal. Active control systems allow inherently unstable aircraft designs to fly and also allow reductions in the size of wing and control surfaces, which in turn allows for more efficient aerodynamics. Gains in aerodynamic efficiency largely translate into increases in range and aircraft manoeuvrability. Active control systems also allow increased control system reliability and reduce the effect of battle damage through multiple redundancy.

The RAAF found, in transitioning from P-3B to P-3C aircraft, that advances in the capabilities of the acoustic detection equipment allowed P-3Cs to fly at higher altitudes while engaged in ASW activities. Less stress is placed on the airframe and also exposure to corrosive spray is reduced. The ability to fly at higher altitudes conferred by modern detection systems, combined with the reliability of modern engines, makes increasingly attractive the use of twin-engined civil airliners in maritime patrol roles. However, one disadvantage of civil airframes is the significant modification required to cater for the carriage of torpedoes or acoustic detection-related equipment such as sonobuoys.

Electronics/Radar Developments

Developments in microprocessors are revolutionising weapon systems and have led to operational capabilities which existed only in our imagination just 10 years ago. Significant reductions in the size of microprocessing equipment and modularisation allows weapon systems to be used in a wider range of roles. For instance it is now conceivable that an aircraft such as the Hornet could be fitted with an acoustic detection suite on a pod for utilisation in the ASW role. Naturally, the aircraft would not have the organic long range and endurance advantage of the P-3C.

Radar performance requirements principally relate to sensitivity, resolution and data rate. Different aspects of performance are emphasised in different operational environments and roles. In a maritime environment and surface surveillance role, radar resolution of stationary or slow-moving targets against the clutter caused by the sea is obviously important. A radar used to monitor high-speed targets in the air requires the application of different techniques to those just mentioned for the maritime surface surveillance role. Transmitter power, frequency, antenna design, pulse repetition frequency (PRF), pulse width, beam width and beam pattern are all carefully considered against the operational requirements of a particular system to ensure optimum efficiency and a good signal-to-noise ratio.[43]

Most modern airborne radar systems incorporate passive phased-array antenna systems. A significant amount of work is currently being undertaken to develop improved versions of these antenna systems. The major area of development is in active phased-array antennas. This technology involves the physical mounting of the transmitter and receiver modules directly behind the antenna array. In a passive phased array, these modules are physically removed from the antenna and radar energy is carried to and from the antenna by relatively lengthy microwave guides. This design inherently involves relatively high energy losses compared to active phased-array antenna systems.

All radar systems are affected by thermal effects within their circuitry.[44] Noise is created by the random movements of electrons and ultimately adversely affects the signal-to-noise performance of the radar. The higher the thermal effect, the greater the noise. Therefore considerable effort is being made to reduce thermal noise in radar systems. The active phased-array antenna has the advantage over the passive phased-array antenna in terms of thermal noise due to the effects of multiple, low-power transmit/receive modules in the former. In a further effort to reduce thermal noise in these antenna systems, gallium arsenide (GaAs) components are now being used in some systems where previously silicon has been used. GaAs components have low thermal noise properties and are almost universally used in satellite antenna systems, primarily for this reason.

Antenna arrays forming part of the surface of the aircraft are termed conformal antenna arrays and are likely to become more prevalent in the future due to their ability to provide 360 degree

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43 See *Jane's Radar and Electronic Warfare Systems 1992-93* (Jane's Information Group, Coulsdon Surrey, 1992), p.3.

44 See George W. Stimson, *Introduction to Airborne Radar* (Hughes Aircraft Company, El Segundo, 1983), p.165.

coverage, if suitably located in the airframe. Another advantage of these systems is in their contribution to reduction of RCS.

In the maritime reconnaissance role, radar systems need to employ such techniques as pulse compression[45] and scan-to-scan processing[46] to eliminate sea clutter. Synthetic-aperture radars simulate radar antenna sizes much larger than the antenna being used and can be used for long-range ship profiling and hence classification.

With changes in technology, eventually, the capability and support costs associated with older avionics systems do not meet contemporary needs. A need for comprehensive change to extant systems, tactical doctrine, operating procedures and support infrastructure is generally the outcome of the rapid change in avionics technology. In the case of the RAAF's F-111C, advances in technology have necessitated an update of the avionics system known as the avionics update programme (AUP). This programme involves updates to displays, computers, communication systems, terrain following and attack radars, the digital flight control system and the aircraft stores management system. A new weapons system support facility (WSSF) and new automated test equipment (ATE) are also being procured.[47]

Infra-red and Electro-optic Systems

Modern maritime patrol aircraft such as the P-3C and fighter aircraft such as the F/A-18 Hornet employ IR technology for various surveillance, ASW and air interdiction tasks. IR equipment is mounted in a forward-looking infra-red (FLIR) pod or turret. There is a trend towards using laser designators in conjunction with IR equipment which, as seen in the Gulf War, dramatically increases weapon accuracy and hence weapon cost-effectiveness. Current developments in FLIR technology are aimed at producing systems with greater detection and acquisition ranges.

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45 Pulse compression is a method of increasing the resolution of a radar while retaining the power transmission capabilities of the radar. The method involves compressing the radar returns from the target.

46 Scan-to-scan processing involves discrimination between objects of differing velocities. In the maritime environment, there is a need to filter out the clutter caused by waves' velocities.

47 See Warwick Shields, 'Updated', *Australian Defence Force Journal*, January-February 1993, p.61.

Electro-optic (EO) systems combine IR technology with a microprocessing capability to produce a passive version of the profiling radar. EO systems can be used in the dual roles of navigation and targeting; this is a capability extant in the low-altitude navigation and targeting IR system for night (LANTIRN) fitted to a number of fighter aircraft such as F-15Es and F-16s. LANTIRN 'provides long-range detection, minimises radar transmit time, allows laser ranging to the target to be done slewed [to] line-of-sight or to the radar, and can be used to slew and point air-to-air weapons [at] the target'.[48] The advantage of EO (and IR) systems is that they are completely passive, unless of course they are combined with a laser designation capability when it is activated. The disadvantage is that they have similar limitations to the human eye in daylight as they are influenced by smoke, rain and some forms of camouflage.[49]

Electronic Combat

The importance of electronic combat (EC) to the application of air power is probably no more graphically illustrated than in the experience of the Israelis in the Yom Kippur War of 1973, where they lost over 100 aircraft to radar-directed anti-aircraft artillery (AAA) and surface-to-air missiles (SAMs). The Israelis learnt the EW lesson so well that in 1982, in the Beka'a Valley, they lost only two aircraft for the destruction of 80 aircraft and 19 SAM sites on the Syrian side.[50] Electronic combat comprises electronic warfare (EW) and suppression of enemy air defences (SEAD). Both EW and SEAD involve monitoring the electromagnetic spectrum used by the enemy. EW involves electronic support measures (ESM), electronic countermeasures (ECM) and electronic counter countermeasures (ECCM).

ESM is the process of passively collecting electronic information for intelligence or early warning purposes and can enhance air operations through the primary tasks of intercept and passive warning. ECM involves active offensive measures to deny an enemy the use of the electromagnetic spectrum and includes the use of

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48 Joris Janssen Lok, 'Expanding Hornet into the Night', *Jane's Defence Weekly*, 29 June 1991, p.1185.

49 See Paul R. Jaszka, 'Guidance Systems Advance in Air-Launched Missiles', *Defense Electronics*, May 1989, p.49.

50 See Carlo Kopp, 'Radar Warning Receivers and Defensive Electronic Counter Measures', *Australian Aviation*, September 1988, p.38.

deceptive transmissions, jamming, decoys and screens. While ESM and ECM result from initiatives taken by operators, ECCM is more concerned with providing equipment which is inherently resistant to ECM. SEAD involves use of electronic or physical means to neutralise, temporarily degrade or destroy enemy air defences.[51]

The sheer volume of electromagnetic emissions from electronic equipment is increasing at a dramatic rate. This presents a daunting situation for the design of EW equipment. The volume of emission, particularly in a combat scenario, means that sophisticated methods of processing the signals being received and determining effective ECM and ECCM responses need to be incorporated into weapon systems. However, the processing power required in modern EW is such that providing appropriate processing power, and hence undertaking effective EW, becomes almost prohibitively expensive. The difficulties with 'defeating the threat', which is the basis of EW, have led to the view that 'avoiding the threat' is an important consideration in weapon system design.[52] Indeed, this is one reason why the development of 'low observability' (stealth) is so important.

Notwithstanding the difficulties involved in designing equipment with a high level of EW capability, EW enjoyed a high degree of success in the Gulf War. In large part, this was due to the use of dedicated jamming aircraft such as the USAF EF-111 and USN EA-6B in support of strike aircraft. Additionally, the effective use of anti-radiation missiles (ARMs), against air defence radars in the SEAD role, ensured that Iraq's air defence system was quickly rendered ineffective. It is important to note that ARMs are only capable of 'soft kill' in the sense that they will only target the source of the electromagnetic emissions, or the radar head. They will not achieve a 'hard kill', which involves destroying the radar and the SAM launcher associated with the radar system. Consequently, in the Gulf War, SEAD aircraft such as F-4Gs and F-16Cs carried bombs, cluster bomb units (CBUs) and Maverick missiles to destroy SAM launchers as well as SAM radars.[53]

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51 See Gary Waters, *Gulf Lesson One - The Value of Air Power: Doctrinal Lessons for Australia* (Air Power Studies Centre, Canberra, 1992), p.185.

52 See James W. Canan, 'How Electronic Countermeasures Went Wrong', *Air Force Magazine*, August 1989, p.41.

53 See Waters, *Gulf Lesson One*, p.190.

The implication for air operations in the maritime environment is that, should the enemy deploy a land-based (eg on an island) air defence system incorporating SAMs, then a SEAD capability will be required. SEAD can only be carried out by air assets and, in Australia's case, that means land-based air assets.

Weapon Systems

The weapon systems available for aircraft to engage maritime targets are becoming progressively more capable. This rate of increase appears to be greater than the development of ships' defensive systems designed to counter them. Weapons have increased stand-off ranges, which translates into reduced exposure for attackers and allows them to remain outside ship missile engagement envelopes. Improvements in warhead size and lethality have led to increasing probabilities of kill (Pk). Indeed, the Pk for modern air-to-surface missiles approaches a probability of one. Close-in weapons systems (CIWSs) have improved the defensive capability of ships but, faced with high Pks, ships are increasingly vulnerable to concentrated multiple attacks from aircraft and missiles.

For the CIWS role, in the maritime or land-based environment, the Goalkeeper system[54] is a state-of-the-art system. However, this system's primary search and tracking methods are X-band and X/Ka-band radars respectively - Goalkeeper is primarily an active system. For effectiveness in a passive mode, these systems need to be employed with an IR scanning capability. However, all these systems rely on guns, which are ultimately subject to ammunition limitations and therefore lead to ship vulnerability under sustained attack.

