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* to encourage and promote the advancement of knowledge related to the Navy and maritime profession; and

* to provide a forum for the exchange of ideas concerning subjects related to the Navy and the maritime profession.

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

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Journal of the Australian Naval Institute

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Editorial

Welcome to the third Edition of the JANI for 1999. I have been fortunate enough to assume the duties of editor from Andrew Bewick who has left the Navy to pursue other interests. I wish Andy all the best for the future and thank him for all his work on our most valuable recent editions.

When first approached with the offer of this position, I was excited by the prospect, expecting that the Future of Surface Combatants issue would generate a flood of expression with which I could fill these pages. This was not to be, and I wondered if I had accepted responsibility for editing a journal that no one was reading. I am convinced that this is not the case, however would like very much to see the ANI membership increase and to see also a broadening in the subjects and approaches taken in the Journal.

I was surprised that I wasn't overwhelmed with responses to Mr Hugh White's article 'Why buy Warships?' that was published in the last edition of the journal. While Mr White does not suggest that we have no need for a surface fleet, I did feel his article lingered around that point. Such an article written by one of the most senior members of the Department of Defence should provoke everyone with an interest in naval affairs. As such, I was pleased to see the article published. It both satisfies the objectives of the ANI and pre-empted in me the expectation of a flood of letters to put into this edition.

My expectation of lively debate has not been satisfied. It seems from reading back-issues that this is the ongoing plea of the editor – more lively debate please!! I have included the one response I did get which comments on Mr White's article from Commander John Shevlin. This, in addition to the articles in the last edition written by Captain Goldrick and Commander Griggs, at least convince me that there is concern for the future of our fleet.

The committee of the ANI has begun another review of the way we operate. Some of the review's suggestions are incorporated in this edition, including the section entitled 'Shots from the Past' which will become a regular segment. If there is an old article that you think is particularly relevant to the present, then let me know and I'll dig it up for inclusion. My aim is to improve the value of our publication and to promote the Institute's objectives. Please have a think about how you can help improve the Australian Naval Institute and let us all know what you are thinking. Get in and have a say, even if you think it is not what those in Canberra or elsewhere want to hear. If needs be, cover your tracks with a pen name, as Lieutenant Newman has done in this edition. His comments are obviously the way he or some of the more junior people he has come into contact with feels. Therefore, they should be aired and encouraged. Whatever it takes, lets generate some debate. Lest we cease to truly satisfy the objectives we claim to pursue.

These are very important times for the Navy. The ANI can play a very important part in the future of the Navy. If you choose it to. I encourage you all to participate more fully in the proceedings of our Institute, particularly through this Journal. Continue to critically assess the implications of what you read and please put those thoughts into a letter to the editor, a short or long e-mail to our new address editor@ani.org.au or an article. Only then can we learn more fully from each other, truly interact and fully satisfy the objectives of our Australian Naval Institute.

MATTHEW ROWE

Letters to the Editor

Dear Sir

A RESPONSE TO 'WHY BUY WARSHIPS'

I read Hugh White's article *Why Buy Warships? – Thoughts on Sea 1400* with considerable interest. He offers an interesting point of view and, whilst I do not agree with all of his conclusions, his views are welcomed. It is appropriate, indeed desirable, that journal articles should be thought provoking and, to some extent, contentious. They should challenge the reader to think about issues and to re-evaluate established practices and accepted doctrine. The article certainly does this!

One may not agree with Hugh White's distinctive perspective of maritime affairs, but it is difficult to ignore. A willingness to challenge conventional wisdom can be helpful and an expectation that reasoned argument and rigorous intellectual analysis should underpin force structure decision-making is only reasonable. Hugh White's views are useful and, now in the public domain, the challenge for others is to subject them to analysis, to publicly identify their shortcomings and thus inform the Surface Combatant Force debate. Only by engaging in this process can we hope to contribute positively to the future shape of the RAN. There are many better qualified than me to progress this task but I would offer a number of observations as a small contribution.

First, I would support the call for a clear public statement of Navy's roles and responsibilities. At the moment, this is lacking and, as a result, we have isolated ourselves from our strongest supporters, the public at large. This situation needs to be reversed. The RAN needs its equivalent of Army's *The Fundamentals of Land Warfare* or the RAAF's *Air Power Manual*. I know that this requirement has been recognised and I understand that this task is a priority for the Director General, Maritime Studies Program, Captain James Goldrick. The thinking evident in Hugh White's article underscores the urgency and importance that this task should attract.

Developing Navy's Maritime Strategy may not be an easy task but it is clearly pivotal to ensuring that the RAN is able to inform and educate those who will be involved in making the decisions that will determine the shape of tomorrow's Navy. BR1806, *The Fundamentals of British Maritime Doctrine*, provides one model of what we might seek to produce. The desired end-state, I suggest, should be a situation akin to that of the USN where the logical linkages between their acquisition program and strategic thinking are abundantly clear. Indeed, the USN has been adept in making these connections and then publicising them. The result is that the USN does not fight its budget battles alone but is supported by Defence lobby groups, elements of Congress and the wider community Navy's Maritime Strategy should lay the foundation understanding upon which a similar Australian coalition might be developed.

Second, I would challenge the article's focus on the role of the Surface Combatant Force in conflict and its assertions about the vulnerability of Surface Combatants. I believe the article makes too much of this last issue and does not pay sufficient attention to Surface Combatants' obvious flexibility and utility. The fact that they can perform a range of tasks is a real plus. Given the fluid nature of Australia's strategic environment, the possession of a Surface Combatant Force able to undertake a variety of roles across the entire threat spectrum underscores their real cost-effectiveness. That aircraft or stand-off weapons might also fulfil some of these roles is not disputed. However, it is also equally clear that these platforms do not have the same resilience and adaptability. They lack a "presence" and, once released, a missile must fly its course or be destroyed. It cannot simply withdraw over the horizon should situations be resolved. Their utility in situations short of actual conflict is also less clear.

The Surface Combatant Force fulfils an important role across the range of military response options described in *Australia's Military Strategy*. Surface Combatants represent a flexible asset that can be deployed in peace and war with equal success. The "prudent diversity" they represent is vital to the ADF and to Australia. Our ability to offer a self-supporting force to the MIF, our success in effecting the Southern Oceans rescues and the support provided to the multinational force in East Timor during Operation Stabilise offer timely reminders of the utility of the Surface Combatant. Whilst these may not be the raison detre of the force, they are nonetheless important in demonstrating to the community and to Government that Surface Combatants are cost-effective assets that can be readily and diversely employed in Australia's interests. Their flexibility makes them value for money. The article's focus on conflict scenarios conveniently ignores this benefit.

Third, I would observe that many of the observations contained in the article are supported but contend that the conclusions drawn are more open to challenge. The same set of facts might support two or more

conclusions but only one has been presented. This may serve the purpose of stimulating discussion but it also presents a somewhat distorted picture of the Surface Combatant Force. We should seek to avoid "either-or" investment decisions and, instead, should be striving to ensure that the future ADF is a properly balanced joint force. In this construct, Surface Combatants should present as primary building blocks of tomorrow's Navy.

Finally, I would conclude by recalling the words of Sun Tsu: "The highest excellence is to subdue the enemy's army without fighting at all." Maintaining a capable Surface Combatant Force with utility in peace and war and across the full threat spectrum, offers Australia some prospect of realising this outcome. This potential is a product of their innate flexibility and emphasises the versatility of Surface Combatants in war and in operations other than war. These characteristics are not available in aircraft or stand-off weapons – the platforms or systems often flagged as legitimate successors to the Surface Combatant.

A/Commander J.P.M. Shevlin, RAN

Dear Sir

I am pleased to hear that an upcoming issue will include articles written by Midshipmen. It will be of interest to note the ideas of our future generation of leaders. The issue of opinions and stances of our officer corps is indeed the basis of this letter and, as I was once a Midshipman, I feel remotely justified in writing at this time.

I note with interest the determination with which the new Chief of Navy, VADM Shackleton, is pursuing the opinions of his people in order to determine the way ahead for the Navy. CN has made himself accessible to all by his oft advertised e-mail address (ChiefofNavy@cbr.defence.gov.au) and his team of Navy re-shapers are also quite openly seeking approach (TNT@cbr.defence.gov.au). This is a nice idea, but it sounds like rhetoric to the cynical me.

The fact that I feel forced to write this letter under a pseudonym would seem to indicate that the idea of honest expression of opinion is not at all a facet of our Naval culture. If your journal is to meet its aim of providing a "forum for the exchange of ideas concerning subjects relating to the Navy and the maritime profession", surely a culture of free expression should be encouraged for those of us within the Navy. This is not just an issue for your journal, but of great relevance if we are to really progress as a Navy. For, as the Tomorrow's Navy Team (TNT) travel Australia in a quest to collate our opinions on the Navy we'd like for the future, I would suggest that the number of sailors and junior officers who have been approached is few. I ask the question

"Who is listening to our sailors and junior(ish) officers?"

No-one, I answer. Because realistically they are not going to call it as they see it. We are imbued with a sense of loyalty to our ship and our service and it would be a personal dilemma that faced the underling when asked by the Admiral or his men how things were going. When in that position, the junior's thoughts could follow this line: "I know what I *should* say here, and I know what I *really* think too, but which of these does this fellow want to hear and is he genuinely interested in my opinion anyway?" And so the Admiral doesn't get to hear what it is he tells us he really wants to hear.

To further cloud the issue, I would postulate that very few of our junior folk have ever had the opportunity to speak freely with senior officers, let alone those of Flag rank. To expect anything beyond respect and constrained niceties when faced with a brief opportunity to do so, or an invitation to submit an e-mail, is unrealistic.

And so to the TNT. We all know that the Captains and Commander on the team are strong personalities and successes in their fields. The average sailor or officer must wonder whether the TNT are really interested in listening to them. No way. The feeling I get from talking to people around the traps is that the TNT are out talking with the brass and designing their future for us.

Maybe a little more time spent talking with DPERS-N, MCAUST or HDPE about our FBT, our fuel allocation and our general conditions of service would be better than paying half-a-dozen officers to show CN in three months what he showed them at WATSON on 3 July. With all due respect, I am sure they are just like the rest of us; motivated by a sense of loyalty and a desire to get ahead with a good report. There's nothing wrong with that, except that it means we get no real answers and the Admiral ends up knowing no more about why it is we're expressing our opinions in the only way we feel free to, by walking out the door into civvy street.

Lieutenant T G Newman, RAN

Vice Admiral David Shackleton

Royal Australian Navy
Chief of Navy

Naval Career

David Shackleton was born in Leeds UK in 1948, and joined the RAN as a Supplementary List Seaman Officer from Adelaide in 1966. After completing initial training, he gained extensive experience through almost continuous sea service from 1967 to 1979. In that time he served in HMA Ships *Anzac, Stuart, Sydney, Vampire, Curlew, Queenborough, Melbourne, Perth* (twice), *Hobart* (twice), as well as undergoing training in the USA and exchange service with the Royal Navy where he served in HMS *Ariadne.*

He saw Vietnam service in HMAS *Perth* while qualifying as a seaman officer, and subsequently qualified as a warfare officer, specialising in combat systems and aircraft direction. He later commanded HMAS *Derwent* (DE49) in 1988/89, and during his time in command, *Derwent* won the Gloucester Cup for overall Fleet Performance. While in command of HMAS *Brisbane* (DDG41) in 1992 he led a major RAN Task Group deployment to South East Asia.

Highlights of staff postings up to the rank of Captain include being a member of the Directing Staff of the RAN Staff College, Project Director for acquisition of the Maritime Intelligence Centre, Director of Operational Requirements for the Jindalee Over-the-Horizon- Radar system, and the inaugural Chief Staff Officer C3I to the Maritime Commander.

On promotion to Commodore in December 1993, he took up the position of Director General, Naval Policy and Warfare in Navy Office, Canberra, with responsibilities for development and coordination of strategic policy for the RAN. During this posting, he also completed the 1994 Senior International Defence Management Course at USNPGS Monterey.

Commodore Shackleton joined the Defence Acquisition Organisation in September 1996 and initially assumed the position of Director General, Information Management. On implementation of the Defence Reform Program in July 1997, he changed roles to become the first Director General, Command and Support Systems, with responsibilities for development and acquisition of all of Defence's major capital equipment command and intelligence information support systems and major operational headquarters.

On promotion to Rear Admiral in July 1998, he took up the position of Head, Capability Development, with responsibilities for sponsoring all new major capital equipment requirements initiatives for the Australian Defence Force.

Vice Admiral Shackleton is an Associate Fellow of the Australian Institute of Management and a graduate of the RAN and Joint Services Staff Colleges. He has a Diploma in Corporate Management, a Graduate Diploma in Management, and was awarded a Master of Business Administration on completion of the Monash Mt Eliza Business School senior executives program. He was promoted to Vice Admiral on 3 July 1999 and took up his present position as Chief of Navy at that time.

Personal Details

Vice Admiral Shackleton is married to Robyn. He has two sons (Peter and Christopher) by a previous marriage.

Statement from the Chief of the Navy

By VADM D.J. Shackleton, RAN

It's been a bit busy since I took over the watch as Chief of Navy from Vice Admiral Don Chalmers AO RAN on 3rd July. I wish to use this forum to publicly acknowledge the great contribution that Admiral Chalmers has made to the Navy, both throughout his entire working life, and especially as the Chief of Navy. It is a personal honour for me to have relieved such a fine officer. I wish Admiral and Mrs Chalmers well in all their future endeavours.

Since I took over the watch, many issues have demanded my attention. The Submarine review has been finalised and important action implemented. A similar plan is in place for getting the LPAs *Manoora* and *Kanimbla* back to sea and the FFG Upgrade Project is moving ahead. *Kakadu* has been and gone and the Fleet has met its targets again. But not without all the toil and effort that goes into making this happen – right across the Navy, and also in the supporting organisations that contribute to this achievement. The Navy's most significant effort at present is the involvement of our ships and people in support of the UN operations in East Timor. The support of these forces and the effort of those involved has been world class so far.

I've had a chance to speak to many people about the issues I see as most important for us in the near future, but there are also many more people that I have yet to meet. I have begun a visit schedule to make sure I get to see the people of the Navy, wherever they might be. By the Navy's people, I include those that work in the many different parts of the overall Defence organisation, as well as some of our no longer serving members.

Warrant Officer David Wilson has recently taken over as the Warrant Officer of the Navy (WO-N), and he is making his way around Navy to meet our people and advise me of their concerns. WO-N talks directly to me about the concerns of our people and I take action on his advice.

There is a whole host of issues to be dealt with. These range from pay and conditions of service, operational tempo, readiness to future Navy capabilities and more. I am working hard to make sure that these are given the direct and personal attention that they deserve. Where the answer is not exactly as Navy people would want, it is not for lack of trying. I am responsible for that and always bear in mind the fact that we are all in the same team.

As you would expect, I am taking a close look at all those things that I am responsible for, and I will take action on any matter that I think needs adjusting. But, let me say to you all, that you also have a personal role to play in leading the Navy. Please don't believe that doing things in a particular way "because we have always done it that way" makes sense to me. You also have some ownership of how the Navy performs, be you a member, ex-member, or anyone with an interest in Navy issues.

From the weekend workshop I lead involving Navy's Senior management at HMAS *Watson* on 3 & 4 July, I have initiated a review of the design of the entire Navy. I have also reviewed Navy's mission and goals as published in the Future Directions Statement a few years back. They are sound, but I have added "Shaping the Navy of the Future" as an important sixth goal. The people we talk to and the things we do send important messages about who we are as a Navy. No matter where we are, we are always in the Navy. We are always on watch and Australia deserves that.

I intend to pay close attention to making sure Navy is even better prepared to go in harms way. And win. And come home.

As such, I have created the Tomorrows Navy Team (TNT). The members of the TNT have visited many Navy people and many in other programs to ensure the Navy is best shaped to operate for capability in the future ADF. You can visit their web-site through the Navy homepage (www.navy.gov.au). The TNT will report to me in October with the best options for the Navy of the future. By the end of this year, I want to decide on the key organisational framework, and start putting the resultant shape of the future Navy in place by early 2000.

The TNT is not a green handgrenade nor a loose cannon, as I have heard. The TNT will not propose a solution that fixes everything. You would be just as surprised as I if that were the case. But what I have tasked them to do, is to advise me how best to arrange the Navy so that the entire shore based element of Navy is focused on getting our capability management efforts right. That means that our fighting forces at sea are the best we can get for the money we have available. This is not a trivial task and I have asked all in Navy for their help to do it.

If you think you can help, get in and e-mail them your say today at TNT@cbr.defence.gov.au

For the benefit of readers who have not seen my assumption of command message, I would like to repeat some of it here. It read in part:

I want to reinforce that the defence of our country is a serious responsibility, it is only entrusted to those who are worthy of the task. Earning the trust of Australians, understanding that our country trusts us; and not damaging that trust is a central consideration for all of us. Fair play, equality and a can-do attitude are distinctly Australian qualities, and Navy will be an organisation that reflects these features of our society. Particular principles we will all be prepared to stand by and demonstrate in our behaviour are:

- *Our proven world class professionalism;*
- *The personal application of physical and moral courage, loyalty, honesty and integrity as individual men and women; and*
- *Demonstrable dedication and commitment to serving the Navy and country as Australians.*

If anyone does not believe that they can live by these values, be they uniformed or non-uniformed, men or women; then they have no place in the Navy. It is that fundamental.

The last few years for Navy have been tough. The operational tempo is higher than for several years. The fire in Westralia *brought home to us all the reality of having to deal with the perils of the sea. But, we are taking delivery of new ships, submarines and minehunters, and new helicopters are on order. The Navy is progressively being modernised and will continue to be the best in the region. Our professional performance is still regarded amongst the best in the world, and we must keep it that way.*

As a component of the Australian Defence Force, and like the Army and Air Force, the Navy is one of Australia's enduring institutions. But, like all institutions, if it is to remain relevant to contemporary society and the people it serves, it needs to constantly refresh itself with new ideas and approaches to doing business.