Aircraft can expect to operate above 10,000 feet with almost total immunity if the enemy employs only defensive weapons systems such as man-portable low-level air defence (LLAD) missiles. LLAD missiles may be radar-guided, but will more likely be shoulder-fired and utilise IR or laser-guidance technology. If the enemy has a radar-guided SAM capability intact, then aircraft will need to apply an appropriate EC capability such as SEAD using ARMs. However, in the Gulf War, ground-launched IR missiles accounted for all but two or

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54 See Joris Janssen Lok, 'Beating the Close-in Threat', *Jane's Defence Weekly*, 30 January 1993, pp.22-23.

three of the 38 US and allied fixed-wing aircraft lost to hostile fire.[55] This reflects not only the effectiveness of SEAD operations but also the vulnerability of aircraft to IR missiles at low level. Unfortunately, existing fighter aircraft do not have a system that adequately warns of approaching IR missiles and automatically dispenses flares or decoys.[56]

If the enemy is not equipped with LLAD missiles, then the danger envelope reduces to around 5000 feet for small-calibre weapons during daylight and to almost sea level at night.[57] Aircraft equipped with day/night target detection and laser designation systems could operate in that environment with immunity and provide precision strike with weapons such as laser-guided bombs (LGBs).[58]

Against more capable ship-borne defensive systems, weapons such as AGM-84 Harpoon[59] could be employed in an open sea environment where target identification is not an issue, as friendly ships will not be confused with the enemy. If 'man-in-the-loop' is necessary until impact, then shorter range weapons such as AGM-65 Maverick[60] and GBU-15[61] would be appropriate. In this case, however, control of the air is a necessary ingredient. Powered weapons such as

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55 Julian Lake, 'Despite Initial Problems, EW Systems Prove Effective in Desert Storm', *Armed Forces Journal International*, July 1991, p.49.

56 ibid.

57 The details of the vulnerability envelope contained in this chapter are drawn from Peter Criss, *Employing Smart Technology in Low Intensity Conflict* (Air Power Studies Centre, Canberra, 1992).

58 Laser-guided bombs are general-purpose (GP) bombs fitted with laser seekers and guidance fins for aerodynamic control. The seeker homes onto laser energy reflected from the target and transmits signals to the fins via the guidance computer.

59 Harpoon is a long-range (approx 40 km) radar-guided air-to-surface or surface-to-surface guided missile. The weapon is capable of a sea-skimming trajectory designed to reduce the probability of radar detection by the target. It is fitted to the RAAF's F-111C and P-3C aircraft. There is a land strike version of the Harpoon (AGM-84E) called the standoff land attack missile (SLAM).

60 The AGM-65 Maverick missile is a precision-guided tactical weapon which travels at supersonic speed and uses infra-red (D,F and G variants), TV (A and B variants) or laser (E variant) guidance. Effective range of the Maverick varies between 20 and 25 km. TV-guided missiles are limited to daylight use only.

61 The GBU-15 is a 2500 lb glide bomb which is guided by TV or imaging infra-red. The operator in the aircraft positions the cross-hairs in his cockpit video display on the target, locks the bomb's camera on the target and then fires the weapon.

Maverick are also capable of matching aggressive manoeuvres which could be expected from craft such as fast patrol boats.

Anti-Submarine Warfare

Improvements in submarine technology and the use of submarines have been met with corresponding improvements in ASW capability to the extent that land-based aircraft can provide an effective counter to the submarine.[62] The point raised earlier about air power providing an ability to react quickly over large areas applies equally to ASW. However, ASW is difficult and the skills required are perishable.

The RAAF's P-3C Orion provides a formidable ASW platform with its AQS-901 acoustic system, and passive sonobuoys, radar, IR detection system, and magnetic anomaly detector. Unfortunately, the torpedo currently in use, the Mk 46, represents old technology, with limited range, a small detection capability and lack of speed.[63] Detection systems (such as fixed or tethered acoustic arrays) can be used to localise a submarine threat, and aircraft can then be used to pinpoint and attack a hostile submarine.

Notwithstanding the foregoing comments, airborne ASW is expensive and has its limitations. There should be little doubt that a combination of submarines, ships and aircraft is necessary for cost-effective ASW. As observed by an experienced RAAF maritime warfare officer: 'ASW is the quintessential joint operation'.[64]

Jindalee Operational Radar Network

The Jindalee operational radar network (JORN) will comprise two radars (near Longreach, Queensland and Laverton, Western Australia) and a JORN Coordination Centre at RAAF Base Edinburgh, South Australia. Each station comprises a high-frequency transmitter which refracts a signal from the ionosphere to a target, and a receiver site which accepts an echo from the target. The transmitter receiver sites are located 100 km apart. Detection range for both ships and aircraft is expected to be 2000-3000 kilometres. JORN uses shifts in

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62 Discussed in detail in Wing Commander Ian MacFarling, 'Airborne Anti-Submarine Warfare' in Stephens (ed.), *Defending the Air Sea Gap*, p.90.

63 ibid., p.99.

64 ibid., p.102.

doppler frequency to monitor moving targets and in this regard is similar to the technique used by pulse doppler radars in fighter aircraft.

In an operational sense, JORN will alert F/A-18 Hornet aircraft and Fremantle-class patrol boats to the presence of targets which need to be intercepted and identified. Surface vessels will find it extremely difficult to avoid detection within JORN's footprint. Moreover, dispersion will become a less effective tactic in areas covered by JORN. Fundamental to the effective identification of targets, detected by JORN, will be the presence of AEW&C aircraft. JORN has applicability in peacetime (for customs, immigration and so forth) as well as in time of conflict. The radars will also monitor weather patterns, which will allow the force and direction of cyclone activity to be plotted.[65]

Navigation and Targeting

Advances in technology are making ships easier to identify and to target accurately. Profiling radars allow identification of the class of a ship from beyond visual range. Global positioning system is being integrated into a large number of aircraft and weapon systems and allows pinpoint navigational accuracy over large expanses of water. GPS not only improves navigation accuracy but enhances target acquisition and assists in weapon delivery and guidance, search and rescue (SAR) and command and control (C^2).[66]

Miniaturised airborne GPS receivers (MAGRs), which are currently being developed, will reduce on-board space requirements of F/A-18 Hornet and F-111C to half that required by current airborne receivers. Airborne GPSs can operate as stand-alone systems that provide aircrew with latitude, longitude, altitude and time, or as integrated systems that further improve navigation and weapon delivery accuracy.

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65 Colin Blair, 'Jindalee Construction Under Way', *Asia-Pacific Defence Reporter*, February-March 1993, p.36.

66 Expanded in Mark Hewish and Gerard Turbe, 'GPS Comes of Age', *Defence Electronics and Computing Supplement to International Defense Review*, 7/1991, p.75.

Conclusion

There have been profound changes in maritime warfare since the advent of air power. The nature of these changes has been evident from the experiences of the Second World War and other wars since. During the Second World War, the view that it was more cost-effective to project air power in the maritime environment through the use of land-based rather than ship-borne aircraft gained credence. The current geostrategic circumstances of Australia and other nations of the Western Pacific support the fundamental importance of air power projection by land-based aircraft.

Australia's defence policy, as espoused in *The Defence of Australia 1987*, is firmly rooted in the defence of the air/sea gap.[67] The strategies of defence in depth and increased defence self-reliance have important implications for defence of that air/sea gap. In Australia's case, pursuit of these strategies involves possession of a credible maritime defence capability with an emphasis on reach, rapid response over large distances, and all-weather performance.[68] The increasing emphasis on economic and trade issues in a multipolar environment also ensures that there is a need for Australia and other Western Pacific countries to protect their trade routes. The Western Pacific is a region of large air volume and sea area. This naturally leads to the countries of the Western Pacific becoming increasingly reliant on the application of air power to protect their areas of interest. The large area involved, particularly in Australia's case, emphasises the fact that technology and air power must provide the foundation of effective defence within the region.

The Gulf War has significantly altered perceptions by both the military and the general public of the importance of both air power and technology to defence matters. In a generic sense, the importance of these issues in the maritime environment has also been highlighted by the Gulf War. Clearly also, the maritime environment needs the application of air power doctrine and technologies which are in many ways unique to that environment. A number of areas of technological development have been discussed in this chapter. The technological improvements discussed, in combination with the geostrategic circumstances which prevail in the Western Pacific region, lead to the

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67 *The Defence of Australia 1987*, p.31.
68 See Schubert, 'Maritime Strike', p.72.

conclusion that land-based air power has a pivotal role which is increasing in importance.

Technological developments have led to increases in reliability and maintainability, which in turn lead to increased sortie rates. Fighter-bombers of the Second World War flew about once every four days; improving slightly to once every three days in Korea. By the time of the Vietnam War, such aircraft flew four out of every five days and in the Gulf War allied planning staffs expected at least three sorties every two days.[69] Increased sortie rates translate directly to increased cost-effectiveness.

This cost-effectiveness has been improved even further through the development of systems that enhance survivability. Loss rates for aircraft have been falling. The combat air loss rate for US forces during the Second World War was 9.7 per cent; during the Korean War, 2 per cent; and during the Vietnam War, 0.4 per cent. Linebacker II, in which US aircraft flew against sophisticated air defences around Hanoi and Haiphong, maintained a loss rate of less than 2 per cent. Israeli losses during the Yom Kippur War were 1 per cent and British losses in the Falklands were less than 2 per cent.[70] In the Gulf War, allied losses were 0.035 per cent.[71]

Further developments in precision-guided stand-off weapons and stealth technology will contribute to improved survivability in the future. Precision-guided stand-off weapons not only enlarge the requirements for defence, they also increase surface-to-air missile engagement problems. Improvements in single-shot kill probabilities afforded by precision-guided stand-off weapons reduce the number of aircraft needed to attack given targets.

When night vision equipment is added to the range of technological developments discussed earlier (GPS, AAR, stealth, PGMs, etc.), air power is afforded the ability to conduct precision attacks against a variety of targets over considerable distances, 24 hours a day, including in inclement weather. In terms of flexibility the

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69 These figures are quoted by Air Chief Marshal Sir Michael Graydon, Chief of Air Staff, UK, in his opening address, Future Air Power Requirements, to the Shephard Conference on Air Power, held in the UK on 11-12 February 1993.

70 Group Captain A.G.B. Vallance, 'The Future: Offensive Air Operations', *RUSI Journal*, Summer 1991, p.24.

71 Waters, *Gulf Lesson One*, p.143.

F-111C, for instance, can be armed with two 500 lb LGBs, two Harpoon missiles and two AIM-9 Sidewinder air-to-air missiles, thus allowing a response to sea, land and air threats in the one mission.[72]

The ADF must expect an enemy's air defence system to include a mix of AAA and SAM defences, with radar, optical and IR tracking capabilities. While the United States is able to invest considerably in dedicated jamming, SEAD and stealth aircraft, such is not the case for Australia or other Western Pacific nations. In terms of stealth, radar cross-sections can be reduced without incurring costs of the ilk of the USAF's F-117A. A low RCS allows aircraft to hide in low-level clutter and this type of technology is affordable for small nations. Modern combat aircraft last much longer than their predecessors. For example, in the 1930s a fighter aircraft had a half-life of about two years. In the 1950s they were obsolescent in five years; in the 1960s in about 10 years; in the 1970s in about 20 years. Those of the 1980s and 1990s will last even longer. The F-4 Phantom has been in service now for 34 years; C-130s have been around for 25 years.

The contribution of weapon systems to national security must be factored into the cost-effectiveness equation and the advances in technology suggest that aircraft are becoming increasingly cost-effective. Commercial aircraft equipment is being produced in ever-increasing quantities and, as the need for the military to 'over-design' and 'over-ruggedise' equipment which has a civilian counterpart diminishes, costs of the total system can be reduced.

Finally, aircraft are an indispensable component of the maritime warfare environment in the Western Pacific region. Air power's unique attributes, which make it such a potent force in the maritime environment, are only enhanced by the technological developments discussed in this chapter.

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72 Stephens (ed.), *Defending the Air Sea Gap*, p.121.