Only the people of the Navy can keep it relevant to other Australians, and I expect all of us to try to understand the business of the Navy as best we can, and be personally committed to improving it. Our successors must be able to thank us for a job well done and take over a better ship, or we will have failed in our duty. Our leadership approach therefore needs to be one with the characteristics of honesty and competency, and be inspirational and forward looking. We all need to lead.

I am proud to have the privilege of leading and serving you. I am on watch. I have the ship.

That's probably about enough from me for now. I have a very strong belief that we all care about the Navy. We wouldn't be reading this Journal if we didn't. I would like your help to make our Navy a better place. If you have any good ideas, you can email me at: ChiefofNavy@cbr.defence.gov.au

Yours Aye

David Shackleton
Vice Admiral RAN
Chief of Navy

The Role of System Modelling and Simulation in Royal Australian Navy Capability Management

By David Saunders, Moya Tyndall and Tom Whitehouse

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Abstract

This paper examines the Navy Capability Management process that has evolved from the 1995 review of RAN logistics support and in response to the more-recent Government focus on output based management of ADF assets.

This paper seeks to show that capability management should be based on quantitative measures, including the insertion of Measures of Performance and Measures of Effectiveness at appropriate points in the management process. Capability management must also refer to operational requirements and is therefore a requirements-driven process. However, the principal difficulty with this management process is the lack of processes and supporting tools. Modelling and simulation are presented in this paper as a means of addressing this difficulty. The main purpose of modelling and simulation is to predict the behaviour of ADF assets (RAN platforms and platform systems) in response to their environments. Environments in this context refer to changing operational requirements and constraints both within and external to the model.

Capability management is a forward-looking, dynamic process and therefore there is a need to develop matching dynamic models as capability management tools. There is no single model that can be generally applied to the many capability management problems, however; modelling may be applied effectively to address specific management and technical issues. Models representing the RAN platforms and platform systems, when applied in a simulation process under a range of conditions, can provide useful capability management information. This information may be used to develop appropriate quantitative performance measures.

1. Introduction

Recent reviews of RAN logistics support [1] and RAAF logistics support [2] have highlighted the need to change business processes to meet the preparedness (readiness and sustainability) and supportability requirements of ADF assets in a resource-constrained environment [3]. These reviews have identified that operational requirements must drive the capability management process. More generally, they have identified significant gaps in the process of linking technology, operational requirements and business practices.

The management of RAN assets including human resources is a complex process that, over time, is likely to increase further in its level of complexity. One of the reasons for this increasing complexity is these RAN assets will not be managed individually, but in conjunction with other ADF assets. To achieve effective financial and materiel management, the RAN will need to develop and apply new processes and tools that capture the dynamics of asset management. These new processes and tools will be used to explore how the technical systems of RAN assets and their in-service support systems respond in a changing environment. The environment in this context refers to changing operational requirements and financial, technical and human-resource constraints. For example, how to optimise the allocation of funds so that the required level of capability can be achieved to perform a particular operational requirement. Another example is when to schedule maintenance so that the capability of a platform is maximised during a specified period of time. The need for these tools has been recognised overseas [4] and within the RAN [5, 6]. Significant effort within the RAN has been devoted to defining the framework for a requirements-based asset-management process [5, 6], but this process will also need quantitative methods that can be applied to the dynamic logistics and in-service support environments.

At present there is no accepted definition of capability management. The 1997-1998 Defence Annual Report [7] deals with capability management in a general way:

"The Government looks to Defence to provide the widest range of effective military options in any military situation that might arise. The Defence organisation's most important priority therefore is to maintain military capability ready for

operations, including, if necessary, for combat. That priority is reflected in Defence's output structure, which identifies the elements of the current capability as the key products provided to the Government."

In this paper, capability is defined as **the ability** of a system to perform specific actions. 'System' is used here as a generic term that describes any system, large or small. Some examples of systems are a Force Element Group (FEG), platform, weapon system, propulsion system, engine and fuel pump. In the Australian Defence Force (ADF) **military capability** is defined in terms *"of two elements – force structure (the number, type and grouping of military units, personnel, equipment and facilities) and the preparedness of that structure for operations"* [8]. An example of how military capability can be managed in an efficient and effective way is given in the Mine Warfare Force Element Group Business Model [9]. This model defines the Mine Warfare FEG capability in terms of materiel support, operations and operational support (Figure 1). The activities or actions that make up this capability include maintenance engineering, training, configuration management, managing preparedness requirements, planning missions, conducting operations and providing port services.

Capability management implies that the ability of a system to perform specific actions needs to be **measured** and compared with a desired measure or benchmark. A **capability gap** exists when there is a deficiency between the measured ability of the system and the desired ability of the system. Simply stated, capability management is the process to identify and address the capability gap within the temporal environment. It is a forward-looking process, particularly when considering a range of possible operational requirements. The main three causes of the capability gap are:

1. changes in operational requirements,

2. changes in the environment, and

3. changes in the performance of the RAN assets.

Figure 1: The Mine Warfare Force Element Group Business Model defines capability in terms of materiel support, operations and operational support.

The critical question that should be asked about capability management is *"manage to do what?"*. Capability management needs to be driven by operational requirements, that is, RAN assets respond to requirements to achieve specific outcomes. The dynamic nature of the capability management process will be discussed in this paper, and following from this, it will be argued that effective management of RAN capability can only be achieved using quantitative methods. The application of system modelling and simulation will be shown to be one method of quantitative management. Modelling and simulation will allow the generation of "virtual histories" which will allow forward-looking management decisions to be made and which will be directly related to the requirements for the capability. The reality of capability management is that RAN assets contributing to the capability cannot be placed (and therefore tested) under all possible operational conditions.

There are many modelling and simulation tools currently available that could contribute to the capability management process. Tools based on modelling and simulation need to be initially developed to address specific aspects of the capability management process. This paper focuses on the materiel support aspects of the capability management process that are the responsibility of the Class Logistic Offices in Support Command – Navy. For example, modelling and simulation tools could be applied to resources allocation, maintenance scheduling, spares optimisation and obsolescence management. The results from these tools will contribute to the performance and effectiveness evaluations within the capability management process.

In the next section capability management is discussed in terms of systems concepts. This is followed by a discussion of the need for quantitative processes in capability management and how modelling and simulation can be applied to this process. Some of the modelling and simulation techniques that could be used are presented in the next section, followed by a short summary of this paper.

2. Capability Management

This section begins with an explanation of system concepts, which is then used to define Measures of Performance (MOP) and Measures of Effectiveness (MOE) in Section 2.2. These concepts are then used in defining the capability management process in Section 2.3.

2.1 Systems Concepts in Capability Management

In this section, the definitions of a "system" and a "component" are given. A more detailed examination of these concepts and their application to capability management is given in [10].

The term "system" is quite loosely applied to many animate and inanimate objects, groups of objects and

ideas. The most helpful and general view of a system is that its collective function is only made possible by reaction and interaction of its overall sub-systems and that no individual system can exist without some level of interaction with other systems. Collective, interactive systems themselves are part of some larger system; thus to understand a system requires appropriate boundaries be established which encompass all essential features contributing to the function of the system under study. This view is most instructive when dealing with management and business systems since the function of a business system cannot be assessed without reference to other systems from which it draws and supplies information while (often) imposing mechanisms and constraints on other systems, including those that provide or use information.

"Every system is part of a larger system. It is a system in its own right, and it is also a sub-system of the larger system" [11]. The purpose of the sub-system is to support the larger system in performing a task. *"There are endless chains of systems within systems, in hierarchical relationship to each other"* [11]. The hierarchies of systems for three examples are given in Figures 2a-c. In each of these examples only one system at each level is given. A number of systems at each level can be combined to form the system at the level above. In this paper the systems at the lowest level in the systems hierarchy are called "components". The analyst who is studying the "total" system determines the levels that make up the system hierarchy. Therefore, in the examples in Figures 2a-c, the components are transformer, anti-ship missile defence system and fuel pump, respectively.

- Government
- Department of Defence
- Navy
- Force Element Group
- Ship/Submarine
- Anti-Ship Missile Defence System
- Radar
- Transmitter
- Power Source
- Transformer

(a)

- Nation
- Government
- Department of Defence
- Navy
- Force Element Group
- Ship/Submarine
- Anti-Ship Missile Defence System

(b)

- Government
- Department of Defence
- Navy
- Force Element Group
- Ship/Submarine
- Propulsion System
- Engine
- Fuel Pump

(c)

Figure 2: Three Systems Hierarchies Examples, adapted from Figure 1 in [11].

2.2 Measures of Effectiveness (MOE) and Measures of Performance (MOP)

Measures of Effectiveness (MOE) and Measures of Performance (MOP) are two sets of metrics that can be used in quantitative management processes. MOEs are measurements of the ability of a system to meet a requirement. Requirements define what a system should be capable of achieving. The effectiveness of a system in supporting the larger system can only be evaluated by determining how well it has helped the larger system meet its requirement [11]. MOPs are measurements of the performance of a system that result from the particular way it is designed. MOPs may be performance characteristics derived from tests and/or trials of systems. Performance characteristics can be measured quantitatively and assessed against a baseline.

To avoid confusion between MOEs and MOPs, it is useful to think of them in terms of the systems hierarchy. It is possible to determine a system's MOPs in isolation but the MOEs of that system cannot be determined unless the requirements of the larger system it supports have been specified. For example, the MOPs of the fuel pump in Figure 2c are inherent

to the fuel pump but the engine is the source of the MOEs for the fuel pump. The performance of the fuel pump may satisfy the designers and manufacturers specifications but its effectiveness is determined by how well it supports the engine in the performance of its function. The capacity of the fuel pump to supply fuel to the engine may be too low for the engine's needs for fuel. Similarly, the performance of the engine may satisfy the designers' and manufacturers' specifications but its effectiveness is determined by how well it supports the propulsion system in the performance of its function. This principle continues up the system hierarchy. The ship or submarine is a sub-system of a larger system, the FEG. The ship or submarine is not working alone but in conjunction with other defence assets in the FEG to accomplish the FEG's mission. Therefore, the MOEs of the ship or submarine are determined by the FEG's objectives. These examples illustrate the differences between MOEs and MOPs and these differences are summarised in Figure 3. (Figure 1 in [12]).
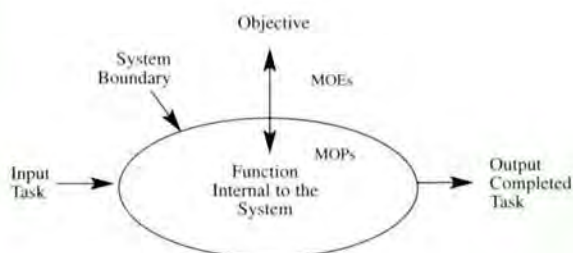

Figure 3: A conceptual difference between MOE and MOP as illustrated in Figure 1 in [12].

2.3 The Capability Management Process

ADF assets, specifically RAN assets, exist to perform specific functions in relation to defence requirements. The capability management process enables RAN assets to achieve specific levels of performance once they have reached the operational phases of their life-cycles[1].

The capability management process is illustrated in Figure 4. This process begins with the mission statement that is derived from Australia's Strategic Policy [3] and translated into a set of military strategies and Military Response Options (MROs) which form the basis of new preparedness directives [7]. The operational requirements for the RAN are then specified in the Chief of Navy Preparedness Directive [13].

The management process requires assessment processes to answer the questions *"How well has the current capability satisfied the current operational requirement and how well will the current capability satisfy future operational requirements?"*. The formal process for verifying this is through the Capability Assessment Reporting (CAR) process and the Capability Management Boards (CMB) [14]. The CAR and the CMB processes highlight deficiencies in capability however, quantitative approaches have yet to be put in place to support this management process.

In the capability management process, both the MOEs derived from the operational requirements and the MOPs of the current capability are used to assess whether the current capability can adequately meet the operational requirements. This assessment process requires MOEs and MOPs to be:

• timely (that is, they can be evaluated within a specified time period),

• relevant (that is, related to requirements which may change with time),

• inserted at the appropriate points in the management hierarchy,

• meaningful to the management level,

• recorded,

• tested (to ensure that data are not biased).

If the outcome of the assessment process is that the operational requirements are not met, or in the future will not be adequately met by the current capability then appropriate action needs to be taken. For example:

1. the capability may need to be changed during its life-cycle,

2. a new capability may need to be introduced,

3. the training may need to be enhanced,

4. the Integrated Logistics Support (ILS) may need to be modified, or

5. the operational requirements may need to be redefined.

Decisions to change the capability or introduce a new capability involve risk-management decisions, such as, cost/capability trade-offs and re-evaluation of operational requirements. The greatest difficulty in the capability management process **is assessing how the capability will meet operational requirements in the future.** The capability management process is a dynamic process involving risk management and continuous improvement as illustrated by the feedback loops in Figure 4.
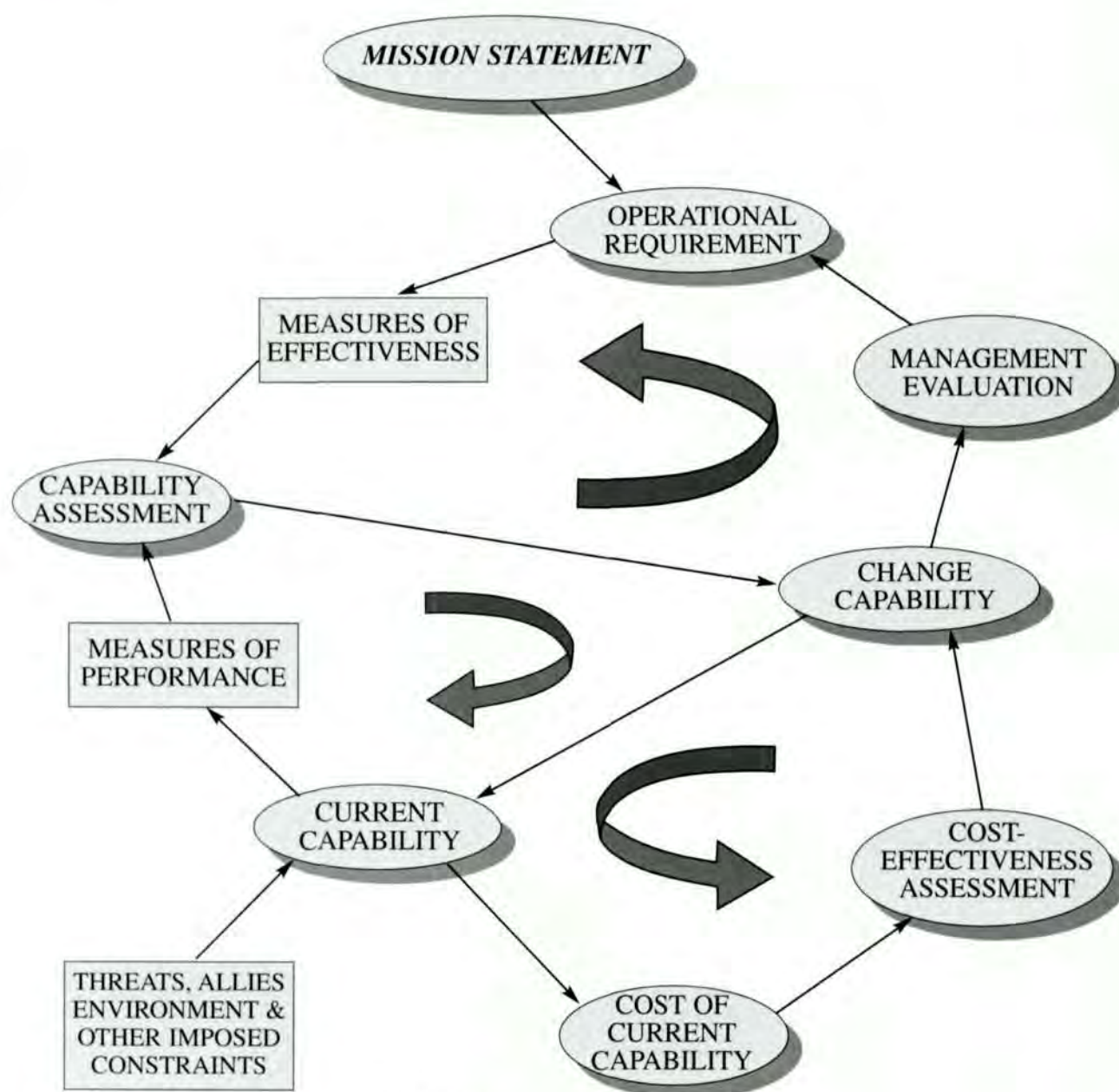
Figure 4: The capability management process.

3. Quantitative Processes in Capability Management

The systems approach to capability management has the potential to provide quantitative measures that can be applied to all levels of the RAN capability management process. Specific issues that need to be addressed for quantitative capability management are:

1. insertion of measurement points in the organisational structure for capability management;

2. integration of capability development and capability management;

3. ability to measure performance in response to a changing environment;

4. risk management and decision making processes; and,

5. continuous improvement in the capability management process.

These issues are briefly addressed in the following sections.