CHAPTER 6

SEA-BASED AIR

Stan Weeks

Developments in sea-based air have continued to evolve with the shifting global security context of the post-Cold War era. For the United States, as well as for the naval forces of many Western Pacific nations, this has meant a trend toward multi-mission roles for both fixed-wing aircraft and tactical sea-based helicopters. This shift toward multi-mission roles informs both force structure and employment decisions for sea-based air.

For the United States, the trend in sea-based air reflects more closely the new littoral, expeditionary, joint nature of current naval operations, as outlined by the recent White Paper, *From the Sea*.[1] For other nations, this trend toward multi-mission, sea-based air provides flexibility to meet the new challenges of a changing security environment.

For fixed-wing aircraft, the prime focus has been on providing multi-mission fighter and attack capabilities in the same aircraft. (This continues an earlier trend of incorporating the tactical air reconnaissance mission in, for example, US Navy F-14 fighter aircraft though add-on tactical air reconnaissance pod system (TARPS) pods.) The new Marine Corps Harrier II Plus version will modify this primary ground attack aircraft with radar and night capability to allow better fighter aircraft performance. US naval helicopters are also changing to reflect more diverse roles including surveillance, shallow-water ASW, and anti-surface missions.

A more detailed survey of more recent and planned developments in US sea-based air will confirm the changing littoral, multi-mission emphasis. The trend toward multi-mission fixed-wing

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1 US Department of the Navy and US Marine Corps White Paper, ... *From the Sea*.

carrier aircraft has been underway for some time. The value of the fighter/attack capabilities of the F/A-18 were validated in the 1991 Persian Gulf War. As noted above, since the mid-1980s, tactical reconnaissance has been performed through adding TARPS pods to F-14 aircraft. With the early retirement of dedicated A-6 attack aircraft, land attack capability (for laser-guided bombs) will be added to F-14 fighters. Each aircraft carrier will now be receiving two HH-60H combat search and rescue helicopters, which can also fill attack and special forces delivery roles. Indeed, the multi-mission trend is perhaps most evident in US naval helicopters.

Some cruiser/destroyer/frigate based SH-60B helicopters have recently been armed with the Penguin missile to attack larger ship targets, and new plans call for arming other SH-60B naval helicopters with forward-looking infra-red radar, laser designators, and Hellfire missiles. To enhance shallow-water ASW, these SH-60Bs are also now slated to receive the same advanced low-frequency (dipping) sonar as carrier-based SH-60Fs.

The trend to multi-mission capabilities in US sea-based aircraft will continue in the future. For the remainder of this decade, F/A-18 aircraft will be the sole procurement for carrier fighter/attack roles, and the eventual permanent A-6 replacement (formerly AFX) is also planned to be multi-mission. In addition to adding dipping sonars and arming ship-based helicopters, some of these are likely to receive laser minehunting capability. Unmanned aerial vehicles (UAVs) are likely to provide major new multi-mission sea-based air capabilities. Pioneer UAVs embarked on US battleships in the Persian Gulf War provided gunfire support spotting and damage assessment. Eventually, new UAVs may fill most of the reconnaissance and targeting roles. By 2000, the first of the Marine Corps vertical/short take-off and landing (VSTOL) V-22 aircraft will join the Fleet. Long-term (post-2010) planning envisions a V-22 VSTOL-type follow-on marine attack/observation (VMAO) aircraft to replace Marine Corps Cobra AH-1s, Huey UH-1Ns, and even OV-10D Broncos in their respective roles of armed escort, combat support and reconnaissance. A similar Navy derivative, SH(X), is envisioned as the long-term replacement for Navy H-60 series helicopters and S-3 Viking fixed-wing carrier ASW aircraft. There are also major long-term implications in plans for a potential advanced supersonic VSTOL (Harrier follow-on) with respect to distributing air power at sea and perhaps eventually reducing the size of dedicated carrier aircraft platforms.

Sea-based air in the countries of the Western Pacific already reflects many of these current changes in US sea-based air, and also demonstrates the new focus on multi-mission roles. The United States is now the only Pacific nation with a carrier fixed-wing aircraft capability, as the Russian VSTOL carriers *Minsk* and *Novorossisk* remain inoperable in the Vladiovstock area, and are unlikely to be repaired. In the future, helicopters will be integral to any standard destroyer class. In Japan, the helicopter force is modern, but there are no firm plans for developing a dedicated helicopter carrier. In the Republic of Korea, Lynx helicopters will be embarked on the new frigates. Taiwan has recently purchased LAMPS I helicopters, which will be integral to their new frigates. And for the People's Republic of China, there is an increased emphasis on helicopters on their new DDGs. The Chinese are also eager to eventually acquire a carrier for blue-water operations, and will probably first acquire a helicopter carrier.

In Southeast Asia, in Malaysia and Indonesia, the move will likely be from a first-generation Wasp-type surveillance/utility/ASW torpedo drop helicopter to a more capable multi-mission helicopter. India has two aircraft carriers, with VSTOL Harrier aircraft embarked, as well as helicopters on ships. Thailand has a helicopter carrier under construction in Spain for delivery in 1995, and may try to purchase Harrier aircraft as well. The rationales for the Thai carrier have varied, and include: defence of Thailand's west coast; support to disaster-relief efforts in Southern Thailand; and, more recently, the need to control sea lines of communication in the Gulf of Thailand. These varied arguments have reinforced the widespread belief that the real reason for Thailand's carrier acquisition is internal military competition and external desire for prestige - irrespective of the undesirable precedent the Thais might set for potential PRC and even Japanese carrier acquisition. Australia, of course, has one of the most modern naval forces in the Western Pacific, including embarked SH-60B helicopters. Although not approved yet, there is considerable naval desire for an Australian helicopter carrier which could fill both training and support roles.

In the future Pacific security environment, sea-based air will continue to perform a variety of missions including surveillance, anti-submarine warfare and anti-surface attack. It will become increasingly important, for example, for countries to enforce archipelago claims and to police fishing, pollution and other EEZ activities. To support these missions, sea-based air will increasingly fill a surveillance function, despite the fact that helicopters are generally less efficient in this than long-range maritime patrol aircraft. Further, as submarines become more broadly acquired throughout the region, and operate at ever greater ranges, sea-based air will need to act as instruments of longer range anti-submarine warfare. In the surface warfare area, the ships of all nations in the Western Pacific now, except those of the Philippines, have anti-ship missile capabilities, making over-the-horizon targeting (from helicopters or patrol aircraft) important. Providing sea-based helicopters with armed attack capabilities is another likely eventual trend for countries with large helicopters and the ability to pay the costs.

In conclusion, then, the trend for sea-based air is multi-mission roles. This trend is most clearly visible in the United States Navy in dual-role fighter/attack fixed-wing carrier aircraft, and the trend to arming and installing dipping sonars on helicopters (in addition to their traditional ASW and anti-surface targeting and attack capabilities). Similar broader aircraft roles and the equipping of helicopters with these additional capabilities will gradually appear in the Western Pacific navies.

CHAPTER 7

MAJOR SURFACE COMBATANTS

Stephen Youll

Introduction

It is not the intention of this chapter to conjure up a future environment of wish lists and what might be technologically feasible in regard to major surface combatant development in the Western Pacific. There are, however, some longer term significant developments which will impact on future surface combatant design in our region. The battle force combatants (BFCs) that will commission into the USN in the 2020s and 2030s will have improved capabilities in all warfare areas including an ability to insert special forces by air and surface.[1]

The BFC will be stealthier in all spectra (electromagnetic, infra-red, acoustic, magnetic and wake) and will probably be able to manage its signature to produce different effects on hostile sensors or weapon seekers. It will also probably have significantly improved self-defence and countermeasures systems, with hard-kill and soft-kill capabilities being totally integrated.

These developments are a long way off for regional navies, however, and this chapter considers the status and nature of generic surface warfare capabilities and then focuses on a couple of regional programmes in order to quantify the degree to which recent developments have been absorbed or are being applied by Western Pacific navies.

It can be, of course, totally misleading to consider surface combatants in isolation when making judgements about a navy's capabilities or evolving development. The successful deployment of a surface combatant capability is critically dependent on a number of

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1 Victor A. Meyer, Surface Warfare Vision 2030, US Naval Surface Warfare Center, December 1990, unpublished.

factors, including intelligence, surveillance, reconnaissance, support both ashore and afloat, quality of manpower, training, and the national interest and the resultant intent or attitude. One only has to recall the Indonesian Navy of the mid-1960s with one Sverdlov, 8 Skoris, 8 Rigas, 4 other frigates and 14 Kronstadts, all less than 10 years old. A formidable modern force at the time, which had the potential to significantly influence regional balances, given the political will.

Turning to some of the component materiel elements which traditionally make up a surface warfare capability, it is useful to note how they have evolved over the past decade or so and what effect this has had on the practice and deployment of the capability. However the examples listed below are just that, and are in no way intended to be exhaustive.

Surface Warfare Combatant Elements - Recent Developments

Hull, Mechanical and Electrical (HME)

Developments

- Gas turbine
- Diesel development - idling
- Controllable pitch propellers
- Stealth
- Modularity

Effects

- Response
- Improved reliability, maintainability and availability (RMA)
- Autonomy
- Endurance
- Survivability
- Reduced support infrastructure requirements

Sensors

Developments

- Smaller, three-dimensional (3D), phased-array, pulse-compressed radars

- Infra-red and electro-optical systems
- Electronic support measures, signals intelligence (SIGINT)
- Shipborne helicopters

Effects

- Affordability
- Passivity
- More information
- Over-the-horizon (OTH) capability

Command, Control, Communications and Intelligence (C^3I)

Developments

- Satellite communication (SATCOM)
- Security
- Internal communications
- Base systems and local area networks (LANs)
- Modularity

Effects

- Greater data compilation capacities and speeds
- Security
- More effective engagement and routine management
- Better presentation
- More valid decision making
- Improved external links
- Growth capabilities

Anti-Air Warfare

Developments

- Guided/corrected gun projectiles
- Vertical missile launching systems
- Close-in weapons systems (CIWS)
- Electronic countermeasures - hard and soft

Effects

- Affordability
- Increased survivability
- Missile mixes

- Growth capability

Anti-Submarine Warfare

Developments
- Sonar detection and signal processing
- Helicopter sensor and weapon delivery
- Torpedo developments and proliferation

Effects
- Increased levels of ASW capability
- Increased survivability

Surface Warfare (SUW)

Developments
- Proliferation of Harpoon and Exocet types
- OTH targeting by third party or organic helicopter
- Availability of helicopter weapons
- Gun developments - guided projectiles, electrothermal combustion (ETC)

Effects
- Increased perceived threat
- Horizon extension and longer range engagements
- Increased tactical options
- Increased targeting requirements

Support

Developments
- Reduced requirement due to HME and weapons systems RMA developments (e.g. Signaal WM 20, guided missile launch system (GMLS) Mk 13, Mk 41 vertical launch system (VLS))
- Replenishment at sea (RAS)
- Construction modularity

Effects
- Autonomy

- Endurance
- Indigenous depot-level maintenance (DLM)
- Importance of equipment selection to provide generic capability and growth capacity (e.g. Mk 45 gun system's ability to accept guided projectiles and ETC propulsion and the non-missile specificity of the Mk 41 VLS).

In summary, all these developments are being incorporated, by degrees, into various regional surface combatant programmes and, indeed, there has been some closing of the technological gaps which existed between regional and extra-regional navies. That it is not to assume, however, that the operational gaps, or the relative abilities to use and deploy such technological developments, have closed to the same degree. The operational and technological benchmarks in our region will continue to be provided by the US Seventh Fleet for at least a generation to come.