3.1 Insertion of Measurement Points in the Organisational Structure for Capability Management

A description of how measurement processes may be embedded within the current RAN organisational structure is given in this section. The measurement points and areas of influence in capability management for the Maritime Commander, Commodore Logistics Support (Navy) and the Class Logistics Managers are shown in Figure 5.
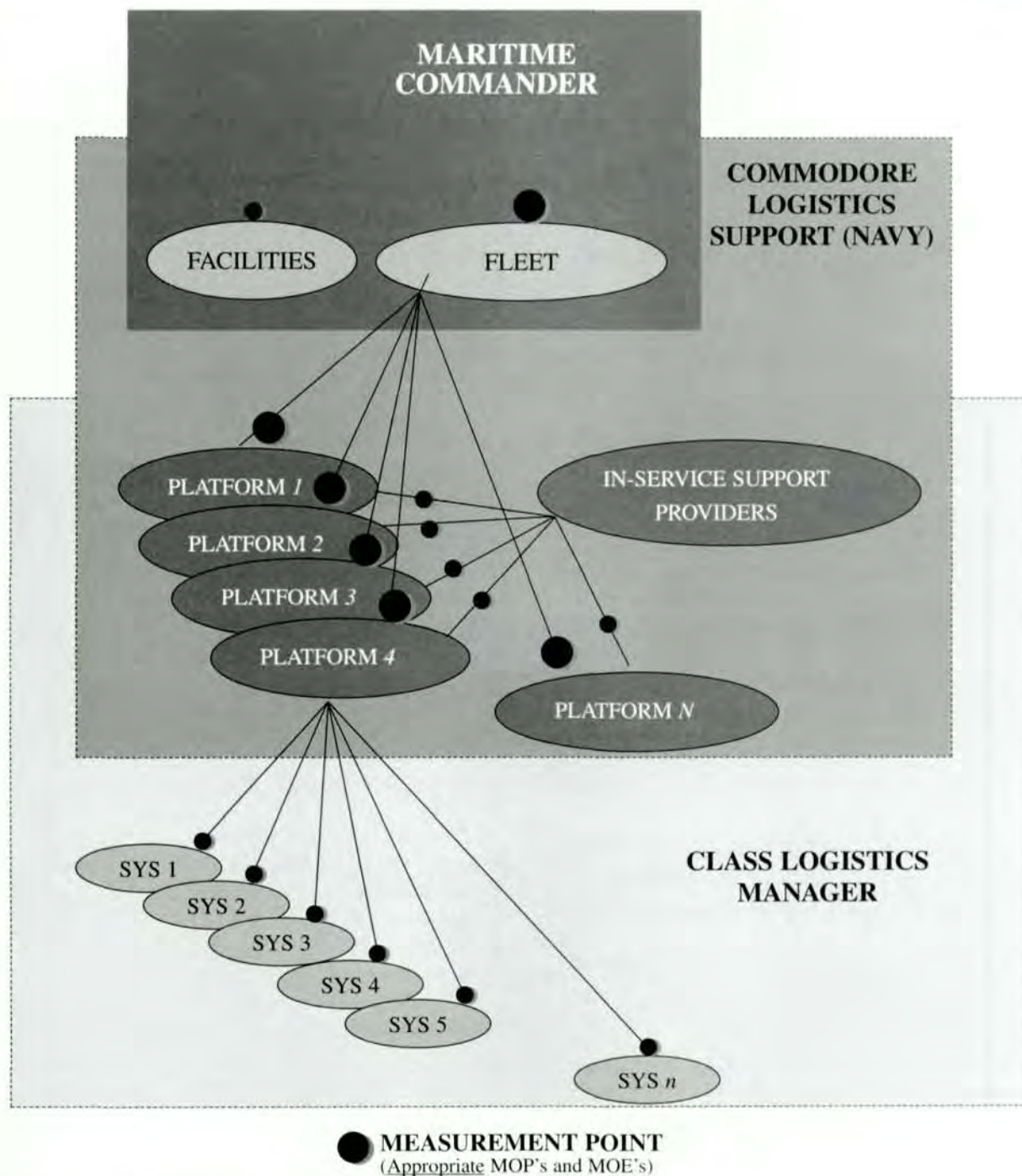
Figure 5: The Hierarchy of Capability Management

The purpose of Figure 5 is to show that capability management will often require different information to be available to the various management levels in the process. For example, the Maritime Commander is primarily concerned with the performance of the fleet and facilities whereas the performance of an individual component or system on board a RAN platform is the concern of the relevant Class Logistic Manager. In this example, a RAN platform (which is a collection of interacting systems) can be managed individually, yet this platform contributes to higher-level requirements in conjunction with similar and/or different platforms. Therefore, it is important to determine the relevant information for each managerial level and to put in place the appropriate MOPs and MOEs.

Informed decision making is dependent on establishing measurement points within the capability management process that are consistent with articulated operational requirements for the capability. The measurement points in Figure 5 that are used to show the appropriate MOPs and MOEs need to be inserted at various positions within the business processes. The purpose of these measurement points is to set targets or benchmarks to be achieved that enable the responsible managers to understand how well the process is performing [2].

Deciding *where* to place these measurement points is a critical issue in the design of the capability management process. At all levels, the measurement points must be capable of capturing information relevant to the operational requirement of the capability. The three principal classes of performance information (which will be measured against performance benchmarks) are:

1. technical,

2. financial, and

3. human (for example, training and in-service support competencies).

Measured characteristics at many of the measurement points will be related. For example, financial performance may have a strong impact on training and hence human performance.

In many management systems it is often possible to find that the performance measures used are those that are easy to measure. However, they may not convey information as to how the system is functioning. For example, from a Defence perspective, there are few performance measures that are related to mission reliability, sustainability and cost effectiveness [2].

This reference also notes that:

> *"... there are no agreed benchmarks for performance measures in an operational planning sense. The type of information available is historic, giving no indications of future trends or outcomes...".*

The result is that operational requirements are usually adjusted to accommodate platform availability rather than operation requirements driving the availability[2].

3.2 Integration of Capability Development and Capability Management

It is important that the **capability management** process is not separated from the **capability development** process. It could be argued that the capability management process commences **before** assets are acquired. As with all logistics processes, down-stream processes are affected significantly by decisions made in the early stages of capability development. There is an obvious requirement that all of the supportability (and configuration) information will be transferred to the operational and support phases of the asset's life-cycle and that it will continuously be **maintained throughout the life-cycle of the asset.** Assets are often managed in an information-poor environment because management processes are not in place to maintain such information throughout their lives. Additionally, the performance characteristics of assets are often evaluated under "test-bed" conditions and therefore do not reflect their performance within the larger Defence environment. Therefore, management processes, including sparing, maintenance scheduling and

maintenance are often based on inappropriate data which are irregularly updated (if at all). Further, new roles and tasks that are outside the asset's original design may evolve for an asset after its operational life begins. Processes need to be developed to clearly state the desired capability of assets and their support requirements continuously throughout the life-cycle.

This has been partially addressed in two areas relevant to RAN assets:

1. RAN's Detailed Operational Requirements document (DOR) for assets is to become a "living document" which will capture changing capability baselines in response to changed operational requirements [13]. This document will become the Capability System Statement;

2. Integrated Logistics Support (ILS) arrangements will be maintained throughout the life of the asset [15] that includes formal processes for the through-life maintenance of the ILS documentation for ADF assets. Collection and management of asset and in-service support provision performance data will be essential to the maintenance of through-life ILS data.

3.3 Ability to Measure Performance in Response to a Changing Environment

One of the greatest problems inherent in the RAN capability management process is that the process is largely undertaken under peacetime conditions and information derived from these conditions does not readily extrapolate to contingency conditions. Information and management processes from peacetime operations may become less relevant and/or inaccurate when in an environment of increasing threat levels. Therefore, the capability management process must include strategies and contingencies to ensure preparedness of assets under all credible operational conditions.

Preparedness is defined in terms of readiness and sustainability [14]. Readiness implies that ADF assets must be at a particular level of operational capability. This includes equipment and its condition, personnel and their level of training. Readiness of RAN assets is currently assessed internally and stated as Minimum Level of Capability (MLOC), Operational Level of Capability (OLOC) and Present Level of Capability (PLOC). These "measures of capability" need to be assessed quantitatively. Collected data may be representative of past and current capability in response to a range of operational conditions but this is only a subset of all possible operational conditions. Unfortunately, difficulties still exist in determining the MLOC to OLOC dynamic [8] because principally there is still no way of quantifying the relationship of platform systems to operational requirements. The development of suitable MOPs and MOEs will provide a mechanism to quantify the relationships between platform systems and operational requirements and this is the focus of current research [10].

Sustainability is the capacity to support ADF forces in operations and includes the adequacy of material support, relief of personnel and serviceability of assets whilst ADF forces are deployed. This includes the ability of industry to maintain a surge capacity for the continual supply of materiel and equipment. It is particularly difficult to assess sustainability because it is an attribute of the capability management process that is forward-looking and must consider more than one operational scenario. **Sustainability modelling presents significant challenges** and further work in this area is highly desirable if preparedness decisions are to be made based on a high level of quantitative information.

3.4 Risk Management and Decision Making Processes

It is also instructive to view capability management as a risk management process, that is, the risk of an action or the risk of inaction to address an identified shortfall in capability. This is embodied in the CN proposal [13] for Navy Capability Management that states:

> "... an essential feature [of capability management] is managing the risk associated with maintaining a credible capability for the prevailing and emerging strategic situation and environment of high technological change and limited resources ...".

From a risk management perspective, the management processes must be forward-looking. Decision making in risk management will need to be undertaken using quantitative data. These data will be used to calculate the two components of risk: the likelihood of an event happening; and the consequences of that event. For example, the risks of using a particular maintenance or sparing policy could be identified before the policy is implemented. Decisions in risk management will often involve cost/capability trade-offs and formal processes such as selection of evaluation criteria, weighting of evaluation criteria and the use of ratios as means of evaluation scoring [16]. Decisions may also be made on the basis of data generated by modelling and simulation and using decision-making tools.

3.5 Continuous Improvement in the Capability Management Process

The use of quantitative measures means that the performance of RAN assets can be tracked in time. These data can be used to continuously improve the assets and the management process. Most importantly, the quantitative measures (MOPs and MOEs) used in the capability management processes need to be continuously tested to determine their appropriateness to the current or "new" operational conditions. It is not sufficient to put MOPs and MOEs in place and assume they will never require modification. As new assets are introduced into the ADF, new methods of

testing or training may be required. Also, the measurement points in the capability management process may either, not be appropriate, or not be located in the same place in the management process.

The level and quality of services such as training, refit capability, maintenance and facilities that are supplied by in-service providers will also change over time. The capability management process must be sufficiently responsive such that it both captures the changing in-service support services and that the process itself is responsive to any changes.

4. Application of Modelling and Simulation to the Capability Management Process

What has been discussed so far in this paper is the dynamic nature of capability management. Capability management is principally concerned with how RAN assets are going to behave in the future. The main purpose of modelling and simulation is to predict the behaviour of systems when constrained to a particular set of operational conditions. The results of modelling and simulation for the capability management process are appropriate MOPs and MOEs for all possible requirements. This will lead to informed decisions in risk management, including assessment of different management strategies and the ability to determine areas of deficient performance.

There are three main constituents required for the successful application of modelling and simulation to the capability management process. These constituents are:

1. models must accurately reflect reality[1] (this includes both the equipment and their operators);

2. appropriate data must be gathered for input to the models; and,

3. predictions are thoroughly assessed for their accuracy and relevance.

The models will be described by entities (objects), the attributes or properties of the entities, the functions performed by the entities, the inputs, outputs and states and the rules governing the interaction of the entities, including the business rules. For example, in the case of the Maritime Defence Assurance System (MDAS) project [5, 6] a set of business rules has been developed to govern the interaction of entities.

When applied to capability management, modelling and simulation has the potential to provide mechanisms which allow the exploration of the outcomes of plausible (and not so plausible) scenarios, requirements, inputs and constraints applied to specified systems. The virtual history so generated provides guidance to managers *before* scenarios are encountered. Therefore, through the

application of modelling and simulation, the capability manager has the opportunity to develop strategies and contingencies before a plausible scenario becomes reality. Modelling and simulation will allow management decisions to be made on the basis of **many** scenarios. Historical data can be used to validate that the modelling and simulation process has indeed predicted the outcome of the actual set of operational conditions. This is one validation technique (others are listed in Section 5.5) and can only be used if the historical data is available. Mean time to failure, mean time to repair, power output and charging rate are all examples of physical performance data captured by management information systems such as Anzac Ship Maintenance Planning System (AMPS), Submarine Information Management System (SIMS) and Submarine Information System (SIS). The data from these platform information systems may be used in the modelling and simulation process. However, this provides little guidance about how assets may behave under conditions significantly different to the conditions for which they were acquired. The role of modelling and simulation as the forward-looking capability management process is summarised in Figure 6.
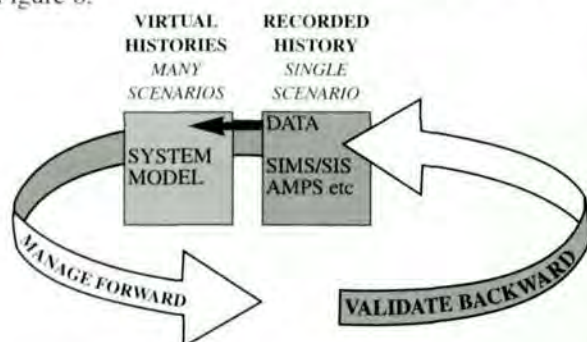

Figure 6: Modelling and simulation as the forward-looking capability management process.

The manager who uses modelling and simulation can better assess the consequences of decisions compared to the "intuitive" manager who relies on personal experience and the experience of others. The manager who uses modelling and simulation is able to **augment** "intuitive" processes by exploring a wider range of scenarios where no experience has been gained. For example, an acceleration of system usage may result in the "intuitive" manager increasing the sparing rate, but modelling and simulation may show that, for this scenario, sparing rate need not increase[4].

Modelling and simulation provide methods that allow "discovery" of problems and sensitivities to internal RAN processes and external environmental constraints, and allow the concurrent investigation of *many* scenarios in the capability management process. This is highly important when there is human activity in the system, since no performance of human activity is exactly the same[5].

Some of the areas of **capability management** in which modelling and simulation can be used are: critical systems analysis, risk analysis, reliability, availability and maintainability analysis, obsolescence analysis; and resource allocation analysis. **Critical systems analysis** involves identifying system failures that could result in non-completion or incomplete performance of an operation and additional **risk analysis** identifies failures that could result in loss of life, injury or illness and significant loss of, or damage to, the asset. One of the purposes of **reliability**[6], **availability**[7] and **maintainability**[8] analysis is to predict the performance of assets. This analysis, when combined with modelling and simulation allows exploration of a range of different scenarios, such as the impact of different maintenance schedules and levels of crew experience. **Obsolescence analysis** is used to identify components and systems that present a significant risk to a system because of discontinuance of production, change of specification or change of manufacturer. **Resource allocation analysis** may include optimisation of sparing levels, crew training and different maintenance schedules for changes in usage, operational roles and operating environments.

5. Numerical Techniques for Capability Management

In this section some of the numerical techniques that could be applied to the capability management process are briefly discussed. These include: modelling and simulation techniques; multi-criteria decision-making techniques; artificial neural networks and expert systems; and, knowledge discovery techniques. This is followed by a brief description of verification and validation techniques. The use of these numerical techniques will assist the capability manager in the decision-making process.

5.1 Modelling and Simulation Techniques

There are basically three mathematical techniques for predicting the response of an asset when constrained to a particular scenario or set of conditions:

1. trend analysis using historical data,

2. analytic models and,

3. simulation models.

The main assumption of **trend analysis** using historical data is that the asset being analysed will respond in the same way as in the past. Therefore, if a future event has not also occurred some time in the past then trend analysis cannot predict how the asset will respond to this event. For example, the effects of aging and the consequences of preventative maintenance cannot be predicted using trend analysis on historical data. **Analytical models** use sets of equations to describe the behaviour of the asset and

then attempt to solve them. However, the equations involved (even for a small system) are extremely complex and therefore a number of simplifying assumptions must be made in order to obtain a solution. One of the most common simplifications is to assume a constant failure rate, otherwise it is impractical to solve the equations. For example, the consequence of using a constant failure rate is the probability of a system failure will be the same whether the system is one month old or a hundred years old, and whether it has undergone maintenance or not. **Simulation models** use statistical sampling to create events in time and simulate the behaviour of the asset as a function of time in response to these events. Unlike both trend analysis and analytical models, simulation models consider all possible behaviour (or states) of an asset and for this reason alone is the preferred mathematical technique.

5.1.1 Modelling and Simulation Tools

In developing models, and applying simulation techniques to these models, it is important to define what "a model" means. In the context of this paper, [19] provides an appropriate definition. A model

"... is the explicit interpretation of one's understanding of a situation, or merely of one's ideas about that situation. It can be expressed in mathematics, symbols or words, but it is essentially a description of entities, processes or attributes and the relationships between them ...".

One important feature of the modelling process is that it often incorporates the modeller's view of the system or situation, thus the modelling process has a high level of human involvement. While different humans may produce different models, the expectation is that the model is still an effective representation of the system or situation[9] under study. This highlights the importance of verification[10] and validation[11] in the modelling process.

5.1.1.1 Reliability Block Diagrams and Fault Trees

Reliability block diagrams [21] are a graphical representation of the serial and parallel functional relationships that exist between components and systems that are required for the overall asset's performance. If each component and/or system can be characterised by a function describing its failure with time then the results from the analysis will be a time dependent function that describes the reliability of the overall system. It can also show what systems and components are important with respect to failure and provide insight into system behaviour.

Reliability block diagrams [21] can be directly converted into **fault tree diagrams**, which show the logical connections between failure events in relation to the defined "top-level" system failure. Fault tree analysis can be used to quantify the "top-level" system failure probability.

5.1.1.2 Influence Diagrams and Decision Trees

Influence diagrams and decision trees [22] are two complementary approaches that can be used for structuring decision problems and, depending on the nature of the problem, one approach may be preferred. The decision analysis tools have different advantages for modelling complex decisions. Influence diagrams and decision trees are isomorphic, that is, any properly constructed influence diagram can be converted into a decision tree, and visa versa. An **influence diagram** is a simple graphical representation of a decision problem. The elements of the decision problem, that is, the decisions to be made, uncertain events and the value of outcomes, are all represented by different shapes in the diagrams. These shapes are then linked with arrows in specific ways to show relationships between the elements. Influence diagrams are very good for showing a decision's structure, but they hide many of the details. A decision tree can be used to show the details that are hidden or embedded in an influence diagram. A **decision tree** represents all possible paths that a decision-maker might follow through time, including all possible decisions and outcomes of chance events.

5.2 Multi-Criteria Decision-Making Techniques

There are many multi-criteria decision-making techniques that could be applied to the capability management process. These techniques can be used in two different ways: to capture the decision-maker's preference; or, they can be used in further analysis of modelling and simulation outputs. Two of the more popular techniques, the Analytic Hierarchy Process (AHP) and Multi-Attributed Utility Theory (MAUT), are briefly described in this section.

5.2.1 Analytic Hierarchy Process (AHP)

AHP [23] is a multi-criteria decision-making technique that allows consideration of both objective and subjective factors in selecting the best alternative. AHP is one of the most popular multi-criteria decision-making methodologies available today and has been used in a wide variety of applications including resource allocation, predicting likely outcomes, cost benefit analysis and supplier evaluation. AHP decomposes the decision problem into a hierarchy. The hierarchy consists of the general goals and objectives at the highest level, the next level or levels down contain the more specific attributes and the lowest level consists of the alternatives. Pairwise comparisons are then made between the elements of each level in relation to their parent level. This produces the local priorities of each element in the hierarchy. The local priorities in the various levels of the hierarchy are then used to construct a composite (global) set of priorities for the alternatives (that is, the elements at the lowest level of the hierarchy). AHP has also been extended for decision problems that cannot be decomposed into a hierarchy or where only a partial hierarchy exists. In these problems there may

be dependencies and feedback and therefore it is more appropriate to use a network in replace of a hierarchy. This process is called the Analytic Network Process (ANP) and has not been applied as extensively as AHP since it is a relatively new concept [23].

5.2.2 Multi-Attributed Utility Theory (MAUT)

MAUT is a technique that uses the decision-maker's preferences, involving uncertainty, risk and other factors, in selecting alternatives. In MAUT, the decision-maker's preferences are captured in the form of a non-linear utility function for each individual attribute or quantitative performance measure. These single attribute utility functions are then combined into a multi-attribute function, which is a single index of the overall desirability of an alternative. Probability distributions are used to quantify uncertainty in the multi-attribute function. MAUT provides a method of combining MOPs and other quantifiable factors into MOEs.

5.3 Artificial Neural Networks and Expert Systems

Artificial Neural Networks (ANNs) and expert systems are often thought to be competing forms of artificial intelligence. However, it is more appropriate to consider them to be quite different approaches, each with distinct strengths and weaknesses. **Expert systems** depend on rules (IF-THEN) and are good at sequential logic. **Artificial Neural Networks**, on the other hand, depend on examples, and are good at pattern recognition. ANNs are trained on sets of data that have known outputs and are then used to predict the output of a set of data that was not used during training. For example, the capability manager may be concerned with some of the parameters that might influence the reliability and operational life of an engine, such as, oil pressure, average temperature, minimum and maximum temperatures, acceleration, deceleration and average speed. Given sufficient data sets on which to "train" an ANN, it may be possible to create a reliable *predictor of critical values* of these parameters.

5.4 Knowledge Discovery

Although **knowledge discovery** [24] is not a modelling and simulation technique, it has the potential to complement modelling and simulation. Knowledge discovery may also provide information that will be used in the validation and verification process for models and may additionally provide guidance on where potential problems lie in the systems under study.

Knowledge discovery is an automated technique used for the "discovery" of patterns or relationships, within data sets, that may not be readily seen by standard observation and analysis. Knowledge discovery does not require a priori knowledge or the development of hypotheses concerning the structure of data relationships. The method uses various algorithms to cluster the data or determine relationships and patterns. This information may then be used for optimising various aspects of an asset or alternatively to advise modelling strategies.

Knowledge discovery is most effective when applied to large data sets, such as data stored within a data warehouse. Thus, with more data, it is possible to form stronger relationships. In this area, the RAN has in operation "on-line" data collection and management systems associated with its assets (such as, AMPS and SIMS/SIS) and additional information relating to maintenance of the assets, training, crew competencies, etc are maintained within these data systems. Provided this data is collected accurately and is well maintained it should be possible to perform analysis on data sets using knowledge discovery techniques.

5.5 Verification and Validation

The final phase that a model, using any of the above numerical techniques, must undergo before being accepted for general use is that of verification and validation. An explanation of both these terms is given below.

5.5.1 Verification

Verification is determining whether a model performs as intended [20]. The following techniques may be used for verification:

- thoroughly debug all subroutines, systematically connect subroutines into the main code and at all stages test the outputs of the main model;

- trace the flow of logic through each sub-module and the main model, and test each state that the model can enter;

- start with a simple model and gradually make it as complex as required rather than starting with a complex model;

- perform "structured walk throughs" of the code and have several people read and evaluate the correctness of each sub-module and the main model;

* test the model's ability to deal with "extreme" conditions;

* test the model using simplified assumptions for which the true characteristics of the model are known; and,

* use graphical outputs if possible to see the progression of simulation models.

5.5.2 *Validation*

Validation is determining whether a model is an accurate representation of the real world system under study [20]. The following techniques may be used for validation:

* the model should seem reasonable to those people with knowledge about the system being modelled;

* the system being modelled needs to be observed and analysed so that the variables that are used are representative of what is actually modelled;

* test quantitatively the assumptions used in development of the model, such as, using "sensitivity analysis";

* test the model's outputs with what might be reasonably expected from the actual system under study;

* if possible, test the results against other similar models;

* test against historical data; and,

* use statistical tests to compare the model's output with that of the system under study.

6. Summary

This paper has provided an overview of the role of modelling and simulation in RAN capability management. Capability management is a forward-looking dynamic process and as this paper has shown, needs to be based on suitable quantitative measures. These measures include appropriate MOEs and MOPs that inform the capability manager on whether a particular system or collection of systems will be **able** to satisfy current and future operational requirements. This assessment process along with other assessment processes, such as, cost/capability trade-offs, is part of the capability management process.

A number of specific issues for quantitative capability management have been addressed in this paper. These included: the insertion of measurement points in the organisational structure for capability management; the integration of capability development and capability management; the ability to measure performance in response to a changing environment; risk management and decision making processes; and, continuous improvement in the capability management process.

Capability management is principally concerned with how RAN assets are going to behave in the future. The application of modelling and simulation to capability management will provide a means of predicting the future behaviour of RAN assets and systems. This will enable capability managers to make more informed decisions by allowing them to evaluate several possible alternatives before choosing their course of action. Some of the materiel support areas of capability management in which modelling and simulation can be used are critical systems analysis, risk analysis, reliability, availability and maintainability analysis, obsolescence analysis and resource allocation analysis.

Some of the numerical techniques that could be used for capability management were also discussed in this paper. These techniques and tools included simulation models, multi-criteria decision-making techniques, artificial neural networks and expert systems, and, knowledge discovery techniques. The simulation models could be based on either reliability block diagrams (fault trees) or decision trees (influence diagrams) and the multi-criteria decision-making techniques could be used to capture the decision-maker's preferences or to further analyse the modelling and simulation outputs. A brief description of verification and validation techniques was also presented.

In conclusion, capability management when based on quantitative measures has the potential to add significant value to the decision-making process of the capability manager.

7. Acknowledgements

NOTES

1 DI(AF) ADMIN9/98 addresses capability management of systems "...from development through to maturity, and replacement where appropriate...".

2 Another issue is whether "availability" (various definitions) is an appropriate performance measure.

3 The results and conclusions of the modelling and simulation are not significantly affected by the simplifications and assumptions made in the models.

4 Hypothetically, under increased usage equipment is not turned off-and-on, thus thermal fatigue is decreased resulting in a decreased sparing rate.

5 The use of "standard operating procedures" etc attempts to overcome this difficulty and often failures in human activity systems can be attributed to "non-standard" procedures.

6 Reliability [17] is "the inherent characteristic of an item related to its ability to maintain functionability when used as specified". This is a function of the item's inherent factors (eg.

strength), environmental factors (eg. influence of temperature) and operational factors (eg. technical education of users).

7   The term availability [18] is used differently in different situations. The availability defined here is the operational availability and is "the probability that a component or system, when used under stated conditions in an *actual* operational environment, will operate satisfactorily when called upon".

8   Maintainability [17] is "the inherent characteristic of an item related to its ability to be restored when the specified maintenance task is performed". This is a function of the personnel factors (eg. influence of skill, motivation), conditional factors (eg. influence of operating environment) and environmental factors (eg. temperature, humidity).

9   The modeller has the discretion to draw boundaries defining the system or situation, thus influencing the modelling process. The modelling process should therefore be approached from a systems engineering perspective to ensure that the model meets the customer's requirements.

10 Verification is "determining whether a simulation model performs as intended".[20]

11 Validation is "determining whether a simulation model is an accurate representation of the real world system under study".[20]

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Biography

Moya Tyndall graduated from Monash University with a B.Sc.(Hons), majoring in Applied Mathematics in 1986. She joined the Explosives Division at MRL in 1987 and in 1988, after being made a DSTO Research Fellow, commenced a Ph.D. in the Mathematics Department at Monash University. In 1991, Moya returned to MRL after submitting her Ph.D. thesis entitled "Numerical Modelling of Shock Waves in Solid Materials". She continued this research until she moved to the Maritime Operations Division in 1992 where she worked on mine warfare modelling in support of operational decision making. In 1998, Moya moved to Maritime Platforms Division and currently works on a DSTO Task, Capability Management of RAN Platforms and Systems, sponsored by COMLOG(N).

Tom Whitehouse graduated from Royal Melbourne Institute of Technology with a B.App.Sc. (Applied Physics) in 1972. He joined MRL in 1975 as a member of the Optics and Camouflage Group working in the area of colorimetry, spectrophotometry and optical testing and design. In 1985 he moved to the Sensor Protection Group where he studied the optical power limiting effects of liquids. In 1988 he moved into Maritime Operations Division where he worked on mine warfare modelling in support of operational decision making. In 1998 Tom moved to Maritime Platforms Division and currently works on Capability Management of RAN Platforms and Systems.

David Saunders graduated from Adelaide University with a B. App. Sc. (Hons) (Secondary Metallurgy) in 1972 and completed his Ph.D at Monash University on the fracture behavior of cast aluminium alloys in 1976. David joined DSTO in 1976 and has undertaken research in the fracture and fatigue behaviour of high strength steels, aluminium alloys and carbon fibre re-inforced composite materials in the Materials, Aircraft Structures and Maritime Platforms Divisions. He has also contributed to the development of a numerical capability to study the response of RAN platforms to underwater shock. In 1998 David completed a Master of Business (Integrated Logistics Management) from RMIT and has established a modelling capability to develop and provide advice on mathematical tools for RAN asset management.In 1970, the Spanish Navy's submarine G7 (S-01), stricken from the navy's pennant list that year, was auctioned at Cartagena, fetching a final price of 3,334,751 pesetas (about US$26,000 at 1970 rates). A fairly common place, even routine occurrence in terms of the fate of warships, this particular event has historical significance in that G7 had commenced life in 1941 as the Kriegsmarine's U-boat U-573 and when she was stricken in 1970, she was the last operational U-boat in the world.

Riachuelo and Humaita

Naval Battles of the War of the Triple Alliance

By Graham Wilson

Introduction

In 1864, the tiny land-locked South American republic of Paraguay embarked on a lunatic war of aggression against the neighbouring republics of Argentina and Uruguay and the giant Empire of Brazil. The causes of this bitter and destructive conflict, known to history as the War of the Triple Alliance, were many and complex but largely had to do with the jingoistic pride and territorial ambitions of the rulers of Argentina, Brazil and Paraguay (Uruguay was drawn into the war unwillingly and largely as a result of its semi-vassal status to Brazil).

The war began with a Paraguayan invasion of Argentine territory in 1865, quickly spread to include Uruguay and Brazil and was to drag on for almost six years, finally resulting in a disastrous defeat for Paraguay. As Paraguay is one of only two completely land-locked countries in South America, the other being Bolivia, it hardly seems likely that any naval actions would figure in the conduct of the war. Yet the war was in fact marked by two major naval engagements which between them helped to seal the fate of Paraguay. These engagements, the Battles of Riachuelo and Humaita, were notable both for their ferocity and for the fact that they were fought on the upper reaches of the might Parana and Paraguay Rivers, over 1000 kilometres from the sea.

Little reported at the time, the battles, like the war they were part of, are all but forgotten today. The aim of this article is to introduce the reader to the disastrous War of the Triple Alliance and to its two major naval engagements.

Background

The area known today as Paraguay ("place of the great river") was the home of the Guarani, a fairly advanced Indian nation of farmers and manufacturers. Spanish colonisation began in about 1536 and was remarkable peaceful, with the Guarani intermarrying very early in the period. Following the colonists came missionaries, in this case Jesuits, who established a sophisticated network of missions or *redduciones* which, by the latter half of the 18th century, housed and governed over 100,000 Guarani. Eventually falling foul of the Spanish and Portuguese landholders in the area, the *redduciones* were brutally broken up during the period 1754–57 and the Indians either enslaved or driven into the jungles. The Jesuits resisted as best they could but for their pains were expelled from the region in 1767. (This disgraceful event, the destruction of the Jesuit missions and the enslavement of the Guarani is poignantly portrayed in the excellent Peter Weir film, "The Mission"). Following the destruction of the missions, many of the Guarani escaped across the Parana River and settled in the region bordered by the Paraguay and Parana Rivers in the east, west and south and the *gran chaco* or great forest to the north. Loosely ruled by Spain after the expulsion of the Jesuits, the Guarani finally threw off this hated yoke and declared their independence in 1811.

After independence, the new Republic of Paraguay was ruled until 1840 by the insane and xenophobic Dr Jose Gaspar Rodriguez de Frania. *El Presidente* Francia closed the country to outsiders and killed or expelled most Europeans, forcing the rest to intermarry with the Guarani. These actions resulted in both the most racially homogeneous country in South America, and its most despotic tyranny. Francia was replaced on his death in 1840 by one of his protégés, Carlos Antonio Lopez (Lopez the Elder). Although Lopez lifted some of the restrictions on both his people and outsiders, Paraguay remained very much a "hermit kingdom". In many ways in fact, the Paraguay of 1864 resembled the North Korea of the 1990s. One benefit of Paraguay's isolation, however, was that the country managed to stay aloof from the wars and upheavals which racked South America in the first half of the 19th century and the country eventually emerged as the most stable and prosperous one on the continent, albeit with its prosperity hampered by the lack of ready outlets to the sea.

Lopez's son, Francisco Solano Lopez (Lopez the Younger) succeeded his father in 1862 (again, shades of North Korea) and generally continued the policies of his father. Under the younger Lopez, Paraguay's foreign policy continued to be marked by isolationism and suspicion of outsiders, as well as resentment of Argentine and Brazilian expansionism, especially Brazilian. This far removed from the time in question, it is difficult for the average reader to appreciate the depth of the hatred felt by the average Guarani/Paraguayan (basically one and the same thing) for the Brazilian *macacos* or "monkeys".

Domestically, Paraguay's life was marked by internal repression and extreme militarism, coupled with an intense "personality cult" centred on the erratic Lopez (again, North Korea). All of this was exacerbated by the ego of the president, who regarded himself as the "Napoleon of the South" and considered Paraguay the

leading nation of South America. The fact that events continued to deny this conceit only added to his hatred and suspicion of his neighbours.

Lopez also saw himself as the arbiter of the political scene in Paraguay's chronically unstable neighbour, Uruguay, and bitterly resented Argentine and Brazilian interference in the perennial squabbles between the two major Uruguayan political parties, the Colorados and the Blancos. In 1864, these two parties were engaged in a hotly contested civil war. Anxious to ensure stability on its southern borders and to protect Brazilian investments, Brazil intervened militarily in the situation in Uruguay in August 1864, to the fury of Lopez who had issued an ultimatum to Brazil, threatening war if Brazil interfered in Uruguay.

Lopez ordered elements of his army and navy north to remove Brazilian troops from the thinly settled and garrisoned Mato Grosso region. At the same time, he prepared a second force to invade Uruguay and oust Brazilian forces from there. Despite these bellicose moves on the part of Paraguay, Brazil delayed declaring war until November, 1864 when Paraguayan naval units stopped and took as a prize a Brazilian steamer which was sailing up the Rio Paraguay on a mission to re-supply the Brazilian garrison at Cuiaba, capital of Mato Grosso province.

If this blatant disregard of international law was not enough to goad the Brazilians into action, the tale that the Brazilian flag from the steamer was presented to Lopez and put to use as a floor mat in his study was more than enough to raise war fever to an unstoppable pitch in Brazil. The tale, by the way, was quite true.

Things remained fairly quiet for the rest of the year and it was not until March of 1865 that Paraguayan troops crossed the Parana intent of expelling the despised *macacos* from Uruguay. Prior to dispatching his troops, Lopez had requested Argentine permission for his forces to transit the Argentine province of Corrientes. When this permission was not forthcoming, Lopez invaded anyway and promptly found himself at war with Argentina as well as Brazil. Then, as Paraguayan troops approached Montevideo in May, Brazil and Argentina, along with the Brazilian installed puppet government of Uruguay, entered into a secret anti-Paraguayan pact, the Triple Alliance.

The Opposing Forces

At first glance, it would appear to have been the sheerest lunacy for tiny Paraguay to take on the three allied countries but, although Paraguay's population of about 525,000 was dwarfed by the combined 12 million of the Alliance, appearances were at first deceiving. The two Lopez's had built up the most powerful army in South America, at the time of the

invasion of Uruguay over 60,000 strong. These troops, well armed and superbly disciplined, were backed by a sophisticated industrial machine, capable of turning out large amounts of the latest types of war material, including rifles, cannons and small warships. This self sufficiency was a legacy of Paraguay's long period of isolation.

Both Argentina and Brazil on the other hand had very small military establishments. Brazil maintained a largely static garrison force of perhaps 25,000 while Argentina, then a loose confederation of independent states under only nominal central government control, depended mainly on state militias possessing a great deal of autonomy and not required by law to serve outside their states. Uruguay's army was virtually non-existent. To compensate, the Brazilian army's officer corps, Prussian inspired and trained, was first rate and the Empire possessed an excellent, well trained, well led navy, equipped with a number of modern and powerful ships.