The trends for the next 10-15 years in Southeast Asian naval force development are already evident.[2] The ASEAN navies have followed an almost consistent path of naval development from brown-water to green-water and evolving blue-water concepts. Their developments, however, have been largely tactical and defensive in nature and commensurate in quantity to their increased economic wellbeing.

In the broader, Western Pacific region, China, Japan and to a lesser degree India have the potential to provide both stabilising and destabilising influences, and the remainder of the region appears resigned to an era of alleged increased instability, but with improving resources and mechanisms to manage contingencies.

What has *not* been seen in the region is alarming and disproportionate investment in significant surface warfare strike capabilities such as dedicated over-the-horizon targeting (OTHT), longer range missiles, specialist training and support infrastructure.

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2 CMDR J.V.P. Goldrick RAN - in an address to a Conference on Maritime Power in the China Seas: Capabilities and Rationale, Australian Institute of International Affairs, Canberra, 7 May 1993.

Some Particular Regional Programmes

In considering some specific regional programmes it is perhaps appropriate to adopt a 'bottoms- up' perspective.

Australia and New Zealand

A very good example of how regional navies have incorporated recent surface warfare technological developments is the way the Royal Australian Navy turned a 2000 tonne offshore patrol vessel (OPV) with a 76 mm gun and an optronics director into a 3600 tonne Anzac ship and with an integrated C^3 system, Mk 45 gun, Mk 41 VLS, Seahawk capability and growth capacity.

The RAN really seems to have got it right this time with support and training infrastructures being put in place to allow optimum use of the capability from first commissioning. Further commendable sleight of hand appears to be in the offing with a 450 tonne Fremantle class replacement in the year 2002 being converted into a 1100 tonne air-capable missile-armed offshore patrol combatant (OPC) in 1998. Eleven hundred tonnes might be a bit tight but Anzac class type armaments of Mk 45 gun and Mk 41 VLS are feasible in MEKO 140s and the 1500 tonne Eurocorvette.

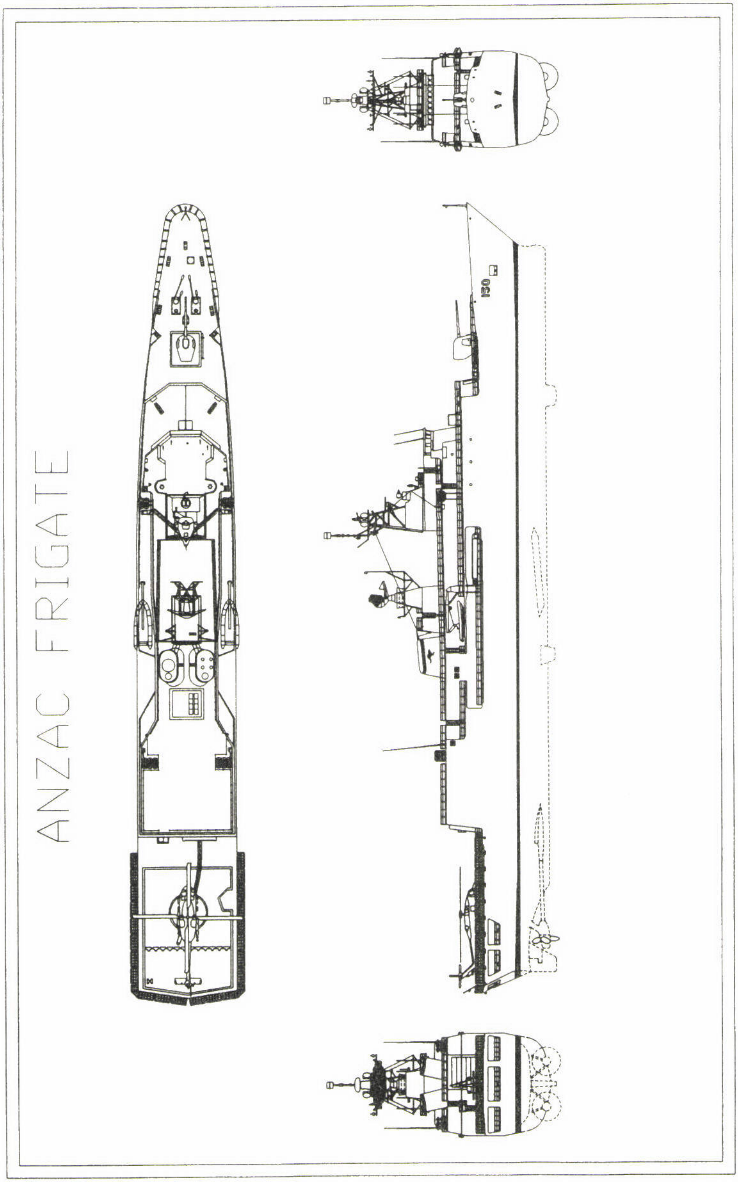
The benefits of operational and technological developments would be optimised if generic systems, such as the Mk 41 VLS, were chosen for the RAN OPC.

Indonesia

Going north, Indonesia has no active technology-based surface combatant project, with the FFG 90 2500 tonne frigate programme for a projected 23 ships now being superseded by a corvette programme for 16 lower cost vessels. Indonesia is well placed, however, to supplement its surface warfare capability by the acquisition of surplus Dutch Kortenaer- and Tromp-class vessels as well as ex-USN Knox-class DE 1052 ships.

This would be a quantitative rather than a technology acquisition, although all three types of ships are very capable and would be only 20 years old.

Figure 7:1
Anzac Frigate Design



Singapore

Singapore has an active programme to obtain twelve, 57 m or so patrol craft to replace the Sea Wolf class. They are expected to be no more sophisticated relatively than the Victory class with the potential for a surface-to-air missile system - possibly the Israeli vertically launched Barak.

A wild card could be, however, if Karlskronavarvet of Sweden offered a variant of their Smydge stealth-engineered surface-effect ship.

Malaysia

The two Royal Malaysian Navy (RMN) Yarrow frigates on order are relatively conventional but very well equipped. They have a 16-cell vertically launched Sea Wolf installation which is missile-specific and therefore does optimise the generic launcher development as provided by the Mk 41.

There is also the much-vaunted RMN OPV programme of up to 27 vessels over the next three Five-Year Plans. The OPVs are expected to be up to 1200 tonne and, although conventional, well equipped and including a Lynx/Dauphin type helicopter-operating capability.

Many recent short lists of potential prime contractors have included Transfield Shipbuilding, which augurs well for a potential joint RMN/RAN programme. The degree to which commonality of technology-based equipment such as laser ring gyros, generic weapons systems, etc., can be achieved will significantly affect capability and supportability of the vessels.

Philippines

The two current Philippine patrol boat programmes will principally provide a much-needed modern technological experience for the Navy and, whilst introducing a surface-to-surface missile capability, there is little or no impact on regional balances.

A plan to acquire three former Soviet Tarantul-class guided-missile patrol boats (PFGs) seems to have foundered.

Thailand

Perhaps the two most interesting ships being acquired in the region are the Royal Thai Navy's Naresuan-class FFGs and the helicopter support ship *Chakri Naruebet.*

Ten years ago the major surface combatants of the RTN consisted of:

1 Yarrow frigate (1973),
2 US PF 103-class frigates (1974),
2 Tacoma frigates (1944),
1 US Cannon-class frigate (1944),
3 Ratcharit-class PTFGs (large guided-missile motor boats) (1979), and
3 Prabparapac-class PTFGs (1976).

Since then they have acquired, additionally:

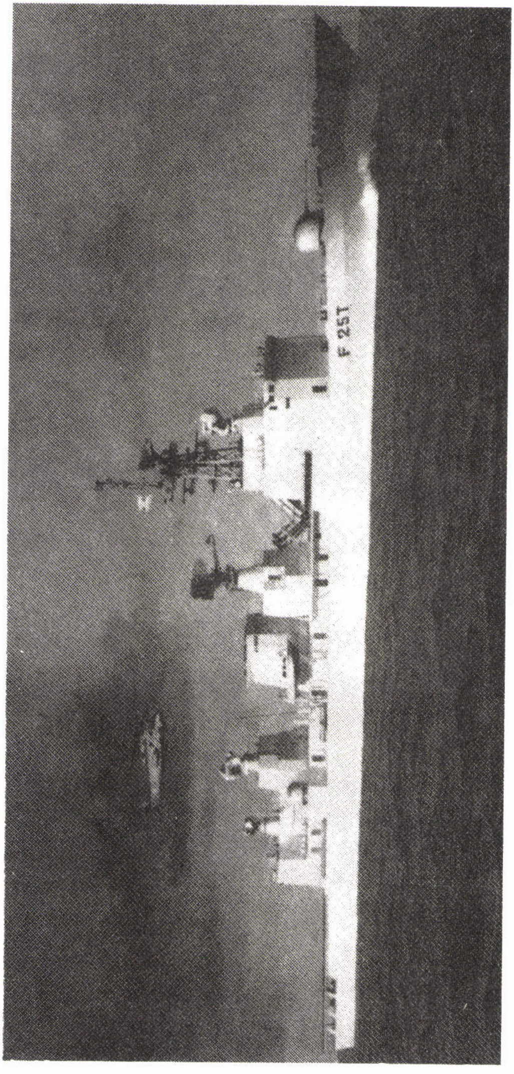
4 Chao Phraya-class FFGs (1991/92),
2 Rattanakosin-class DEGs (guided-missile escort ships) (1986/87),
3 Khamronsin-class ASW corvettes (1992),
6 Sattahip-class PTFs (patrol torpedo boats, fast) (1983/86),
3 Chon Buri-class PTFs (1983/84);

and have on order: 2 Naresuan-class FFGs and 1 helicopter support ship - *Chakri Nareubet.*
They are also looking at a 20000 tonne logistic support ship and submarines.

Naresuan-Class FFGs

The Naresuans are due to commission in 1995 and their design incorporates all the recent technological developments including VLS. It should be noted, however, that the mix of Chinese and Western HME, C^3 and weapons systems elements must be an integration task of no little challenge.

Figure 7:2
RTN Naresuan-Class FFG (model, 1991)



Source: *Jane's Fighting Ships 1993-94* (Jane's Information Group, Coulsdon Surrey, 1993).

RTN Naresuan-Class FFG[3]

Displacement	2980 tonnes full load
Dimensions	120 x 13 x 3.8 metres
Main Machinery	Combined diesel or gas turbine propulsion (CODOG) 2 x GE LM 2500 - 30 gas turbines 2 x MTU 20V 1163 diesels
Speed	32 knots
Range	4000 nm at 18 knots
Complement	150
Missiles	8 x Harpoon 16 cell Mk 41 VLS with Seasparrow
Guns	1 x Mk 45 Mod 2 127 mm 2 x 37 mm twin
Torpedoes	2 x 3 Mk 46
EW	Type 945 GPJ decoys Mirage ESM/ECM
Radars	1 x LWO 8 1 x Type 360 2 x SPS 64
Fire Control	2 x Signaal separate track and illumination radar (STIR) Type 374G
Sonar	Type SJD-7
Helicopters	1 x Seasprite or Super Lynx

Helicopter Support Ship

The Bazan-designed *Chakri Naruebet* is a very capable ship and able to accommodate up to 15 Sea King size helicopters or 12 AV-8B Sea Harriers and is Chinook-capable.