The Road to Riachuelo

Paraguayan forces did well in the early days of the war, expelling the Brazilians from the southern Mato Grosso and capturing the Argentine city of Corrientes. Although the Paraguayan's were soon forced out of Corrientes by superior Brazilian forces, they were able to besiege the city and established control of the all important confluence of the Parana and Paraguay Rivers.

Keenly aware of the need to cut Paraguay off from the outside world, the Triple Alliance decided on a naval blockade of the river approaches to Asuncion, the Paraguayan capital. To that end, a strong Brazilian squadron under the command of *Vice Almirante* Barroso steamed up the Rio de la Plata to reach the Rio Parana and thence inland to Tres Bocas, the point where the Parana joined the Paraguay. Reaching Tres Bocas, they dropped anchor near the mouth of the Riachuelo River, a tributary of the Parana, on the last day of May 1865 and settled down to what promised to be long months of blockade duty in the sweltering heat of the tropical hinterland.

The Brazilian squadron consisted of the paddle wheel ram cruiser *Amazonas*, equipped with 68–pounder Whitworth guns and flying the flag of Admiral Barroso; two corvettes *Beberibe* and *Jequitinhonha*; and six gun boats, *Aruguari, Belmonte, Iguatmei, Ipiranga, Mearim* and *Parnaiba*. Barroso deployed his ships with *Belmonte* in the van, followed by the flagship with two gunboats moored on either side, then the two corvettes, with *Aruguari* moored in the rear as guard ship. All of the Brazilian ships except for *Amazonas*, a side wheel paddle steamer, were screw powered steamers, a decided advantage when it came to manoeuvring in the swift flowing Parana.

The Battle of Riachuelo

With overwhelming firepower on their side, the Brazilians fully expected the blockade to stretch on for months. But they did not count on the aggressiveness and desperation of the Paraguayans.

On Sunday, 11 June the crews of the fleet mustered for Mass in celebration of the Feast of the Holy Trinity. Mass was hardly over, however, when at about 0900 a lookout on board *Mearim*, astern of but to the side of *Belmonte* reported a ship in sight upstream. Shortly a second and then a third ship hove into view and the lookout changed his first report to "Enemy squadron in sight!"

Riding down on the three-knot current were fourteen Paraguayan vessels - eight armed steamers and six flat-bottomed barges towed by the ships and each mounting an eight inch gun. The total firepower of the Paraguayan squadron was 47 guns and like the Brazilians, the ships carried a large contingent of soldiers, over a thousand in fact, ready to act as boarders. In the lead was the *Paraguari*, a modern iron clad warship mounting eight guns. At the rear of the column was the flagship, *Tacuari*, flying the flag of Admiral Pedro Ignacio Meza. And just ahead of the flagship, to the fury of the Brazilians when they identified her, was the *Marques de Orlinda*, the former Brazilian steamer which had been captured by the Paraguayans the previous year, and now served in the Paraguayan navy mounting eight field guns.

In less than fifteen minutes available to them between the first sighting of the Paraguayan squadron and the firing of the first broadside, the Brazilian sailors and marines rushed to raise steam, prepare their guns and clear for action. The Brazilians were still struggling to ready themselves as the Paraguayans steamed by in line astern, holding close to the west bank and firing a raking broadside as they passed.

Admiral Barroso had been attending Mass aboard *Parnaiba* when the alarm was sounded and had had himself rowed back to his flagship as quickly as possible, returning aboard *Amazonas* in time to watch the Paraguayan's make their first turn downstream. To gain a better view of the enemy, the sixty-one year old Portuguese-born officer climbed up onto one of *Amazonas's* paddle boxes. As he stood there, he called to a waiting midshipman to make a pair of signals.

At the admiral's command, the midshipman scampered away to have the signals made and in short time flags broke from the flagship's yards giving the commands *"Bater o inimigo que estiver mais proximo!"* and *"O Brasil espera que cada unm cumpra o seu dever!"*

The first command was for the ships to engage and destroy the enemy at close quarters. The second, an excusable bit of plagiarism, reflected Barroso's respect for the great Horatio Nelson, and read: "Brazil expects that every man will do his duty!"

As the Paraguayan squadron completed its turn and started back upriver, the Brazilian ships manoeuvred into position in the channels between the sand banks and islands and opened fire. One of the Paraguayan steamers, the *Jejui*, took a shot through her boiler and beached out of action; the remaining seven ships and the six barges closed for battle, breaking their line astern formation and forming groups of ships and gun barges which made for specific targets. The Brazilian corvette *Jequitinhonha* was assailed by three Paraguayans firing ball and grapeshot and with their musketeers raking the corvette's decks. The gunboat *Parnaiba* also found herself under attack by three Paraguayans, including the iron-clad *Tacuari* and *Paraguari*, which poured fire into the Brazilian as they steamed up to her, intent on boarding.

Within the great bend of the river, as the twenty one ships and gun barges blazed away at one another, the opening stages of the Battle of Riachuelo were going badly for the Brazilians for, no sooner had they turned to face the challenge of the Paraguayan fleet than they faced a new threat – the twenty-two guns and Congreve rockets of the Paraguayan shore battery north of the mouth of the Riachuelo opened up in support of their naval comrades. Aboard the Paraguayan ships, the barrage from ashore was greeted with wild cheers.

The Paraguayan *chatas* or gun barges were flat bottomed punts, each about six metres long and mounting a single gun. Their crews concentrated their fire on the wooden hulls of the Brazilian ships, hoping to blast through the planking to pierce a boiler or detonate a magazine. Very early in the engagement, one *chata* was blown to pieces when a lucky 68-pounder shot from *Amazonas* detonated its ammunition supply. Even the largest Paraguayan vessels were at a disadvantage against the Brazilians. Apart from *Paraguari* and *Tacuari*, the Paraguayans were river steamers, converted merchant vessels like the captured *Marques de Orlinda*, and small compared with the Brazilian ships towering over them. Additionally, the fact that most of the Paraguayans were paddle steamers put them at a distinct disadvantage when trying to manoeuvre in the swift current of the Rio Parana. But this did not daunt the Paraguayans as they prepared to board their larger adversaries.

Unfortunately, as the *Tacuari, Paraguari* and the tiny *Salto* closed on the *Parnaiba*, the Paraguayan soldiers discovered to their dismay that the grappling hooks needed to successfully effect a boarding had been left behind in Asuncion. Nothing daunted, *Tacuari* attempted to close with *Parnaiba* and two Paraguayan soldiers actually leapt from one of *Tacuari's* paddle boxes onto *Parnaiba's* bulwarks. Without grapples,

however, the *Tacuari* could not keep alongside of the enemy long enough for the rest of the soldiers to follow their comrades. As *Tacuari* stood off, the pair of boarders incredibly managed to leap unscathed back onto her deck.

As *Tacuari* drew away, *Salto* moved in on *Parnaiba*. Unlike *Tacuari*, *Salto* was screw driven and her experienced, river wise helmsman was able to manoeuvre her into position and pass slowly and closely enough alongside the Brazilian gunboat for thirty Paraguayan soldiers to leap aboard. Supported by sniper fire from riflemen aloft in the three Paraguayan ships, the boarding party swept the decks clear of Brazilian defenders and within fifteen minutes had secured her as a prize for *El Supremo*, despite the fact that a large number of Brazilian sailors and soldiers were still barricaded below.

The Paraguayan triumph was short lived, however, as *Amazonas* loomed out of the smoke, bearing down on the four ships. Passing between *Tacuari* and *Salto* to starboard and *Parnaiba* to port, the Brazilian cruiser fired double broadsides, the starboard one battering the two Paraguayans while the port, loaded with grapeshot, swept *Parnaiba's* decks and felled most of the surviving Paraguayan soldiers. Hearing the uproar, the Brazilians below deck broke through the hatches and finished off the surviving Paraguayans with the bayonet. *Parnaiba* was back in Brazilian hands.

The battle see-sawed for four and a half hours although it seemed that with their superior size and firepower that the Brazilians were beginning to prevail - the *Jejui* was sunk, the *Salto* was beached and *Marques de Orlinda* took a shot in her boiler house and ran aground on a sand bank. But even on these hulks, where a cannon remained mounted the Paraguayans kept on firing. And although the Paraguayans had lost three ships and two *chatas*, the battle was still undecided as the Brazilians had also been mauled – *Belmonte* was holed at the waterline and aground, *Jequitinhonha* was stuck fast on a sand bank and *Parnaiba*, though back in Brazilian hands, was effectively out of action.

Following her rescue of *Parnaiba*, the Brazilian flagship *Amazonas* had turned about and steamed slowly upriver, exchanging shots with the surviving Paraguayan ships as she passed. Observers were puzzled at the action of the flagship as she seemed to be steaming away from the scene of battle. But Admiral Barroso had no intention of leaving the battle. About a mile upstream, *Amazonas* turned about and drove back downstream at full steam, her great paddle wheels churning the water. Driving down with the assistance of the three knot current, *Amazonas* traded connonades with Paraguayans as she passed them, suffering punishment but with a single purpose in mind. With black smoke belching from her stack and red flame spouting from the muzzles of her guns,

she steamed directly toward the *Paraguari*, newest vessel and pride of the Paraguayan navy.

Barroso's intention was to ram and although the captain of *Paraguari* realised this at the last moment and attempted to manoeuvre out of harms way, it was too late. Despite frantic efforts on the part of the Paraguayans, *Amazonas* struck *Paraguari* square amidships, her great iron ram buckling iron plates and smashing through bulwarks. *Amazonas* struck with such force that the Paraguayan ship was driven sideways through the water and on to a sand bank.

As *Amazonas* reversed her paddles and backed away, her crew cheered, cries of "*Viva Dom Pedro Segundo. Viva Brasil!*", ringing across the waters. But *Paraguari* was not finished - although many of her crew were dead or had been thrown overboard, some men remained aboard and cleared *Paraguari's* last surviving gun, a 12–pounder, for action and in desperate defiance fired on their larger tormentor. It was nothing more than a futile gesture, however, as *Amazonas* turned side on and fired a devastating broadside which destroyed the last serviceable gun, further wrecked the stricken gunboat and killed or wounded the last defiant Paraguayans on her deck.

With the grounding of *Paraguari* and damage to a fifth gunboat, the Paraguayan flagship, *Tacuari*, signalled "Break off action!" Aboard *Tacuari* the Paraguayan commander, *Almirante* Meza, lay mortally wounded, one of a thousand Paraguayans killed or wounded that day, three time the number of Brazilian casualties. With *Tacuari* covering their retreat, the three remaining vessels steamed off, pursued for a short way by two Brazilian ships. The Brazilians, however, were so exhausted and their ships so damaged that they did not dare continue the chase into the Rio Paraguay and under the guns of the enemy's fortresses. Within a short distance, the Brazilians gave up the chase, content for the moment that *El Supremo's* fleet was shattered and that Paraguay was denied access to the Parana and therefore the outside world.

Even though the survivors of the Paraguayan fleet had withdrawn, however, the guns at Riachuelo had not yet fallen silent. The Brazilian corvette jequitinhonha had been pounded by the guns of three Paraguayans and assaulted by boarding parties, who had been beaten off in bloody hand-to-hand combat. But in manoeuvring along a narrow channel, she had run aground on a sand bank within range of Paraguayan shore batteries. The crew of the stricken corvette suffered the murderous fire of the Paraguayan guns and rockets for over three hours, during which time over half of her crew were killed or too badly injured to fight and two desperate and unsuccessful attempts were made to tow her off by her sister ships. Respite only came at about 1600 when *Amazonas* closed in dangerously close to the shore, turned her guns on the

Paraguayan shore batteries and bombarded them until they withdrew.

The final shots were fired at about 1700 and the Battle of Riachuelo was over. With the Paraguayans dead or beaten off, the Brazilians turned to count the cost. *Belmonte* and *Jequitinhonha* would not fight again and *Parnaiba* was so badly damaged that she would not be available for service for over a year; the rest of the Brazilian ships had suffered varying degrees of damage; and over three hundred Brazilian soldiers and sailors were dead or grievously wounded.

On the other hand, the Paraguayan navy had ceased to exist as a fighting force, over one thousand Paraguayans had been killed or seriously wounded and the Rio Parana was closed to Lopez forever. So the Brazilian commander, Barroso, soon to be ennobled by a grateful Emperor, could claim both a tactical and strategic victory.

From Riachuelo to Humaita

Despite their stunning victory at Riachuelo, the Brazilians failed to follow up with an attempt to force a passage to Asuncion, being content for the time being to rest on their laurels and settle back into a blockade routine. There were a number of reasons for this. Firstly, although victorious, the Brazilians had been shocked by the ferocity of the Paraguayan attack and were psychologically unprepared to take them on again. Secondly, the battle had revealed the vulnerability of wooden ships to modern rifled guns, and even to relatively obsolescent weapons at close range; with this in mind, the Brazilian naval ministry launched a modernisation program to improve the fleet, purchasing some ironclads overseas and building others in Brazil's own yards.

Thirdly, Admiral Barroso, who had handled the battle of Riachuelo competently and gallantly, if not particularly brilliantly, was promoted and replaced by *Vice Almirante* Joaquim Jose Ignacio, an experienced officer who was, however, even more cautious than his predecessor. In Ignacio's defence, it should be noted that he had spent a 30 year career sailing the brad expanse of the Atlantic Ocean and the treacherous and claustrophobic upper reaches of the Parana and Paraguay Rivers were an alien world to him.

For all of these reasons, the Brazilian fleet were to be content to remain on blockade duty for almost three years. Although the fleet was idle, however, its success at Riachuelo had cleared the way for an allied invasion of Paraguay. In April 1866, after a period of skirmishing and build up, an Allied army of over 62,000 men, with 100 guns, crossed the Rio Parana into Paraguay at Pas de la Patria. This crossing, carried out under heavy Paraguayan artillery fire, was one of the most successful Allied operations of the war.

Once across, however, the huge Allied army was unable to make much headway in the face of a combination of the terrible terrain and determined Paraguayan resistance. The inconclusive Battle of Bellaco Swamp on 2 May was followed by the Battle of Tuyuti on 24 May which was counted as an Allied victory although both sides suffered appalling casualties.

On 2 September 1866, Allied confidence, and especially naval confidence, was shaken by the loss of the brand new Brazilian ironclad *Rio de Janiero*, which was sunk with great loss of life by Paraguayan mines near the strong point of Curuzu. *Rio de Janiero* had been taking part in naval operations in support of a land assault on Curuzu. Despite the loss of the ship, Curuzu fell to the Allies on 3 September.

Under Allied pressure, Lopez called for a peace conference but was only able to convince president Mitre of Argentina to meet him on 12 September. As Mitre was unable to negotiate on behalf of his Brazilian and Uruguayan allies, the meeting came to nothing. Ten days later, the Battle of Curupayty ended in a stunning victory for Paraguay. An uncoordinated Allied frontal assault on the Paraguayan field works at Curupayty, ineffectually supported by the Brazilian fleet, resulted in the Allied army being repulsed with over 9,000 casualties while the Paraguayan defenders suffered only an incredible 54 killed. The prestige of the Brazilian Navy suffered a terrible blow as a result of Curupayty as the naval commander assigned to the task of bombarding the Paraguayan defences, Baron Tamandares, had boasted that he would destroy the defences within two hours. Despite the fact that the Paraguayan earthworks were practically out of reach of his guns, Tamandares still gave the signal that the defences were destroyed after a two hour bombardment. As a result, the Allied assault went in and much of the blame for the slaughter which followed was laid at the feet of the navy, quite justifiably.

Following Curupayty, the war, which increasingly became a Brazilian affair as both Argentina and Uruguay became more and more disaffected by the casualties and lack of success, settled down to a series of small battles which constantly drained the paraguayans. During the period September, 1866 to July, 1867, both sides carried out raids, probing attacks and reconnaisances, at the same time building up their forces for the next round of battles. During this period, the Brazilian Navy was largely idle, contenting itself with maintaining the blockade of the Parana River and fighting off the occasional, usually suicidal, Paraguayan water-borne attack. *Vice Almirante* Ignacio, was impervious to demands that he sally his fleet against the Paraguayan defences in an effort to force a passage to the enemy capital of Asuncion.

One of the Brazilian naval commanders main reasons (excuses?) for his fleet's inactivity was the Paraguayan position at Humaita, the formidable, so-called "Sebastopol of the Americas". While the Army commander, the Marquis de Caxias, argued that forcing a passage of the Paraguay River at Humaita would cut the fortress off and assist in its eventual capture, Ignacio demurred, claiming that the defences were too strong to risk his ships against. For good measure, he also added that he was not prepared to attempt to force a passage until the land commander could ensure that the ships would be able to rendezvous with friendly forces above Humaita!

The Battle of Humaita

The main Paraguayan defensive works on the Paraguay River covering the approaches to the capital at Asuncion, were located on the heights of Humaita, rising above the surrounding swamps on a bend of the river. Dry ground was rare around Humaita, with the nearest firm standing being at Timbo, on the western shore of the river, and Tayi, on the eastern shore, both about 15 kilometres north of Humaita. Several foreign observers, while fairly contemptuous of the landward defences of Humaita, testified to the strength and cunning placement of the riverside defences.

At the bend in the river, an intruding sand bank made the approach dangerous, forcing approaching vessels to use a channel which led directly under the Paraguayan guns. The channel itself was swept by a swift current which made navigation difficult. A tongue of land from the western side of the river reduced the width of the channel to less than 700 yards. Added to these difficulties were a smattering of small rocky reefs.

And while nature itself had conspired to make Humaita a difficult navigational problem, man had added to the problems. The riverside defences consisted of upwards of 200 guns of various calibres while at the northern end of the river passage, a chain stretched across the river to impede progress. The defences were the work of two foreigners, George Thompson, an Englishman, and Wisner von Morgenstern, a Hungarian, military engineers in the service of Lopez. Paradoxically, the Brazilian navy had stood a very good chance of ending the war in September 1867, when the fleet, prodded into action by the exasperated Brazilian Minister of Marine, had steamed past the Paraguayan defences at Curupayty with minimal damage and casualties. Had they but known it, or had they but been prepared to risk it, the fleet could have steamed past Humaita virtually unscathed as the Paraguayans had earlier removed almost all of the guns there to reinforce Curupayty. With the way to Asuncion and thus a possible end to the war open, however, the Brazilian fleet, much to the disgust of the majority of its officers, had instead dropped anchor just north of Curupayty. In due course, the guns from the bypassed defences at Curupayty had been re-located to Humaita.

And there they stayed as *Almirante* Ignacio stubbornly refused to be forced into risking his ships until his demands were met. Unfortunately for the admiral, one of his conditions was eventually met when, on 2 November, 1867, a combined force of Brazilians and Argentineans carried out a brilliant assault on Tayi following a gruelling approach march through the surrounding swamps. With their flanks secured by cavalry, the Brazilian infantry stormed the Paraguayan positions with the bayonet and drove the defenders into the river. For good measure, a Brazilian horse artillery troop galloped its four Whitworth field guns to the water's edge and quickly destroyed two of the three wooden steam ships which had been supporting the Paraguayan defence. Igancio now had no real excuse to delay the attempt on Humaita as it was pointed out to him that the position was virtually surrounded and that there was now a substantial Allied force above Humaita for him to rendezvous with.

Finally giving in to the proddings of Caxias and Celso, the navy minister, Ignacio gave orders for the attack on Humaita. For the assault he planned to use three ironclads and three monitors with a number of other ships in either support or reserve. The attack was scheduled for midnight on 18 February, 1868 and was to be carried out by the ironclads *Barroso, Bahia* and *Tamandare* in company with the monitors *Rio Grande do Sul, Alagoas* and *Para*. Overall command of the assault squadron was vested in *Capitao-de-Fregata* Pereira do Santos, flying his flag in *Bahia*. Ignacio's plan called for the ironclads *Lima Barros* and *Silvado* to close in on the strongest of Humaita's batteries and fire case and grapeshot in support of the six assault ships, one of their most important tasks being the destruction of the chain at the northern end of the passage. Other units, including five ironclads, seven wooden ships and a gun raft were located at various points downstream with orders to fire on advanced Paraguayan positions in order to deter them from attempting to reinforce Humaita.

An admirer of US Admiral Farragut, Ignacio ordered that, in imitation of Farragut's attack at Mobile Bay during the American Civil War, the ironclads were to go into battle lashed to the monitors, in theory to provide protection for the smaller ships. His captains vehemently protested against this order on the grounds that, firstly, it was unnecessary as the monitors were quite well protected and armoured and, secondly, the move would seriously hamper ship handling and manoeuvrability in the treacherous channel. But the admiral was not to be dissuaded and thus, as the fleet began getting up steam at about 2300 on 18 February, *Barroso*, which was to lead, was lashed to *Rio Grande do Sul; Bahia* to *Alagoas*; and *Tamandare* to *Para*.

As the fleet steamed away from its anchorage just before midnight, the Paraguayans, warned by the noises of preparation, fired rockets to alert the defences. After two halts to regroup the squadron after it became strung out in the river current, the assault force finally came within range of Humaita just before 0300 and *Barroso* began firing. Despite intense Paraguayan fire, *Barroso* and *Rio Grande* forced their way past the main batteries with relative ease and no casualties, firing a rocket at 0330 to signal that they were past the batteries and the way ahead was clear. With the defenders by now thoroughly aroused, however, the following pairs of ships did not have such an easy time of it.

In the face of withering Paraguayan fire and with his ship handling atrociously, the captain of *Bahia* requested permission to retire. But *Almirante* Ignacio, who was aboard *Bahia*, had obviously at last had enough of waiting and ordered that the ship press on. This she did, even as a lucky Paraguayan shot parted the cable linking her to *Alagoas*. The monitor began to be swept back by the current and *Bahia* also lost way temporarily, colliding with the following pair of ships and holing the monitor *Para* so that she began to take on water. *Bahia* slowly fought her way back upstream, as did *Tamandare* and the leaking *Para*, and by 0450, as dawn was approaching, all three had successfully forced the passage and joined *Barroso* and *Rio Grande* above Humaita.

This only left *Alagoas*. The little monitor, left on its own, had the greatest difficulty in making way against the current. Three times she was swept back and three times she fought her way forward again. On the third attempt, just as she reached the now destroyed chain near the top of the channel, a lucky Paraguayan shot penetrated into the engine room and damaged her engines, causing her to lose all power. As luck would have it, this occurred at a moment when *Alagoas* was unfortunate enough to be in one of the rare patches of "dead" water - calm, currentless patches created by the mingling of various currents - and thus she was a virtual "sitting duck" for the Paraguayan gunners as her engineers struggled to repair the engines and get up steam again. Luckily, the damage turned out to be relatively minor and was repaired within ten minutes, under constant Paraguayan fire, and the plucky little ship was on her way again. But progress was still painfully slow and *Alagoas* did not finally manage to steam out of the range of Humaita's defences until 0630, rejoining the rest of the squadron shortly after.

But while Humaita itself had been passed, the guns had still not fallen silent. Lopez, anticipating Brazilian moves, had ordered a mixed battery of 8-inch and 32-pounder guns to be installed at Timbo and these now opened a furious fire on the Brazilian squadron as it steamed on towards Tayi. The Brazilians fired back as they steamed slowly up the river towards their goal, which they finally reached by mid-morning on 19 February. The last to arrive was *Alagoas* and she was also the hardest hit, having suffered over 200 hits in her journey up the river. And her troubles were not yet over as she had no sooner dropped anchor than she was attacked by 20 or so canoe loads of Paraguayan soldiers, launched in a desperate suicidal attempt to destroy the Brazilian ship. As the canoes approached, however, *Alagoas'* captain ordered all hatches and ports closed to deny access to any lucky boarders and then swept the gallant but doomed attackers from the river with case shot. The Battle of Humaita, which had cost the Brazilians a total of 11 wounded was over.

Afterwards

As the fleet was forcing its passage past Humaita, the land commander had launched an assault which had captured, at great cost, the Cierva Redoubt and carried the forward trenches at Curupayty. With the fleet finally north of Humaita, the way to Asuncion was at last open. Eager to press on now, Caxias ordered the fleet to steam upriver and invest the enemy capital. *Tamandare, Pare and Alagoas* were too badly damaged to proceed and had in fact been grounded to prevent them from sinking, so Igancio proceeded upriver of the morning of 20 February with *Barroso, Bahia* and *Rio Grande*. The combination of Paraguayan defences and the treacherous river ensured that the voyage took over four days, Asuncion finally being sighted at 0900 on 24 February. On reaching the capital, the fleet carried out a short bombardment of the city, including shelling the presidential palace, and then turned down river again. Had the ships carried some troops, the capital could have easily been captured, as much of the population had been evacuated and the garrison had been stripped to provide reinforcements elsewhere, leaving the city virtually defenceless. Thus, the Brazilians lost another chance to shorten the war. On the other hand, while the raid caused little material damage, it provided a major psychological boost for the allies and especially the Brazilians.

The war still dragged on though, and two more naval actions were to be fought. The first occurred in the early hours of 2 March when a force of Paraguayan soldiers in camouflaged canoes mounted an attack on the Brazilian fleet anchorage below Humaita. But although some boarders managed to get onto the decks of the ironclad *Lima Barros*, the attack was eventually beaten off with great loss of life for the attackers. The Brazilians for their part lost two officers and eight sailors killed and about 50 wounded. A few days later, the last two ships of the Paraguayan navy, *Tacuari* and *Ygueri*, survivors of Riachuelo, were caught by Brazilian ironclads and sunk in a brief action near the confluence of the Paraguay and Guaycuru Rivers.

But although the war was over as far as the navy was concerned, apart from patrolling and blockade duties, the war itself was to drag on for another two years. The garrison at Humaita, starving and sick, held out until 5 August 1868, when it was surrendered by the senior surviving officer, a colonel who was too weak from hunger to either stand or speak. The last major battle of the war was fought at Lomas Valentinas, also known as the Battle of Ita-Ybate, and referred to as the Paraguayan Waterloo. A ragtag army of between 3,000 to 8,000 Paraguayans (account differ), endured over a week of bombardment by Brazilian artillery and then were assaulted by 27,000 Brazilian infantry and cavalry on 27 December, 1869. Not surprisingly, the Paraguayan lines broke but *El Supremo* somehow managed to get away.

By this stage, the Paraguayan army consisted largely of women and boys, some as young as 10 who wore false beards to fool the allies. When the Brazilian commander, the now Baron Caxias, discovered this in the aftermath of Lomas Valentinas, it was too much for the essentially kind old man, and he asked to be relieved. His replacement, the Emperor's son-in-law, soon also sickened of the task of hounding women and children through the mountains and resigned. Asuncion finally fell on 1 January, 1869 and the Brazilian flag from the captured *Marques de Orlinda* which had been used as a floor mat in *El Supremo*'s study now fluttered proudly over the presidential palace. *El Supremo*, meanwhile, harried by the Brazilian army and pushed further into the hinterlands, continues to miraculously produce armies out of thin air and to continue to inspire his starving people to fanatically resist the hated *macacos*. Lopez in fact remained at large for over a year, his ragged army slowly whittled down until, on 1 March, 1870, he and the last 200 troops of the Paraguayan army faced 8,000 Brazilians in the foothills of the Amambay Mountains. Defiant to the last, Lopez led his little band in a hopeless battle against overwhelming odds, he himself eventually dying with the cry "Muero con mi patria" ("I die with my homeland") on his lips. His 15 year old son, Colonel Juan Francisco Lopez, died protecting his mother, *El Supremo*'s Irish-born mistress, Eliza Lynch, from the Brazilians. Allowed to go free by the chivalrous Brazilian commander, Madame Lynch buried her lover and son in a shallow grave, which she scraped with her bare hands, and then departed. The War of the Triple Alliance was over.

Conclusion

At the outbreak of war in 1864, the Argentinean president Mitre had crowed: "To the barracks in twenty-four hours, at the frontier in three weeks, in Asuncion in three months". In actuality it took over five years and cost the alliance 100,000 dead. Paraguayan losses were even more appalling, the war reducing the population of Paraguay from 525,000 to 220,000, of whom less than 28,000 were males, most of them old men or pre-adolescent boys. For many years following the war, Paraguay was little more than a Brazilian plantation, the only reason for the country not being absorbed into the Empire being the fear that such a move would lead to war with Argentina.

Little known today, the bloody and bitter War of the Triple Alliance was largely ignored at the time it was fought, due mainly to the isolation of the arena of conflict and the fact that it was overshadowed by other contemporary conflicts such as the American Civil War and the Franco-Prussian War. While mainly a land war, the conflict, as the foregoing shows, definitely had a fascinating naval aspect. Riachuelo, despite the fact that it was fought over 1000 kilometres from the sea, was as epic a naval battle as any fought on the high seas. For its part, the Brazilian action to force the passage of the Paraguay River at Humaita ranks with other similar engagements, such as American admiral David Dixon Porter's fight at Arkansas Post on the Mississippi River during the Vicksburg Campaign of the American Civil War, or the doomed Allied attempt to force the Dardanelles by naval action in 1914.

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Green for Go?

Why does CN sign all correspondence with a green pen?

By Graham Wilson

Now for something a little bit different! I am sure that everyone out there in Naval Trivialand knows that the Australian Chief of Navy (CN), formerly Chief of Naval Staff (CNS), signs all CN correspondence with a green pen and always has. Has it ever occurred to anyone out there to wonder why? It has to me.

In the total absence of any written record as to why CN should pursue such an individualistic correspondence idiosyncrasy I have formulated a theory for the use of the green pen. To be fair to anyone else who might have a differing theory, I will also admit that I have heard an alternate theory and I will expound that theory alongside my own.

My personal theory is based on the fact that the Royal Australian Navy traces its roots very, very firmly to the Royal Navy and therein lies the answer to the question (at least I think so). The two most powerful and dominant figures involved with the Royal Navy prior to the First World War were Winston Churchill, First Lord of the Admiralty from October 1911 to November 1915, and Admiral of the Fleet Lord John Arbuthnot Fisher, 1st Baron Fisher of Kilverstone, better known as "Jacky" Fisher, who was First Sea Lord from 1904 to 1910 and then again from 1914 to 1915.

These facts are probably well known to most readers. How many know, however, that Churchill and Fisher were in the habit of exchanging official correspondence in red and green ink respectively? This is a fact and this series of correspondence is known historically as the "Port and Starboard Letters." I don't know if Jacky Fisher was the first First Sea Lord to pursue this idiosyncrasy but certainly every First Lord since then down to the current one has signed all official correspondence with a green pen.

Now that's the Poms, what about us? From what I can gather, the senior uniformed officer of the RAN, whatever he had been called over the years, from William Rook Creswell onwards has always signed correspondence with a green pen. My theory for this is that the RAN grew out of the RN and for the first several decades of its existence, its senior officer was always an RN officer. I theorise that these worthies took on the airs of the First Sea Lord by utilising the sacrosanct green ink to sign their correspondence and this has become almost law through custom.

That's my theory. Here's the other one. I heard this theory from a colleague who worked as a technical officer for the RAN for many years and has an interest in naval history. It's not actually his theory, he was only repeating what he had been told. The theory goes that the use of green ink to sign correspondence goes back the the Second World War and was started by no less a person than the German Navy's Admiral Karl Dönitz. Apparently green ink was *verboten* in the *Kriegsmarine* but Dönitz used it for all his correspondence. He supposedly used it for even such mundane things as inserting marginal notes in orders and staff papers sent to him. The story is that Dönitz often didn't even bother to sign his correspondence, relying on the fact that the use of green ink would alert the recipient or reader as to who had written the correspondence and this would galvanise the recipient into the appropriate action or response! The theory espoused by my colleague goes on to posit that this use of green ink and its magical properties (staff process-wise) was learned of by the heads of other navies around the world. The result was that the use of green ink became a common practice amongst the heads of all the world's best navies.

Not a bad theory but it doesn't stand up to mine. First of all, it is a recorded fact that Jacky Fisher used green ink way back when Dönitz was a callow young *Leutnant-sur zee* at most and every First Sea Lord from then on has also used green ink. Secondly, the best evidence available indicates that the professional head of the RAN has always used green ink. Finally, the former Flag Lieutenant to CN, the charming LCDR Liza Stephenson, was good enough to check through CN's recent correspondence and has advised me that not only does CN still use green ink, it is also used by the chiefs of the Bangladesh, Royal Malaysian, Royal New Zealand, Pakistani and South African Navies, as well as by the RN's First Sea Lord of course. Note that all entries before "RN's" are ex-Pom navies. It is illuminating that none of the heads of other navies ("Flags" was able to provide me with advice on the Portuguese, Japanese, Philippines and United States Navies) use green ink, so either the magical properties of green ink are no longer appreciated or it never happened in the first place! QED.

So there's my theory and a competitor. I think my theory is the better one and stands up to the test of close examination better than the other. I will close with the obvious question: "who cares?" I do for one, otherwise I never would have written this short article!

The Last U-boat

The Career of U-573 in the German and Spanish Navies
Plus – What happened to the rest of the U-boats?

By Graham Wilson

In 1970, the Spanish Navy's submarine *G7* (S-01), stricken from the navy's pennant list that year, was auctioned at Cartagena, fetching a final price of 3,334,751 pesetas (about US$26,000 at 1970 rates). A fairly common place, even routine occurrence in terms of the fate of warships, this particular event has historical significance in that *G7* had commenced life in 1941 as the *Kriegsmarine's* U-boat *U-573* and when she was stricken in 1970, she was the last operational U-boat in the world.

This short article will examine the career of *U-573/G7* while also looking briefly at the later careers of a number of other U-boats which survived both the war and Operations *Regenbogen* and *Deadlight* and which went on to serve operationally with a number of navies for various periods after the war.

U-573 was a Type VIIC U-boat laid down at the Blohm & Voss yards at Hamburg on 8 June 1940. Completed in April or May 1941, she was commissioned after acceptance trials on 5 June 1941. Her first (and only) German commander was *Kapitanleutnant* Heinrich Heinsohn. Under the command of *Kptl.* Heinsohn, *U-573* carried out a total of four war patrols. The first of these was during the period June to October 1941 when she operated out of Kiel as part of the 3rd Flotilla. At the end of October, she redeployed along with the rest of the Flotilla from Kiel to La Pallice in France. This was one of the satellite establishments which made up the great U-boat base at La Rochelle[1]. *U-573* operated from La Pallice from September to December 1941, carrying out one war patrol, before redeploying from the Atlantic to the Mediterranean (via the Straits of Gibraltar – must have been an interesting trip). In the Med she was attached to the 29th Flotilla operating out of La Spezia on the north west coast of Italy.

Two war patrols were carried out by *U-573* from La Spezia. The first was from January to March of 1942. After a period of refit and rest in La Spezia, she departed on her fourth and final war patrol in mid April. On 29 April 1942 north west of Algiers she was attacked with depth charges by a Hudson of No. 233 Squadron RAF. Although she survived the attack and managed to beat off her attacker, *U-573* was too severely damaged in the attack to consider making the hazardous voyage back to La Spezia. With little choice in the matter, *Kptl.* Heinsohn made for the Spanish port of Cartagena which he reached on 2 May. Contrary to normal usage, the Spanish authorities allowed the Germans a generous three months (rather than, say, the 48 hours which had been

granted to the damaged *Graf Spee* at Montevideo in 1940) to carry out repairs to the damaged U-boat. This concession led to strong British protests to the Spanish foreign ministry, all of which were ignored.

The damage to the U-boat was so severe, however, that it quickly became clear that repairs could not be carried out in time to meet the dead line, generous or not. Regardless of any sympathy the Spanish may have held for the Germans, they could not afford to antagonise the British more than necessary and the presence of the U-boat was a potential cause of some embarrassment at the least. Intense negotiations between the Spanish and German navies, however, solved the problem when it was agreed that *U-573* would be sold to Spain for one and a half million Deutschmarks. The deal was closed with only hours to spare and the Spanish flag was raised in a simple ceremony aboard *U-573* at 10am on 2 August 1942 and she became *G7*.