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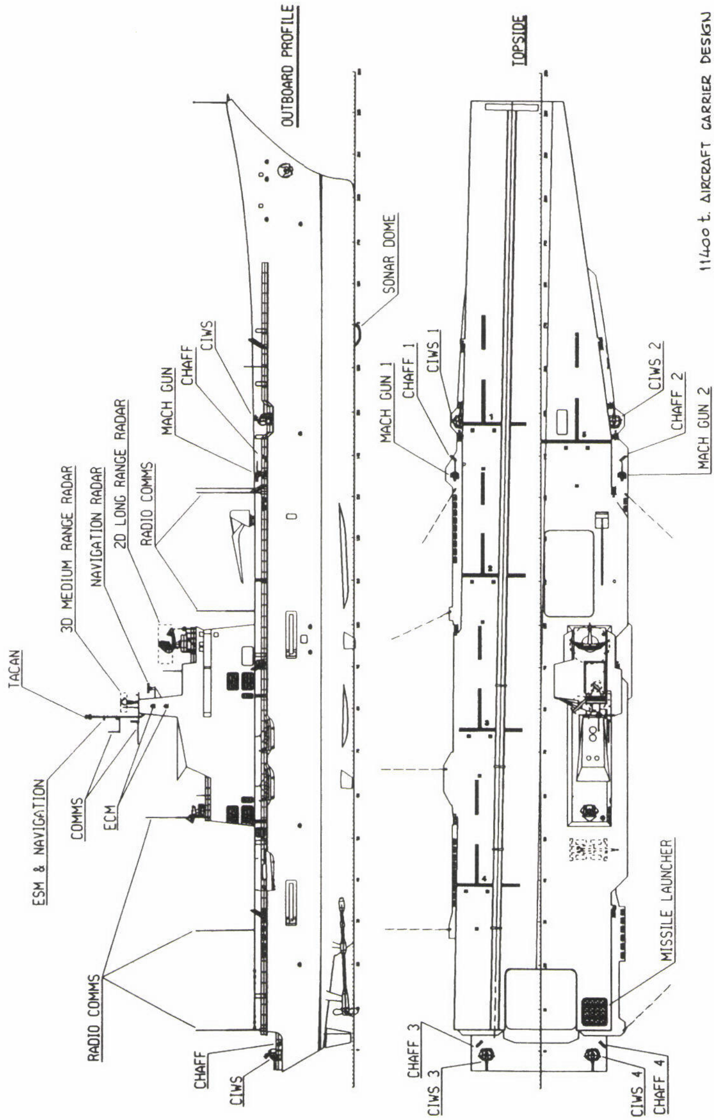
3 AMI International, *Worldwide Naval Projections Report* (AMI International, Seattle, 1992).

Figure 7:3
RTN Helicopter Support Ship Design



Source: Empresa Nacional Bazan, Madrid.

RTN Chakri Naruebet-Class OPHC[4]

Displacement	11485 tonnes full load
Dimensions	182.6/164.1 x 30.5/22.5 x 6.25
Main Machinery	CODOG 2 x GE LM 2500 gas turbines 2 x MTU 16V 1163 diesels
Speed	27 knots (16.5 on diesels)
Range	10000 nm at 12 knots 7150 nm at 16.5 knots
Complement	455 (62 officers) plus 146 aircrew plus 4 (Royal Family)
Missiles	Space and weight (S&W) for 2 x 8-cell Mk 41 VLS with Seasparrow
Guns	S&W for 4 x CIWS
EW	4 x decoy systems ESM/ECM
Radars	3D medium range 2D long rage Navigation Aircraft control Fire control
Sonar	Hull-mounted
Aircraft	15 SH-3D Sea King or 12 AV-8B Harrier

Whilst it is stated that this particular ship is being acquired for presence, surveillance and disaster relief, an ability to operate 12 short take-off and vertical landing (STOVL) aircraft, supported by 2 Naresuans and 4 Choa Prayas, a support ship, eight other surface-to-surface missile (SSM)-equipped vessels and adequate land-based air surveillance and strike is not much less than a formidable and new capability in the region.

It will therefore be important for the Thais to send the right messages to their neighbours over the next few years, particularly in regard to the potential acquisition of Harrier-type aircraft.

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4 Information supplied by Empresa Nacional Bazan.

North Asia

As this chapter has the objective of focusing on developments closer to Australia, discussion of surface warfare developments in North Asia is not as detailed as for other parts of the region. Capabilities which may, however, impinge on developments in surface warfare in the region are:

Japan

- Aegis destroyers
- Maritime Self-Defense Force (MSDF) carrier plans and prospects

Korea

- Reunification prospects
- the Korean destroyer development (KDX) programme
- Green- and blue-water skills development

China

- the 4-5000 tonne Zhan Jiang-class destroyers
- the 2250 tonne Jiangmei corvettes with vertically launched SAMs
- the People's Liberation Army-Navy (PLA-N) carrier plans for a 40000 tonne, 40 aircraft vessel

Conclusions

The steady adoption of available technology by regional navies has tended to close the maritime technological gaps and nations like Australia can no longer maintain the degrees of relative advantage that they may have previously enjoyed. Acquisition of technology-based systems, however, does not translate directly into capability and there are penalties involved in deploying new equipment such as OTHT. The means, skills, adequate support infrastructure such as RAS and, most importantly, people, all play their part.

The 'people' dimension has many facets, of which raw quality and quantity, training, professionalism, motivation, leadership and attitude are paramount. A navy, of itself, cannot provide all the resources and influences to achieve success in these aspects - national resources are consistently required to underpin the enterprise.

In summary, on the surface warfare front, there are increasing regional acquisitions of technology that translate into firepower or warfighting technologies which have a tendency to imbue competitive and escalatory influences and are conducive to destabilisation. For the foreseeable future, however, evolving and individual national interests are probably more important than the odd hardware acquisition.

CHAPTER 8

SUPPORT AND LOGISTICS SHIPPING

Bob Ormston

Frequently, the focus of emerging operational and technological developments in modern warfare is on the 'sharp end' of military capabilities. This chapter examines developments in the 'tail', concentrating on support and logistics shipping in the Western Pacific, including amphibious forces.

The key question addressed in this chapter is the extent to which developments have enhanced the power-projection capabilities of countries within the region, and their impact on the regional naval balance. That question is addressed through an analysis of support and logistics shipping under the following headings:

- Trends in regional naval capabilities.
- The utility and availability of commercial shipping.
- Strategic sealift developments.

Trends in Regional Naval Capabilities

A Matter of Definition

A particular difficulty in examining support and logistics shipping relates to terminology. The latest edition of *Jane's Fighting Ships*, for example, lists 33 different types of support vessels in its glossary. Moreover, individual countries add to the confusion by sometimes describing ships not in terms of what they are, but rather as what the country would like its neighbours to think it has in its naval inventory.

For the purposes of this paper, and in the context of providing some meaningful comparative trends, support and logistics shipping capabilities are considered under three broad headings and six functional groupings, namely:

- Amphibious forces
    - Landing ships tank (1,500 tons plus)
    - Landing ships medium (500-1,500 tons)
    - Personnel transports (2,000 tons plus)
- Logistic shipping
    - Underway replenishment ships (2,000 tons plus)
    - Underway replenishment tankers (1,500 tons plus)
- Support shipping
    - Repair and salvage ships (1,500 tons plus)

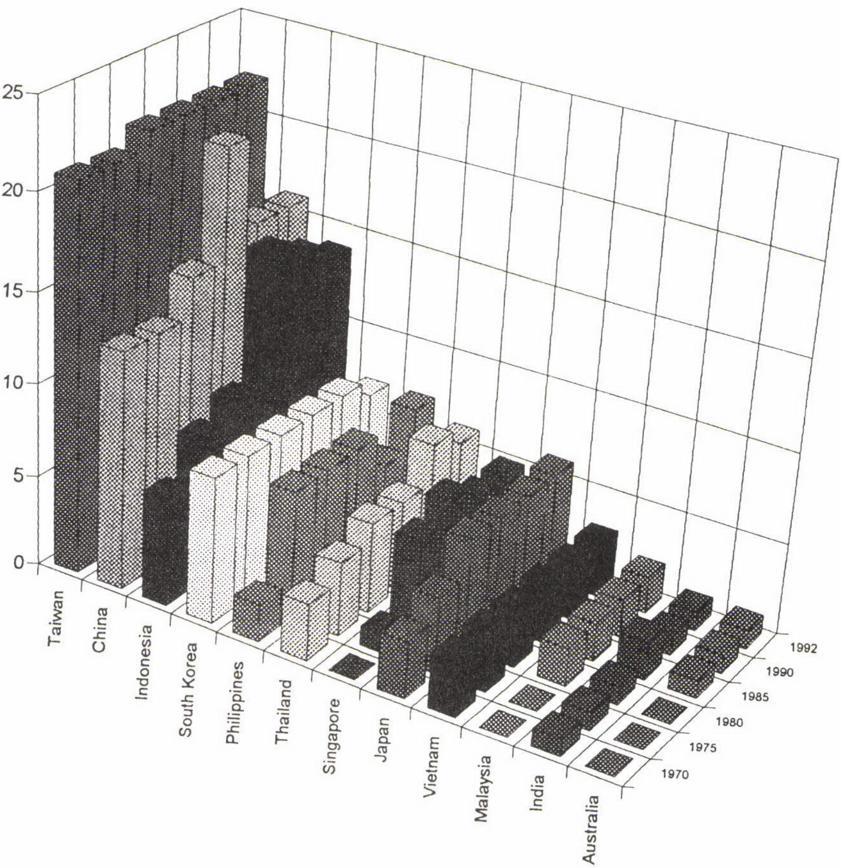
Landing Ships Tank

The number of landing ships tank (LST) held by individual countries in East Asia, Southeast Asia, South Asia and Oceania (hereafter referred to as the Western Pacific), in the period 1970 to 1992, is shown at Figure 8:1. (The capabilities of the United States and Russia are addressed separately.)

Many of the ships are United States-origin LSTs built in the 1940s. That applies particularly to those of South Korea, Taiwan, Vietnam, the Philippines and Malaysia, and to at least half in the inventories of China, Thailand and Indonesia. Singapore's LSTs are also ex-US 1940s-vintage ships, but were substantially modernised in the late 1970s.

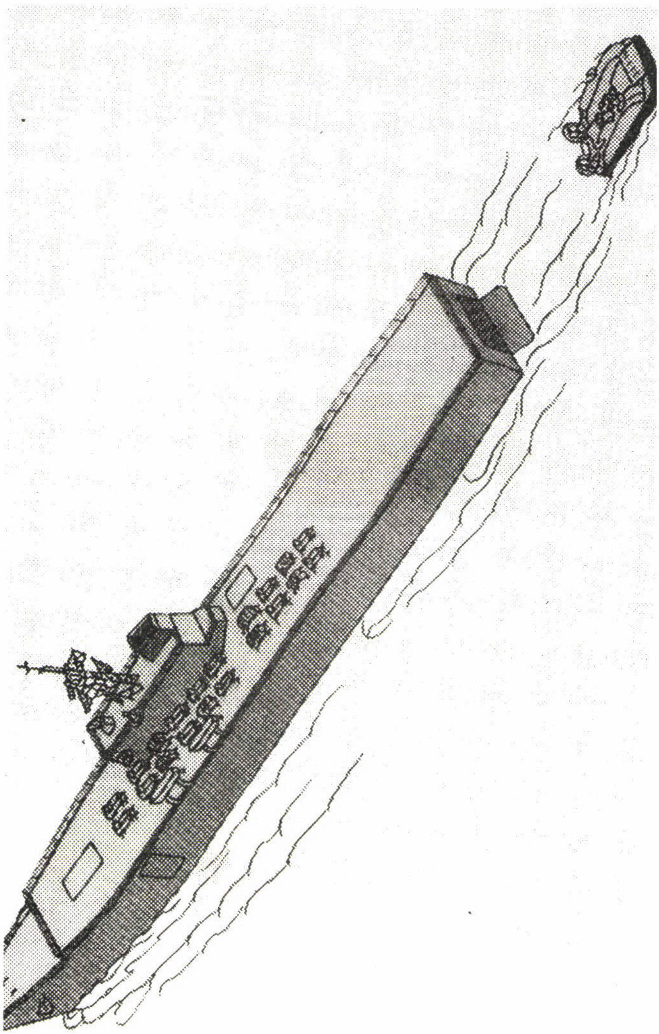
Of the remainder, Japan's six LSTs were built in the mid-to-late 1970s. China's three Yukan-class LSTs were built in the early 1980s. Indonesia's six Korean-built LSTs were commissioned in the early 1980s, as was Australia's HMAS *Tobruk.* The only relatively new LSTs in the Western Pacific are India's *Magar,* commissioned in 1987, and Thailand's indigenously built Normed-class LSTs, commissioned in the late 1980s.

Figure 8:1
Trends in Amphibious Forces 1970-1992:
Landing Ships Tank (+1500 tons)



Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1970-1992).

Figure 8:2
Japan's Planned Amphibious Landing Ship
(an artist's impression)



Source: *Jane's Defence Weekly*, 5 September 1992, p.23.

Looking ahead, a potentially controversial acquisition is a new 8,900-tonne amphibious landing ship for Japan, included in Japan's recently published *Defence Funding Request 1993*. The design of the 170-metre-long ship, costed at US$410 million, is politically controversial because it locates the superstructure to starboard, aircraft-carrier style (see Figure 8:2).

Japanese defence officials say that the design is not for an aircraft-capable ship and that it would allow the embarkation of only one medium-lift helicopter. It would also have two hovercraft-type landing craft in its floodable well-deck, each capable of carrying one 50 tonne tank or 25 troops. Nevertheless, it seems unlikely - given domestic and regional sensitivities - that Tokyo will agree to the proposed design, at least before China makes any move towards acquiring its own aircraft or helicopter carrier.

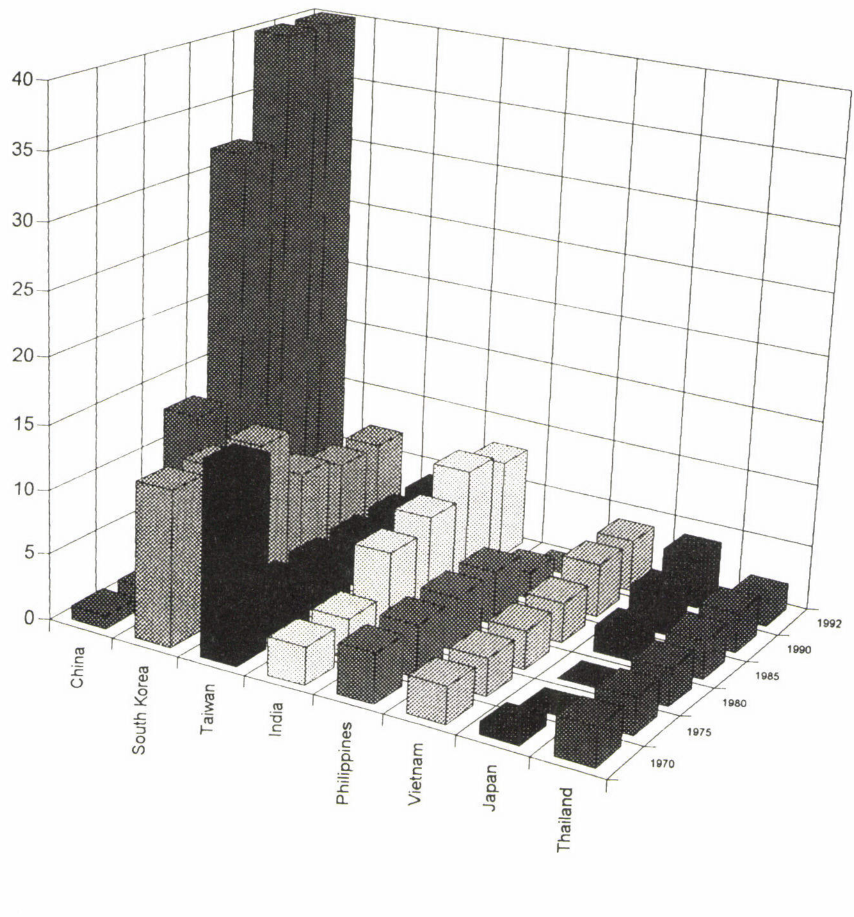
Landing Ships Medium

The number of landing ships medium (LSM) held by countries in the Western Pacific is shown at Figure 8:3. Of importance is that none are held by Malaysia, Singapore, Indonesia, Pakistan, Australia or New Zealand.

As for the LSTs, a number of the LSMs are United States-origin ships, built in the 1940s (those of South Korea, Taiwan, the Philippines, Thailand and a quarter of those in the Chinese inventory). Those of Vietnam and India are of Soviet or Polish construction of the Polnochny class, built between 1975 and 1985, but based on technologies from the early 1970s. Japan's Yura-class and Yusotei-class LSMs are some of the most modern but, being at the bottom end of the tonnage range, should almost be considered as 'landing craft' rather than ships.

The one country in Figure 8:3 showing a strategically significant capability trend, particularly over the past decade, is China. It is progressively phasing out its ex-US Hua-class LSMs, while building up its numbers of indigenously produced Yuliang- and Yudao-class ships. Production in both classes began in the early 1980s, turning out LSMs around 1000 tons, capable of carrying three tanks.

Figure 8:3
Trends in Amphibious Forces 1970-1992:
Landing Ships Medium (500-1500 tons)



Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1970-1992).

Personnel Transports

Only three countries in the Western Pacific have dedicated personnel transports in the 2,000 tons-plus range (see Figure 8:4).

The eight Indonesian ships, allocated since 1978 to its military sealift command, are used primarily for the movement of stores and troops between outlying garrisons. Taiwan's eight ships, six of which were commissioned in the late 1980s, are listed as attack transports capable of lifting over 5,000 personnel. They presumably could be used, for example, to reinforce or withdraw troops from the offshore Quemoy and Matsu garrisons, in the event of conflict with China.

China's nine Qionsha-class ships were built in the 1980s as personnel attack transports. All nine are allocated to the South Sea Fleet, presumably to facilitate amphibious operations in the South China Sea. Two of them have been converted to hospital ships. The remainder are each capable of transporting 400 troops and 350 tons of cargo. These ships have light cargo booms fore and aft, and carry a number of light landing aircraft.

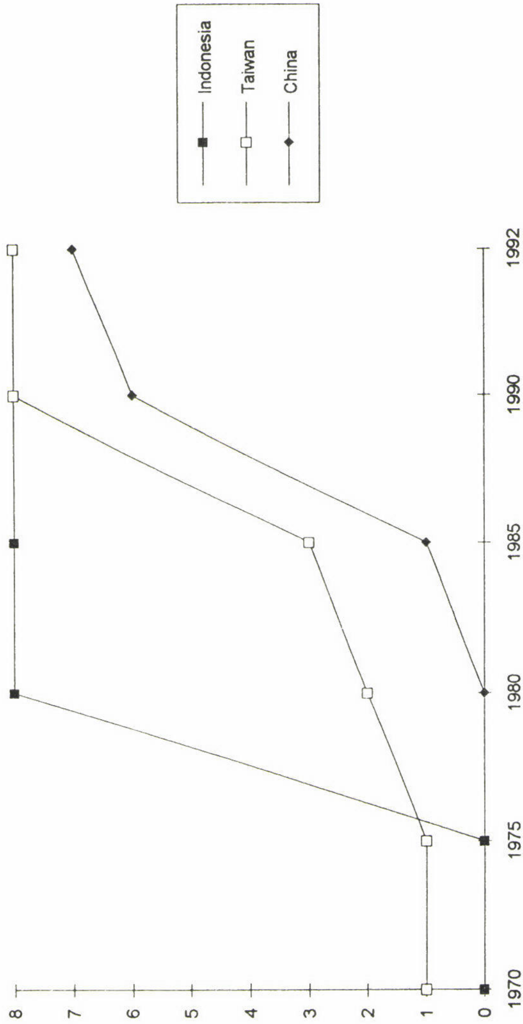
Underway Replenishment Ships

Only four countries in the Western Pacific currently have the capability to conduct multi-product underway replenishment (see Figure 8:5). Moreover, it is only in the last decade that most have acquired the capability.

Japan has one 5000-ton Sagami-class fleet support ship (with a 5000-ton cargo capacity) commissioned in 1979 and three 8,100-ton Towada-class fleet support ships (with a 5,700-ton cargo capacity), commissioned in the late 1980s. Taiwan's capability is based on a single combat support ship of 17,000 tons, commissioned in 1989, with beam replenishment rigs on both sides.

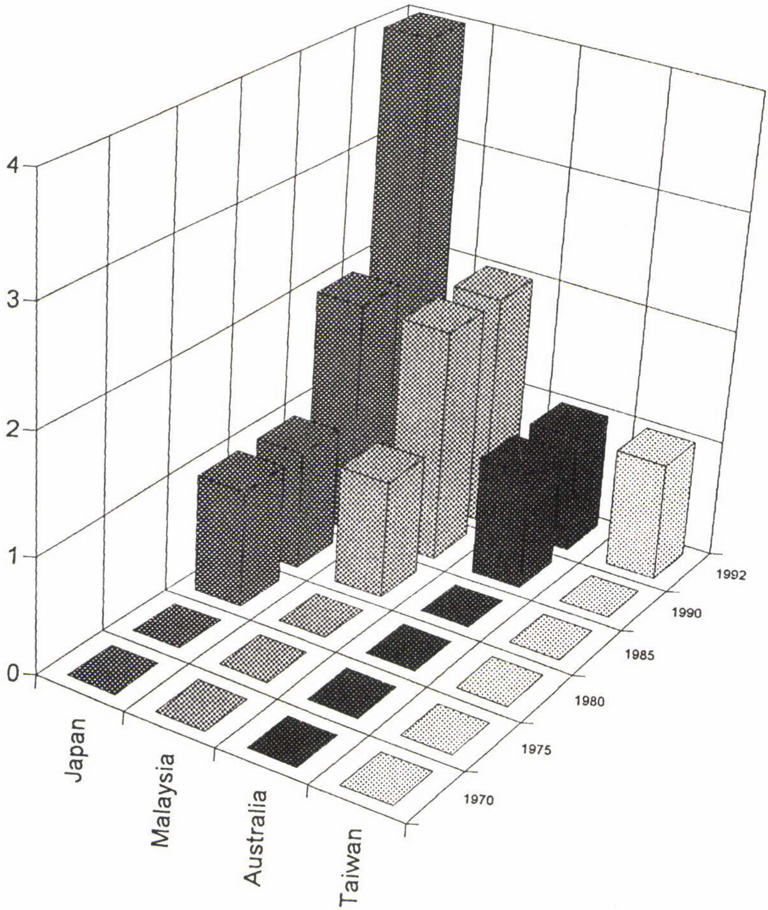
Malaysia has two logistic support ships of 4,300 tons and 4,900 tons, commissioned in 1980 and 1983 respectively. While the main role of these ships is long-range support of mine countermeasure (MCM) vessels and other small ships, they have secondary roles of command support, troop and ammunition transport, and training ships for cadets. Australia has one Durance-class underway replenishment tanker of 18,000 tons, HMAS *Success*. This ship was commissioned in 1986 and has a cargo capacity of 20,000 tons of fuel and some 500 tons of ammunition and stores.