An explanation of the new name of the U-boat is in order. The Spanish Navy had planned to construct a class of six boats in Spanish yards based on the German Type VIIC U-boat, utilising plans and designs obtained from Germany. These six boats were to constitute the G Class and were to be named *G1, G2, G3, G4, G5 & G6*. This plan was still extant when *U-573* was acquired and thus she was allotted the name *G7*. Shortly after this, however, the plan to build the other six G Class boats was scrapped and *G7* became the only G Class boat in the Spanish Navy.

With their boat no longer theirs, the crew of *U-573* were repatriated to Germany. *Kptl.* Heinsohn quickly got another boat, assuming command of *U-438* in March 1943. Sadly, Heinsohn lost his life, along with all of the rest of his crew when *U-438* was sunk by the RN sloop *Pelican* on 6 May 1943 off Newfoundland.

The Spanish Navy, meanwhile was unable to get any immediate use out of its new acquisition. Spain and its economy had been wrecked by the Civil War which had raged from 1936–39 and there was no money to spare to pay for repairs to the former U-boat. As a result, the newly christened *G7* spent the rest of the war in dock at Cartagena. Finally, in 1946, funds were allocated for repair and after an extensive period on the slips at Cartagena *G7* joined the Spanish fleet at sea in 1947.

U-573 does not appear to have had a particularly spectacular time as *G7*. This is not to say that she was not an important fleet unit. When she joined the fleet in 1947, *G7* became part of a submarine arm

consisting of three Spanish built submarines *(B2, C1 and C2)* the survivors of Spain's pre-Civil War submarine fleet, and the two old ex-Italian boats *General Mola* (ex-Italian *Evangelista Toricelli*) and *General Sanjurjo* (ex-Italian *Archimede*). These latter two boats had operated as Nationalist Navy units during the Civil War, first with Italian crews sailing under the Nationalist flag with an embarked Spanish liaison officer to answer awkward questions (in Spanish) in the event of a challenge by Non-Intervention Patrol ships. Later they operated as fully Spanish boats after transfer to the Nationalist Navy in 1937.

These boats were joined from 1947 to 1954 by the three new boats of the "D" Class. These boats had been authorised as far back as 1926 and *D1* was actually laid down at Cartagena in 1933, followed by *D2* in 1934. Construction of the two boats was then held up by the Civil War and the ensuing economic crisis in Spain. Construction recommenced in the late 1940's and the third boat in the class, *D3*, was laid down in 1945. *D1* joined the fleet in 1947, the same year as *G7*: *D2* was commissioned in 1951; and *D3* finally joined the fleet in 1954. Although the "D" Class boats were launched years after *G7*, they were in fact far older boats as they were built to 1920s designs. The other Spanish built subs and the two ex-Italian boats were also old pre-World War Two designs and *G7* was in fact the most up to date boat in the Spanish submarine arm!

It was a tribute to the excellence of the original design and the quality of the workmanship in her construction that the former U-boat was the mainstay of the Spanish Navy's submarine arm for a number of years and would in fact outlast several boats commissioned after her. *G7* served until the early 1960's as an operational unit of the Spanish submarine force and then was relegated to a training role. She was withdrawn from service in 1969 and stricken and sold out of the service in 1970. A fairly creditable 23 years of service to the Spanish Navy, not to mention her earlier service with the *Kriegsmarine*.

When *G7* joined the fleet, she was not the only U-boat sailing the seas under a new flag. The surrender signed at Luneberg Heath had specified, amongst other things, that the ships of the *Kriegsmarine* were not to be scuttled but were either to remain in German ports or sail to specified Allied ports for surrender. This was a pill too bitter for Admiral Carl Dönitz to swallow as he felt that it sullied the honour of the German Navy. As a former submariner, Dönitz in particular was galled at the thought of his beloved U-boats surrendering tamely to the Allies. Accordingly, Dönitz gave the order for Operation *Regenbogen* (*Rainbow*) to be put in train. The operation order specified that on receipt of the code word *regenbogen* individual U-boat commanders were to scuttle their boats and then surrender themselves and their crews.

The Allies quickly got wind of the plan and pressured Dönitz to rescind his order. A number of U-boat skippers, however, believed that the counter order from Dönitz had been made under duress (it had) and that it was contrary to his will and intentions (it was) and went ahead with *Regenbogen* anyway. In the end, 231 U-boats were scuttled, mostly in the Western Baltic.

Operation *Regenbogen* did not account for all of the surviving U-boats. In compliance with Dönitz later orders, 154 U-boats surrendered to the Allies. These included several boats which had been in Far East waters and which had been taken over by the Japanese in May 1945 following Germany's surrender. Of these, 119 fell victim to the Allies' Operation *Deadlight*. This was the Allied operation to dispose of unwanted U-boats and saw the 119 boats scuttled off Scotland, Northern Ireland, Singapore and Java between December 1945 and February 1946. The distinction of being the last U-boat scuttled under *Deadlight* was the Type XXI boat *U-3514* which was sunk of Northern Ireland on 12 February 1946 by HMS *Loch Arkaig*. Interestingly, *Loch Arkaig* took 30 minutes to sink *U-3514* using 4" gunfire, "Shark" depth charges and "Squid" missiles, proving just what tough boats the Type XXI's were. The action commenced at 0936 and it was not until 1004 that *U-3514* slid beneath the waters of the Irish Sea, the last U-boat sunk during Operation *Deadlight*.

The claim was made at the beginning of this article that *G7/U-573* was the last operational U-boat in the world. It could be argued by a purist that this is not entirely true as two other U-boats served on until after 1970, one in the Soviet Navy until 1973 and one in the West German Navy until 1984. On examination, however, the case can easily be made to support the claim of *G7/U-573*.

The first of these two U-boats, *U-3515*, a Type XXI boat, surrendered in Norway in 1945 and was taken as a prize by the British. She was commissioned into the Royal Navy as *N30* but was transferred within months to the USSR. Commissioned into the Soviet Navy as *B27*, she would change her title first to *BS28* and then finally to *UTS3*. Employed as a training ship from 1957, by early 1960's she was so run down that she was relegated to shore side duties as a static training platform and it is probable that by 1970 she was no longer even used in this role and was probably derelict. She was certainly not an operational boat. Stricken in 1972, she was broken up in 1973.

U-2540, another Type XXI boat, had one of the shortest careers of any *Kriegsmarine* U-boat. Commissioned on 24 February 1945, she was assigned to the 31st Flotilla at Hamburg but carried out no war patrols and was scuttled near the Flensburg Lightship on 4 May 1945 as part of Operation *Regenbogen*. Raised in 1957, she underwent extensive

repairs and refitting and was commissioned into the *Bundesmarine* on 1 September 1960 as *Wilhelm Bauer*. As such she served in the West German Navy as an unarmed trials, research and experimental ship until she was decommissioned in 1984. It was originally intended to sell *U-2540* for scrap but in the end sanity prevailed and she was transferred to the *Deutsches Schiffahrtsmuseum* (German Maritime Museum). Since then, she has been restored almost to her original state and, open to the public as a museum ship, is the last surviving Type XXI U-boat in the world². Again, although like *U-3515* she served as a commissioned naval vessel longer than *U-573*, she was not an operational boat as such. The original claim that *U-573* was the last operational U-boat stands.

NOTES

1 The U-boat pens at La Pallice are not only still in existence but are also still in use (by the French Navy). The last, and most famous, U-boat to operate out of La Pallice was *"U-96"*, the full sized mock up Type VIIC boat constructed for the movie "Das Boot/The Boat". The scenes at the U-boat pens at La Rochelle at the beginning and end of the movie were filmed at La Pallice. An article on the life and death of the real life *U-96* is in the works.

2 Three derelict Type XXI boats, *U's-2505, 3004 and 3506*, actually exist entombed in the bombed out Elbe II pen on the south bank of the Elbe River in Hamburg. The boats were unaccounted for 40 years until finally located by three German U-boat enthusiasts after a 10 year search. The boats had apparently been partially stripped for spares in the dying days of the war and were left undiscovered in the bombed out pen until 1985. The ruined pen is on private property and following the discovery of the boats the property's owner, who has no wish to lay himself open to civil damages suits by careless sightseers, filled the pen in with gravel.

Warrant Officer of the Navy – Warrant Officer David Wilson

The position of Warrant Officer of the Navy was established in 1992. WO Wilson is the third WO-N to be appointed by the Chief of Navy. The role of the WO-N is to travel throughout the Navy to gather the solicited and unsolicited views of members of the RAN. WO-N reports those issues directly to CN, Commanding Officers and other directorates.

Warrant Officer David Wilson enlisted in the RAN as an Adult Recruit in November 1972, from Sydney. Following Recruit Training he completed his Common Sea Training in HMAS *Brisbane*. Category training was conducted in HMAS *Watson* and HMAS *Penguin* during 1973.

During the years 1973-1979, Warrant Officer Wilson served in HMA Ships *Hobart*, *Supply* and *Vampire* as an Able Seaman and in HMAS *Perth* as a Leading Seaman.

In 1980 he graduated from his Advanced Underwater Control Course and was then posted to HMAS *Waterhen* for service in the Diving Tender Vessel *Porpoise* until rejoining *Perth* until 1983. He was promoted to Petty Officer in March 1982 and served at the RAN Trials and Assessing Unit during 1983. He then joined the Commissioning Crew of HMAS *Darwin* in early 1984. He served in *Darwin* until July 1987 and was promoted to Chief Petty Officer in February 1987.

Following service in *Darwin* he was selected to be part of the Staff Crew for the Sail Training Ship *Young Endeavour* as Bosun and Watch Leader until October 1988. He then joined the Australian Defence Force Academy as a Squadron Sergeant Major.

January 1991 Warrant Officer Wilson rejoined *Young Endeavour* for service in Australian waters prior to *Young Endeavour* departing for the world voyage in December 1991. During this posting he was awarded the RAN Squared Rigged Sailing Ship Bridge Watch Keeping Certificate. On 26 March 1992 he was promoted to Warrant Officer.

Warrant Officer Wilson joined the ASW Faculty in *Watson* late in March 1992 until assuming the duties of SEAAC Division Manager from June 1992 until December 1994.

In December 1994 he commenced duties as the Defence Administration Assistant at the Australian High Commission Islamabad, Pakistan. He served in this interesting and rewarding position until December 1996.

He returned to Australia in January 1997 and joined HMAS *Creswell* as an Instructor on the Senior Sailors Advanced Staff Skills Course Phase Two until January 1999.

In January 1999 he joined the staff at Directorate of Sailors' Career Management as the Warrant Officers' Career Manager until he was appointed as the third Warrant Officer of the Navy on 30 July 1999.

He is married to Colleen and they have two teenage sons. His interests include bush walking and sailing.

Shots from the Past

So You Want to Drive A Grey Ferrari

By CAPT D J Shackleton RAN

In The Beginning

So you are aspiring to command an ANZAC destroyer, or, if you are really lucky, a DDG. You need a watchkeeping certificate and you are looking for some advice on how to speed up the process, commensurate of course with the need to remain a Phase 4 officer long enough to fully exploit the party circuit and the XO's sense of humour whilst you are "under training". You figure that if you can afford the SAAB or BMW, and drive it around at incredible speeds, it really can't be that difficult to drive a warship – the other guys and girls make it look so straight forward – it's a snack. But why does the Navigator keep whingeing at you – is he from the northern hemisphere – have you noticed that all Navigators seem to have peptic ulcers that explode at the sight of Phase 4's, it must be something they learn on the long secret handshake course.

For those of you readers to whom this circumstance is apropos your current predicament, I have penned these few words in the hope that it will save you some angst with the "old man", and help life assume a more meaningful posture. If you have passed the point where comparison of your experiences with herein is useful, perhaps you can reminisce.

Of course the real premise behind becoming a qualified OOW is to impress the rellies, but another is to have fun at great speed and feel one's pile is in one's sock. A watchkeeping certificate, endorsed for a destroyer, is the ticket you need, for they are the ships in which being an OOW requires you to have the skills to drive a battleship grey Ferrari. For those who continue to demonstrate their abilities to excel, it is the fundamental qualification of a seaman officer to future career challenges, and potentially their own command.

A destroyer bridge watchkeeping certificate is a license to kill. I would expect submariners and aviators to argue that their skills are harder to obtain and hone, have you ever met any that don't argue, but driving a destroyer into station on another from ahead with a relative closing speed of about 60 knots and combined mass of over 9000 tons, with only the pelorus and distance meter to help get you in the slot,

requires talent, nerves of steel and courage. Acquisition of a watchkeeping certificate shows that an officer has reached a significant milestone in their career as a professional seaman. One definition of professional is:

> "...one belonging to one of the learned or skilled professions..." (Macquarie National Dictionary)

and that of your own choosing by being a member of the RAN, you want to be a professional officer in a professional Service which applies that learning. This means being a good OOW.

Welcome Aboard

So Dave and Davina, you have just joined HMAS *Incomparable*, the most professional destroyer in the RAN, you are here to gain the certificate which qualifies you to join the select group of officers authorised to exercise sea command. What should you do?

First, after meeting the Captain and Executive Officer, you find out the names of the other officers and at least the senior sailors. You will need to know more as time goes on but these are essential. Next, read Captain's Standing Orders and find out, at least, how the Captain has directed the OOW to perform his task, including when he is to be called, and the relationship between the OOW, the Executive and Navigating Officers. After this you need to find out about the ship's handling characteristics and any special rules about use of the propulsion system – what are the maximum and minimum speeds or revolutions to meet particular configuration arrangements, what are the machinery defects which will produce different results and limiting speeds.

Read the Bridge File. Cover to cover. You need to be at least able to find the information you need if it is not memorised. Find out where the navigation light switches are, how to dim them and how to turn them on and off; find out where the emergency switches are; find out where the upper deck lights are and how to get them turned on and off. When they don't work – 42who are you going to call? – you need to know. Make sure you know about the darken ship arrangements and how to make them happen.

Spend a couple of hours learning what every switch, knob and dial does on the bridge, find the dimmer switches, work out the communications units – where does the headset plug in, how does Open Line work, how does the main broadcast operate and how do the various general alarms function – what do you do when any of the magazine alarms go off, what effect do the Action etc alarms have on the SRE system. Go through changing over steering, memorise the procedure, find out where the steering motors are operated from and what are the likely symptoms of various types of steering failure. Know the Rule of the Road. You will not be permitted to keep solo watches until you do, and that will leave you feeling embarrassed as a professional.

Last but not least, memorise the revolutions per knot in those ships where this is still done. Prepare a card for your pocket which has the table copied onto it, as well as any useful formulae you use for station keeping. Bring it to the bridge – with your sense of humour – every watch. Remember the red torch at night time, or how will you see it.

Authority of the OOW

Your authority is derived from the traditional and legally enforceable concept that the OOW is the Captain's representative. Only he can relieve you of the responsibilities of being the OOW, but the Executive Officer can also relieve you if the Captain has so authorised in his standing orders – you need to check this point.

This means that Heads of Departments cannot give you orders so far as your personal responsibilities are concerned, and neither can PWOs closed up in the bat cave. But you would be wise to listen carefully to their counsel because they may be aware of things you are not. By extension, as an ASLT, or of not much more seniority, you have the responsibility and accountability for the ship and her people on your shoulders. You would do well to lose some sleep contemplating this, and coming to grips with what it means.

Your authority means that you must look at life through a serious pair of glasses. All that you do reflects on your reputation as a professional seaman officer, and your reputation is everything in a professional Service. By definition this means that you will want to be one of the best. If not, then you have the wrong address.

Taking Over the Watch

The best way to start is at the beginning. You should always start the watch by a visit to the operations room so that you can find out what is going to happen operations-wise during the time you have the keys to the Ferrari. There is merit in finding out which

problems you are going to be presented with and those solutions which might work in the next four hours or so. Take the time to be briefed by the PWO on the setting signals and instructions relevant to the practice serials you will be involved in. This is not only for the Wombles to do – you are part of the team, not a liability. If you are in more serious circumstances, read those parts of the operation order and implementing instructions as are available to you, remember that the OOW is part of the command team as well and ignorance of operational matters will make your life more difficult (you may need to do this in your own time as part of your own preparation to be effective). It also helps if you are on speaking terms with the PWO, and are able to help him bring off the most brilliant tactical coup while also scoring points with the C.O. – you will have rights to some of the kudos and maybe champagne later in the Wardroom bar if it goes well.

A visit to the operations room also has the benefit of letting you know how much shipping is around, and allows you to build up an early mental picture of the avoiding action you may have to take, particularly if sea room is tight and you are constrained to a limited number of alternatives. Arrive in a positive frame of mind, committed to spending your watch only thinking about your responsibilities.

Leave other matters behind to be worked on later. If it is quiet, spend some time considering the "what if" aspects of your responsibilities.

You will already have a good idea of what to check with the off going OOW, but most importantly, do not accept the watch unless you are perfectly happy with all which has been bequeathed you. It is foolish to think the Captain will thank you for accepting a bag of nails. Apart from finding out how many propellers have been lost in the preceding couple of hours, put a fix on the chart. The Captain will have little happiness, and neither will you, if you get the ship lost, or worse, have her stand into danger. When you have done this, check to see that the track for the remainder of the watch is on the chart and, if necessary, has been correctly transferred to the next sequential chart (don't forget your relief in this respect either). Find out if the Navigator has left instructions when to be called. Remember, the OOW does not have the authority to arbitrarily decide which port to visit.

Next, find out which ship is the Guide and which others are in the formation, and who is leaving and joining during the watch, also if any ship is expected to operate aircraft or conduct replenishment. Have a look at Daily Orders, sometimes they are accurate in their forecast of events. Find out what the hands are doing, whether any RADHAZ conditions exist and if any weather deck restrictions are in force – it is your option to put the upper deck out of bounds if weather

conditions make it unsafe. Make sure you know how to contact the watch on deck, and who the swimmer is – and don't forget reliefs for lookouts. Last, but not least, make sure you know what your own station is and any likely changes that will happen during the watch, including any that may be precipitated by another ship operating aircraft etc. You must think ahead

If applicable, read and sign the Captain's Night Orders, sometimes they will be written for day time activities as well. Read them carefully and ask the off-going OOW to explain any points. You should remember that the Captain cannot put all his thoughts into Night Orders and they must necessarily be brief. If you have any doubts at all, you must call the Captain.