Figure 8:4
Trends in Amphibious Forces 1970-1992:
Personnel Transports (+2000 tons)



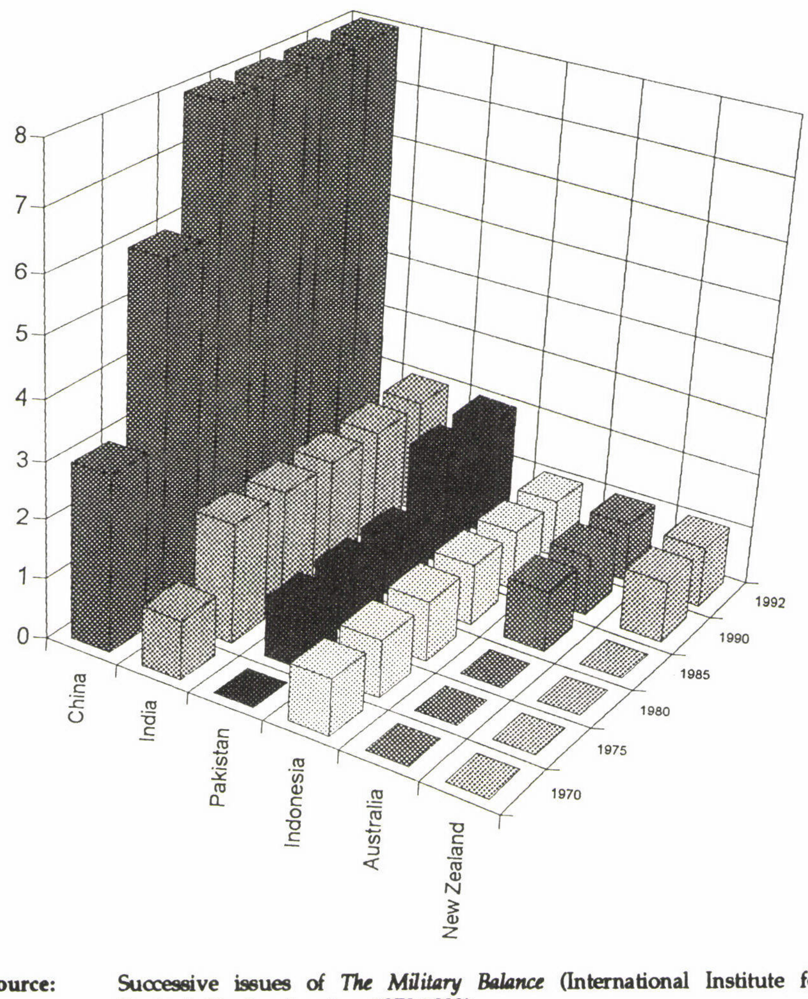
Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1970-1992).

Figure 8:5
Trends in Logistic Shipping 1970-1992:
Underway Replenishment Ships (+2,000 tons)



Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1970-1992).

Figure 8:6
Trends in Logistic Shipping 1970-1992:
Replenishment Tankers (+1,500 tons)



Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1970-1992).

Underway Replenishment Tankers

Several more countries in the region have the capability to refuel naval forces at sea and to conduct limited multi-product underway replenishment (see Figure 8:6).

However, very few of these tankers are modern. One of Pakistan's two tankers, for example, is a 5,700-ton ex-US Mission-class ship, commissioned in 1944. Indonesia has the 5,100-ton replenishment tanker Sorong, commissioned in 1965. India's capability is based on two 6,700-ton Deepak-class tankers, commissioned in 1967 and 1975. And China's six 2,300-ton Fulin-class tankers, each with a single replenishment rig, were built in the mid-1970s.

The more modern ships in the region include Australia's 33,600-ton Leaf-class *Westralia* (commissioned in 1979) and China's two 7,500-ton Fuqing-class tankers, which were commissioned in 1979 and were the first class of ships built for underway replenishment in the Chinese Navy. Even Pakistan's latest tanker, a Fuqing-class ship commissioned in 1987, is based on Chinese technology of the 1970s. New Zealand's fleet supply ship *Endeavour*, commissioned in 1988, is the most modern in the region.

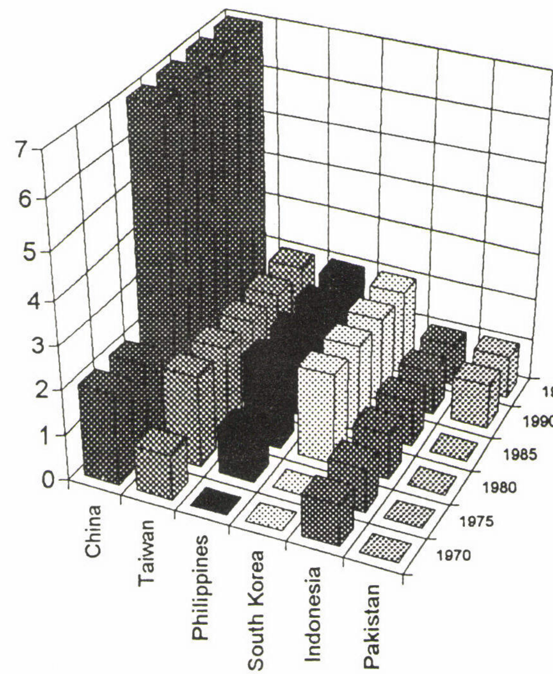
Repair and Salvage Ships

Only six countries in the region have dedicated repair or salvage ships (see Figure 8:7).

Moreover, only six of the 15 repair/salvage ships in the region have been built since 1949. The ships of South Korea, the Philippines and Indonesia were all built between 1943 and 1946. Pakistan's one repair ship, transferred from the United States in 1989, was commissioned in 1944, although it reportedly is being modernised.

Surprisingly, perhaps, the most modern repair and salvage ships belong to China. They include the three 10,900-ton Dajiang-class submarine support and salvage ships, commissioned in the mid-1970s, and the 2,500-ton Dadao-class salvage ship, commissioned in 1986.

Figure 8:7
Trends in Support Shipping 1970-1992:
Repair and Salvage Ships (+1,500 ton)



Source: Successive issues of *The Military Balance* (International Institute for Strategic Studies, London, 1970-1992).

The Influence of Extra-Regional Powers

Overlaying the support and logistic capabilities of the maritime states of the Western Pacific are the respective capabilities of the United States, Russia and, to a much lesser extent, several of the European maritime nations.

Certainly, against the general level of capabilities in the Western Pacific, the support and logistic capabilities of the United States, in particular, are predominant. For example, in 1992 the US Navy had an amphibious lift capability of 59 ships. And the United States' capabilities in underway replenishment, such as the resupply of carrier battle groups under operational conditions, leave most regional navies at an altogether different level of technological and operational competence.

Indeed, even the much-maligned underway replenishment capabilities of the Russian fleet - with its over-the-stern methods, slow pumping rates and laborious accounting procedures - are a generational advance over most of the capabilities in the Western Pacific. Russia has seven underway replenishment ships, 21 underway replenishment tankers and 34 repair and salvage ships, an impressive 'tail' by most standards.

Yet the importance of extra-regional powers, in terms of regional power-projection capabilities and the regional naval balance, arguably relates not to their capabilities per se but to the influence those capabilities have on navies within the region. Countries in the Western Pacific, for example, are exposed to the naval capabilities of extra-regional powers during port visits, on joint and bilateral exercises, and through the marketing activities of arms manufacturers.

Traditionally, and particularly throughout the 1960s and 1970s, that influence resulted in countries such as India and Vietnam modelling themselves on Soviet practices, while countries such as Japan, Thailand, the Philippines, Australia and New Zealand most usually followed the example of the United States. In between were such influences as France and China on Pakistan, Britain on Brunei and Malaysia, and perhaps Israel on Singapore.

Nowadays, those distinctions are becoming increasingly blurred, particularly as former Soviet trading partners look further afield, as the United States and a number of European countries relax their previous restrictions on arms sales, and as the former Soviet republics aggressively market military equipment into the Asia-Pacific region.

It seems likely, therefore, that countries in the Western Pacific will increasingly become exposed to a number of the leading-edge technologies and operational procedures in service with the major extra-regional powers. They might include:

- New developments in underway replenishment.
- The employment of landing craft air cushion (LCAC) vehicles.
- New developments in ship-to-shore transfers, such as lighter aboard ship (LASH).

That is not to suggest that the Western Pacific is about to see an arms race in support and logistic shipping capabilities, not least because few countries in the region could afford to purchase or support state-of-the-art developments. Nevertheless, it does seem likely that countries in the Western Pacific will be able, to a limited extent, to adapt some modern developments to their requirements, resulting possibly in some quite innovative solutions.

The Utility and Availability of Commercial Shipping

One Potential Solution?

One area for consideration is the possibility of countries in the Western Pacific making increased use of commercial resources for their support and logistics shipping requirements. Certainly, a number of countries in the region already have dedicated navy ships available to them, additional to those already noted. China, for example, has some 14 tankers in the 1,000-ton-plus range and seven 1,500-ton-plus logistic support ships. Moreover, a number of countries already make some use of commercial assets, both for the movement of personnel and stores, and to support their fleets.

But beyond that, which classes of commercial ships are militarily useful, how many ships within those classes are flagged to the countries of the Western Pacific and how many of them are realistically likely to be available for military contingencies? Those are questions largely beyond the purview of this chapter. Nevertheless, it does seem useful to examine briefly the potential utility and availability of commercial shipping within the region, not least to put into context the somewhat vague notions often heard expressed that certain countries really do have a force-projection capability, based on their ability to press commercial ships into service.

The Definition of Militarily Useful

Individual countries in the region would each have their own views on which classes of ship would be militarily useful, under varying strategic circumstances. As a guide, however, the United States' *Third Report of the Commission on Merchant Marine and Defense,* published in September 1988, suggested that:

- Militarily useful *tankers* are those less than 100,000 dead weight tons, capable of carrying military petroleum products.
- Militarily useful *cargo ships* are those capable of carrying 3,200 short tons of dry cargo.
- Militarily useful *container ships* are those capable of carrying 1,500 containers or about 17,000 short tons of containerised cargo.[1]

A Survey of the Regional Directory

Applying the above definitions to commercial shipping in the Western Pacific would need to be the subject of a separate, detailed study. However, a cursory assessment against Fairplay's *World Shipping Directory 1992-93* provides the figures shown at Table 8:1.

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1 *Third Report of the Commission on Merchant Marine and Defense: Findings of Fact and Conclusions* (Government Printing Office, Washington DC, 30 September 1988), pp.10-11.

Table 8:1
The Availability of Militarily Useful Commercial Shipping in Countries of the Western Pacific (ships operating commercially under the flag of that country)

	RO-RO	Tankers	Container Ships	Total
Japan	66	246	181	493
Russia	66	156	59	281
United States	33	33	103	169
China	13	42	66	121
Taiwan	0	1	116	117
Singapore	4	71	37	112
South Korea	2	16	59	77
Indonesia	0	49	1	50
Thailand	0	6	19	25
Malaysia	0	6	17	23
Australia	8	8	4	20
Philippines	3	10	3	16
New Zealand	7	0	1	8
India	0	4	1	5
Vietnam	0	1	0	1
Pakistan	0	0	0	0

Source: P. Malpas (ed.), *Fairplay World Shipping Directory 1992-93* (Fairplay, Surrey, 1992).

While it would be premature to draw too many conclusions from such a preliminary assessment, several observations can be made:

- The predominance of Japan.
- The relatively weak position of the United States.
- The position of China at fourth place in the list.
- The lack of cargo and container ship capabilities in Indonesia, India, Pakistan and Vietnam.

Strategic Sealift Developments

Given the potential availability of militarily useful commercial shipping in the Western Pacific shown at Table 8:1, it is evident that several countries in the region - notably Russia, Japan and China - could develop a strategic sealift capability, if they were so inclined. That is, such countries have the potential sealift resources to move strategically significant quantities of troops and materiel in support of large-scale force projection operations.

Needless to say, the only country with a developed strategic sealift capability - and with the inclination to maintain it - is the United States. Yet somewhat paradoxically, the United States does not rate particularly well at Table 8:1, compared to Japan and Russia, and would be hard-pressed to maintain a sealift capability if it had to rely solely on the militarily useful ships under its own flag.

Lessons of the Gulf War

Certainly, the reality that the United States needed to rely during the Gulf War on foreign-flag shipping for strategic sealift was often overshadowed by the deserved accolades for a superb logistics effort. But in his *Annual Report to the President and the Congress* of February 1992, Secretary of Defense Cheney warned that:

> It is important to remember ... that some aspects of this deployment - such as the large contribution of foreign-flag ships ... may not be replicated in future contingencies.[2]

In the same report, Cheney reported that 168 of the 197 commercial ships chartered from civilian carriers were foreign-flagged, and that those ships delivered 37 per cent of the 3.1 million tons of dry cargo sealifted into the Persian Gulf theatre.[3]

The Demise of the United States' Merchant Marine

Yet the inability of US-flagged ships to meet the United States' sealift requirement had been officially recognised in the late 1980s. The *Third Report of the Commission on Merchant Marine and Defense,* dated

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2 US Secretary of Defense, *Annual Report to the President and the Congress* (Defense Department, Washington DC, February 1992), p.92.

3 ibid., p.93.

September 1988, noted that 'the inventory of available ships suitable for strategic sealift in July 1988 was inadequate to meet the requirements of a single theater conflict', while the shortfall for multi-theatre operations would be in the order of 100,000 tons.[4]

Moreover, the Commission predicted that by the year 2000 the number of US-flagged cargo ships and tankers would fall from 379 to 192, of which only 156 would be militarily useful (see Table 8:2). For a single-theatre conflict, the shortfall would then be 120,000 tons, while for multi-theatre operations it would be in the order of 800,000 tons.[5]

Table 8:2
Trends in the Number of US-Flagged Ships 1988-2000
(militarily useful ships shown in brackets)

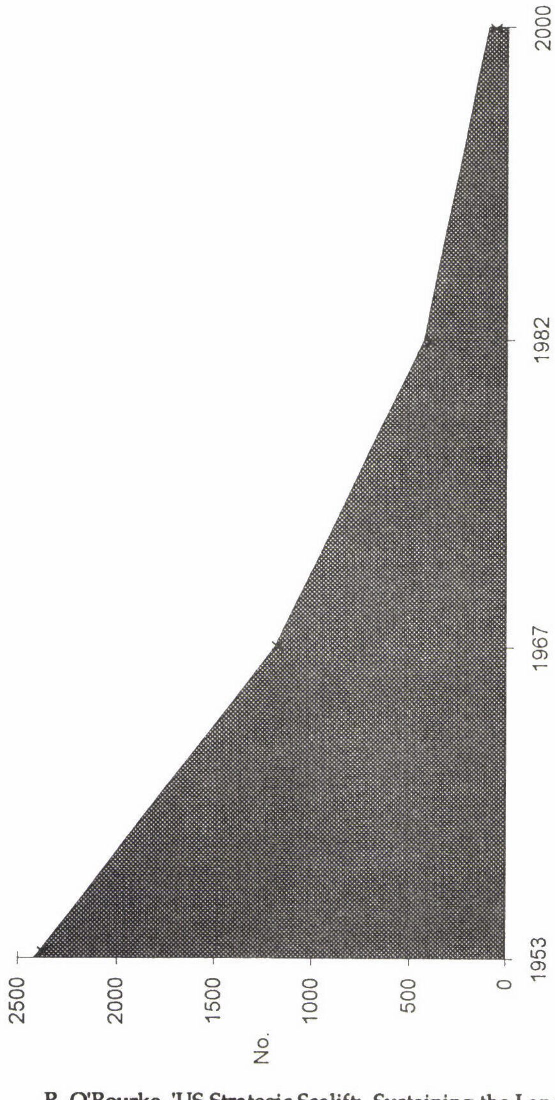
	Cargo Ships	Tankers	Total
1988	176 (176)	203 (154)	379 (330)
2000	100 (100)	92 (56)	192 (156)

Source: *Third Report of the Commission on Merchant Marine and Defense*, pp.12-13.

The reduction in militarily useful ships US-flagged ships can be seen even more graphically over time (see Figure 8:8). Indeed, the 400 ships used to support US forces in the Korean War represented 16.5 per cent of the nation's militarily useful ships; the 420 ships used in Vietnam represented 35 per cent of the hulls, while a deployment to Southwest Asia in 1982 would have required more than 80 per cent of the available total.

4 *Third Report of the Commission on Merchant Marine and Defense*, p.15.
5 ibid., p.16.

Figure 8:8
Trends in the Availability of US-Flagged Cargo Ships 1953-2000



Source: R. O'Rourke, 'US Strategic Sealift: Sustaining the Land Battle', *Strategy and Naval Policy*, November 1991, p.34.

Tackling the Issue

That is not to suggest that the US military has been turning a blind eye to the problem. During the 1980s and early 1990s, it invested some US$7 billion in strategic sealift, towards meeting the requirement to move the unit equipment of three divisions and about 30 days of supplies in a single sailing. That equates to the requirement for about 12 million square feet of capacity and over 2 million short tons of capacity for supplies.

The United States' objective is to be able to move about 21 million square feet of unit equipment (the equipment and supplies of five heavy divisions) in a single sailing by the year 2000, with a follow-up lift capability of 800,000 short tons within the first 60 days of deployment.[6]

The United States' planned sealift force is as follows:

- *Ready reserve force.* 116 ships under the operational control of Military Sealift Command (19 new RO/RO ships to be acquired 1993-95).
- *Afloat prepositioning force.* 12 ships (7 cargo, four tankers and one hospital ship) prepositioned at Diego Garcia, carrying equipment and supplies for early-arriving army and air force units.
- *Maritime prepositioning ships.* 15 ships (in three squadrons) carrying the equipment and supplies for three marine expeditionary brigades plus a heavy brigade (two new container ships to be acquired by 1995). One squadron deployed in the Eastern Atlantic, one at Diego Garcia and one in the Western Pacific.
- *Fast sealift ships.* Eight Algol-class vehicle cargo ships, together able to lift 93 per cent of an armoured or mechanised infantry division.[7]

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6 *Annual Report to the President and the Congress*, pp.94-5.
7 ibid., pp.101-103.

Conclusions

Given that the key question under consideration has been the impact of developments on power-projection capabilities and the regional naval balance, what then are the conclusions to be drawn from the preceding examination of support and logistics shipping in the Western Pacific? Probably the most obvious is that countries in the region are generally not affording much priority to either support or logistics shipping, and that capabilities across the region are probably lagging two or even three decades behind state-of-the-art developments.

In part, that is a consequence of the relatively small size of most navies and associated budgetary constraints. But it is also a consequence of the reality that most navies in the region are essentially brown-water or littoral navies, operating within relative proximity to shore-based facilities.

Most countries, therefore, have little requirement for support and logistics shipping capabilities. Indeed, a number of those that do possess rudimentary capabilities have acquired them not through their own requirement process but as 'hand-me-downs', primarily from the United States. Yet having acquired such capabilities, some countries are understandably loath to give them up, given that such ships often prove extremely useful for a variety of tasks in littoral and archipelagic waters.

Similarly, some countries have in the past seen the acquisition of a range of support and logistics ships as the necessary prerequisite to acceptance as a serious player within the region or on the wider, global stage, or simply in terms of matching the capabilities of a neighbour. Whether or not those capabilities were justified in terms of the prevailing strategic circumstances, and whether they intermeshed effectively as part of the total system, were sometimes secondary considerations.

In contemporary terms, the two regional countries standing apart from the rest, in terms of new and developing capabilities, are China and Japan. China is clearly developing naval capabilities relevant to limited force projection within the region, most likely focused on the South China Sea. Japan's longer term aspirations are more difficult to discern. But there is nothing to date, linked to its support or logistics shipping capabilities - apart from the proposed amphibious landing ship - which would suggest that Japan is assiduously developing a sustainable force projection capability.

In terms of the influence of extra-regional powers, it seems likely that all countries in the Western Pacific will be exposed to the increased marketing of new technologies and developments by suppliers more prepared than in the past - because of the changing strategic circumstances of the New World Order - to put commercial considerations ahead of traditional, strategic interests. The result may be that certain countries acquire unexpectedly advanced technologies. And others may develop or acquire quite innovative, non-traditional solutions in, for example, the areas of at-sea replenishment or ship-to-shore transfers.

In an associated development, some countries may see benefit in the increased use of commercial resources, including the commercialisation of some traditionally core capabilities. That may have implications in definitional terms for the regional naval balance. Certainly, it may be prudent to monitor more closely the utility and availability of commercial shipping within the region, as an additional dimension to the regional naval balance.

Finally, it is evident that the United States - despite some bravado to the contrary - will find it increasingly difficult to maintain its planned strategic sealift capability with US-flagged ships alone. Countries in the Western Pacific, therefore, seeking a possible bargaining chip with Washington, on either trade or security issues, may see benefit in an agreement or pledge to assist the United Statejs with militarily useful commercial shipping in the event of future Gulf War-type contingencies.

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There is a growing emphasis on maritime capabilities in the development of military forces in the Western Pacific region, particularly in Northeast and Southeast Asia. This reflects both the relative economic prosperity of the region and a growing concern over maritime security issues. Regional countries are seeking to take advantage of the technological developments which have occurred in recent decades in the field of maritime warfare; some are taking steps towards defining their force structures in terms of what can be built locally and what benefits can be gained for their economic development as a whole from transfers of technology.

For all regional navies new issues have arisen. There is the thorny question of balancing resources as well as the risk of opting for too high a military capability and being left with the wrong weapon in the wrong fight. Much of the new equipment entering regional force structures is based on state-of-the-art technology and it is necessary to develop the ability both to operate and to maintain it. New problems are faced: of training and management, of shore-side support, and of testing and evaluation. Technologies which lead to force structuring to suit the unique environment of the region also lead to increased rigour in defining missions, tasks and requirements, and ultimately to the refinement of doctrine and tactics.

This monograph is based on papers delivered at a seminar jointly hosted by the Royal Australian Navy's Maritime Studies Program and the Australian Naval Institute at HMAS *Watson*. It explores recent operational and technological developments in all aspects of maritime warfare - air, surface and sub-surface - and touches on many of the issues facing force planners in respect to the future of maritime security.