When, and only when, you are completely happy that you have fully taken in the advice and details necessary for a professional watch, you may use the words "I HAVE THE SHIP". This simple phrase of acceptance totally transfers the onus to you for all things which happen from then on, the buck stops fair and square with you. IF YOU ARE NOT COMPLETELY HAPPY, DO NOT ACCEPT THE SHIP, YOU MUST CALL THE CAPTAIN IMMEDIATELY. You have no discretion in this. It is better to do this and perhaps feel slightly embarrassed than be responsible for a disaster

The Captain will not be critical of you for this course of action, and will make other OOW understand you will not accept a pig in a poke for a handover.

Now She is Yours

Having accepted the watch, what should you do, how should you behave, what do others expect? First you have to establish yourself as the controller of the bridge. You must act as if you are in command; always answer the intercom or telephone "OFFICER OF THE WATCH". This does not mean that Adolf Hitler can be reincarnated, but it does mean that others on the bridge and those that deal with your bridge staff understand that they are dealing with a professional officer who sets the example and expects only the best from all who are present. You must ensure that an atmosphere of formality sensibly tempered to foster team commitment exists on the bridge. This is not the place for staff to read paperbacks or generally take no interest, they all work for you so you must ensure that they understand what is expected of them. Does the Bosun's Mate have his Bosun's Call and a cap, do you have your own cap in case saluting needs to be done.

You have a badge of office, not your headset – your binoculars, and they should be worn for the whole watch. The key word in OOW is "watch". Not only does it relate to a time span of responsibility, it refers to being alert and seeing all manner of things with a

trained eye. You must look out, predominantly forward of the beam, but frequently scan the entire horizon for the unexpected ship, aircraft or other object you were not aware of before. Once in five minutes all round is not too frequent, but develop the habit of walking from wing to wing just for the purpose of looking out. This does not reduce the responsibility of lookouts to do their job, but if they know they are on watch with an officer who prides himself in being first to see things, it can act as a challenge to their own prowess. If you are constantly seeing contacts first then the lookout needs to be censured and encouraged to do better. Make sure they are briefed of anything particular to watch for and that they are formally directed which sector to look at. Cooks and Stewards sometimes make the best lookouts because to them to be on the bridge is a novelty.

Everybody on the bridge is a lookout. This includes the Quartermaster, Bosun's Mate and Signalmen when not involved in their jobs. The Leading Signalman does not have the option of spending the watch in a chair and taking no interest – sometimes he will be the next most experienced man on the bridge – use his talents, and those of the QM, for your own purposes, and you will probably find they really are as good as they (usually) modestly suggest. The lifebuoy sentry is also a lookout, make sure you brief him as such.

Being an OOW is busy work if you are doing your job, having an assistant is a luxury. You have to be able to cope on your own, in company, in the Malacca Straits at night at 20 knots. Work at being able to take a fix, plot and DR/EP and write up the OOW note book and log in 3 minutes or less. While you are doing this, make sure the remainder of the bridge team are watching out for you. Let one of them answer the operations room intercom or other stations which call up such as the engineroom: They will develop a greater sense of involvement if you let them do some of those things normally reserved for officers, and they will look forward to being on watch with you because they know they contribute to the overall solution by being part of a professional team.

Conning the ship is one of the joys of being an OOW. There is nothing like a starboard 95-ish at high speed to give one a sense of power and satisfaction when you can roll out exactly in station, (make sure the ship's company knows that a Grand Prix performance is about to happen – they enjoy it too, but they don't appreciate the spoiled meals and cleaning up caused by inconsiderate Ferrari drivers). But it is unprofessional to go past the new course and leave a zig zag for the fellow astern to follow. The same is true of getting the ship to about 10 degrees off the new heading with rudder still on and telling the helmsman to steer the new course – you are effectively abrogating your responsibility to make the ship point

in the right direction. Don't let the ship meander by not giving the helmsman a course to steer. Don't let him decide how much wheel to get you on course when in close company. Do get the ship to within 2 degrees before giving him a "steer", and if in close company, try to get the ship precisely on course. If the course alteration is however, less than 10 degrees and you are not in close company, then it is acceptable to give the helmsman a wheel order followed by the course to steer. But never forget, it is your responsibility to have the ship pointing in the right direction all of the time.

Fudging fixes and not being willing to admit that a problem might exist, however, means you are not really entitled to hold your license to drive the Ferrari. There is therefore every chance it will be taken away, meaning you shall certainly be relegated to shameful disgrace as the man who betrayed the trust of his shipmates – gloom!!

You are now happy you have got it weighed off, but how accurate should station keeping be. As accurate as possible is the answer. This means one degree for bearing and up to 50 yards for range in reasonable sea conditions. In line ahead you should be able to achieve station keeping to within one degree.

Relative velocity is a tricky thing. But once you have the principles it is not difficult. Read the instructions (especially when all else fails) on how to use the Battenberg, but most importantly try to develop in your mind where you are going to be when in station and then work backwards to calculate how you will get there. The reciprocal club is easy to join, put yourself in the middle of the plotting circle and work it out that way.

The operations room has a large impact on how effectively you can perform your own task, as well as the overall performance of the ship. Bridge and operations room teams must work together as a combined team, or else everybody will have to unnecessarily work that much harder. You should expect assistance from the surface plot in helping you stay alert to the shipping in your area, and the RP's ought to provide you with details of courses, speeds and closest points of approach for ships which will close. But the sailors manning the plot need your instructions as to what you want. As you are taking over the watch, and having already been to the operations room on the way to the bridge, you should have formed an idea of the shipping density and how much assistance you need. For instance, in a busy shipping area it would be appropriate to tell the operations room to only report contacts which will pass within say, three miles, when those contacts are at eight miles; this gives you time to handle the reduced number of reports and work from one problem to another without becoming overloaded. Don't be afraid to change the instructions when it

becomes apparent that you are not getting the information you need when it is needed; don't forget to order a watch to be kept for a high coastal point on any of the ship's search radars available when making a land fall or if fixing is becoming difficult.

There are control words for giving the surface plot your instructions in terms of how the plot should report contacts. Learn them all. Don't simply tell the sailors to "watch" a contact unless it is entirely inconsequential to your concerns; there is merit in ordering the contact to be reported again at a shorter range, that way you don't forget about it – if the CPA is some distance off you can order the contact to be reported at that point, again you are then reminded of its presence and reassured that it presents no problem. Computerised operations rooms do not always result in an improved standard of service to the OOW – computers are demanding little beasts and can become an end in themselves – you must be positive and persistent in your statement of requirements.

Use of the operations room does not relieve you of calculating your own CPA's; use the plotter on the bridge PPI or calculate it yourself, but compare it with the operations room and in a subtle way let them know that you will check their results – there is no harm in a competition for accuracy. The PWO and OOW must work as a team but, like any good professional personal relationship, you need to know your obligations to each other; do not make assumptions about who is doing what – for that is the way to confusion, certain disaster, and perhaps a "friendly chat" about life in general by both of you and the Captain. Both of you have clear responsibilities, and you need to be fully aware of them.

Open Line can be awkward until you are used to it; don't forget your prime responsibility is safety, but you have to be able to achieve that at 28 knots in company, in rain, at night and with no radar. If you find the headset is constraining your ability to do your job, don't think twice, take the headset off, tell the PWO and call the Captain.

Emergencies

As the OOW you are always going to be the first to react to an emergency, this also means you will need the support of the team that is your bridge staff. Not only does it mean that you need to be capable of recognising when a crisis exists, it means that you (meaning you) will be primarily responsible for solving it until others are able to grasp the problem and take over. For instance, other people may be injured or access to the bridge cut off – so who is going to take charge? – YOU ARE, that's who. Make sure your bridge team know what to do in any of the circumstances you could find yourself in. There is no future in having to operate the Main Broadcast as well as conning the ship because no one else knows the

pipes and routines for Emergency Stations etc. See to it that the QM instructs the Bosuns Mate, he can be very useful when trained.

You owe it to yourself to think about these things – it could pay off one day – and then you will really be famous. For instance, recovery of a man overboard is something I hope you will never have to do, but you must always be prepared. Decide early whether you will use a swimmer or the boat, and adjust your pick up arrangements to suit. Spare a thought for what it must be like to be in the water watching your ship steam off. Seeing the lifebuoy sentry spinning salty dits with a mate, and the cooks ditching bio-degradable gash (but not plastics) as she goes; only to then feel real terror at the prospect of being recovered in one piece as she turns around and comes charging directly at him at the speed of watery light and attempting to stop terrifyingly close amidst a great swirling of water as the fast astern rotating propellers sweep many tons of water toward the ship's boat – which loses steerage and turns over in the turbulence. Gloom!! Remember, the boat is more manoeuvrable and faster than the ship if you have a RIB; so get the boat in the water as quickly as possible.

Swimmers don't like 15 knot currents or being sucked into the propeller blades either. Speed of recovery is of the essence, but the word is recovery, not butchery.

Ensure that the operations room help is used, if necessary having someone repeat their information to you while you are on the bridge wing – but don't ignore it – the man is one of their shipmates. Personally make sure that an individual is nominated to watch and point at the man in the water while constantly calling the relative bearing to you. Ideally you should also watch the man, rather than being glued to the pelorus and not able to see where you really want to go. Don't forget either, to stop the ditching of gash, attracting white pointers is only acceptable at the beach, and then with some discretion. If the Captain takes the con, make sure he knows where the man is and that you continue to provide him with the maximum assistance you can in running everything else.

Night Time Tips

Night vision is important, so plan to start night watches about 10 minutes earlier than those during daylight hours. At night insist that the chart table light is dimmed and that extraneous light is cut off; make sure that all other dials, strip repeats, signal desks, bosun's mates positions etc only have the minimum light necessary for the job; if nothing is going on – turn them off. A great way to see a ship at long range at night is the flash up of cigarettes pipes and cigars, make sure that precautions are taken to prevent the use of portable flame throwers on the bridge and upper deck.

Night time also has the effect of changing your perception of distance. Take the trouble to look at other ships through the binoculars and develop a feel for how much of the field of view is being taken up, take notice of the size of the wake and bow wave. When there is radar silence, make sure that you know the distance between steaming lights and side lights and various combinations, because that will be the only way you can set the scale on the distance meter.

Night time station keeping without radar and with navigation lights switched off can be exhilarating, not to mention making you wish it was somebody else's watch. You need to develop your seaman's eye to judge distance and the aspect of those ships you can see so that you can gauge whether an opening or closing range rate is happening. Have you worked out what you are going to do "if", and as importantly, have you decided what the triggers will be to make you react instantly rather than believe it isn't happening to you.

The OOW is responsible for calculating sunrise and sunset and this is a good time to test your abilities of working to an accurate standard. There should be no reason that each cannot be worked out to within 30 seconds, a competition between the OOW and his assistant is always beneficial if circumstances permit, and for one good with numbers, champagne can become cheaper this way. Don't forget to work out moonrise and moonset. While quiet night watches are opportunities for those not yet in the wheelchair brigade to contemplate on the probabilities for meeting celestial objects ashore in exotic places, and for those so afflicted to reminisce, there is also the more immediate and practical benefit to all OOW of checking the gyro against the celestial objects obvious in the night sky.

Calling The Captain

Captains of ships are posted to the billet at least, in part, because they don't like to have an all-night-in; they have also learned the art of suppressing the ecstasy associated with this privilege. There is the truism, however, that they will certainly not thank you for not calling them because you felt he was tired and needed sleep. Orders will invariably contain standard occasions for calling the Captain, but remember, those occasions are not just for the night time, they are standing requirements to call him for the myriad of occasions he has deemed it necessary to do so irrespective of the time of day and night. And don't assume that they will be the same for every ship, you must read and memorise them, and additionally apply commonsense by calling him when you think that things just do not feel right.

Even though it appears the Captain is awesomely knowledgeable, he still wants to know more – there will, and this might come as a surprise to you, be

circumstances he has not been able to foresee, and it is here you must use your judgement.

There are two simple tests over and above the standard occasions on which you should call the Captain.

The first is:

"Will it only take one or two things to happen to cause a close quarters situation which will require me to take action?"

This should be self evident but it requires a conscious and constant appraisal of the situation you find yourself in. It is vital when such circumstances exist that you do not let yourself become distracted by other matters. The second and more important is:

"Would I want to know if I were the Captain?"

This latter rule of thumb is fundamental, you are the Captain's representative for his responsibilities and he can either be courts martialled or promoted on your judgment – but so too can you, and it is that serious; and that is why it takes so long to get a ticket, and that is why a qualified watchkeeper is a somebody.

Handing Over The Watch

Having managed to get through the watch it becomes time to prepare to hand it on the next OOW. Double check the Guide's course and speed and your own station, find out if any signals are pending. Put your own fix on the chart so that you feel comfortable in asking your relief to do the same.

Get the Bosun's Mate to get rid of the empty coffee cups and empty the ash trays, tidy up the chart table and make it look as if a professional has been in charge of the bridge. Update the machinery and radar states and manpower disposition if applicable, as well as any routine stateboard matters.

The most effective way to prepare to handover the watch is to go through it in your mind as if you were coming on watch yourself, ask yourself all the questions you would want answers to if the person climbing the ladder to the bridge was yourself. In the morning watch, and certainly before the Captain arrives to survey the scene, make sure the litter is removed, bright work is done and the windows are cleaned both sides. Don't forget to have the bridge ladder and its runner cleaned as well as ensuring that the deck is swept and scrubbed out if possible. Who

can keep a professional watch in a slum. If you are on the ball early in the morning, many brownie points can be gained by making sure that Father is not left out of the bacon and egg sandwich order given to the breakfast galley team.

The Paperwork

The job is not finished until the paperwork is done, remember what your mother said. Make sure the Log and all other administrative items are completed before you start the handover to your relief. OOW are not to leave the bridge until this has occurred.

Remember to check the Assistant's entries during the watch. Those who are inexperienced sometimes lack the ability to recognise that they should be asking for help. It is your signature in the Log and OOW Note Book, and you are accountable for their contents; make sure you can live with what they portray.

Summary

You are commended to inwardly digest the sentiments of the preceding comments and advice. Your Captain will be looking for its application during your watch on the bridge of the ship for which he has ultimate responsibility.

From this missive you should have a clear understanding of needing to adopt a very personal commitment about being a top class OOW; because, very simply, your reputation is the same as that of the ship, and vice versa. Your aim is to be one of the best.

And then you can borrow the keys to the grey Ferrari.

Three Grey Ferraris in action

REGIONAL DIPLOMACY – RAN RETURN TO VIETNAM

1999 marked the beginning of Australian/Vietnamese defence cooperation with the establishment of a position of a Defence Attache, Colonel Gary Hogan CSC, in the Australian Embassy in Hanoi during February. This led to closer defence relations and an offer for some Vietnamese military officers to attend the Australian Defence Force Academy with the assistance of Australian Defence Scholarships. It also paved the way for the RAN to return to Vietnam in April 1999, when HMA Ships PERTH (CAPT L. Rago RAN) and ARUNTA (CMDR G. Yorke RAN) visited Vietnam. This was the first ship visit to Vietnam since late 1972 when HMA Ships SYDNEY and VAMPIRE were involved in the withdrawal of Australian troops. The following is a candid view of the return of two Aussie sailors to their Vietnamese families.

Aussie – Vietnamese sailors return home

by Patrick Griffiths, Department of Foreign Affairs – Vietnam and
Lieutenant Commander Lee Goddard, HMAS Arunta

The scene is Saigon Port, Vietnam, April 24, early in the morning. At 1100 the RAN ships HMA Ships *Perth* and *Arunta* had sailed in on the Saigon River tide to berth in Ho Chi Minh City, to begin a historic ship's visit aimed at cementing the young Australian-Vietnam defence relationship.

Sub-Lieutenant Toan Vo strides down the gangway, past the spot where the Ho Chi Minh City People's Committee had earlier welcomed the ships, and then up the 200 metre road away from the wharf. Having waited at the Saigon Port entrance, an aged, balding Vietnamese man walked eagerly, but slowly, forward toward the approaching *Perth* officer. Sub-Lieutenant Vo still had the naval relaxed but semi-formal look on his face, but then as he got closer to the uncle he had not seen in many years a huge grin emerged.

After Toan's uncle kissed him on the left cheek he was soon followed by a woman who appeared to be in her 50s, and as they walked toward the busy roads outside the port the entourage grew as more family members arrived on motorscooters. More kisses amid the banter. The excited family members checked watches to work out whether or not Toan would have enough time to travel to someone's house before he had to be back for an official reception onboard *Arunta* that evening. The deadline for the return was 1800. So a taxi was arranged and Toan was taken away to the family home.

When asked about his family Sub-Lieutenant Vo told Navy News at Saigon Port:

> "When we've been together we've just been catching up. We have always kept in contact but when you see someone for the first time in such a long time there is plenty of news."

Vietnamese people are very family-orientated. Most homes and many shops have a small altar – usually in the front room which is most often the lounge room – at which ancestors are prayed to. During the ships' visit Toan was able to go to his grandfather's grave to pay respect.

For Lieutenant Luan Du, the return to the city where he spent his childhood years took him right back to his old neighbourhood when he accompanied his crewmates to the Gecko Bar before the 2300 curfew.

> "My family used to live just nearby this street for a while, so I grew up in this neighbourhood," Luan said as cyclo drivers and postcard-selling children eyed him with friendly curiosity.

> "You're Vietnamese aren't you?", one cyclo driver ventured.

Politely he answered in the affirmative, before explaining to an interested Australian tourist looking on that his parents in Sydney had been nervous about him returning to Vietnam.

"Perhaps two years ago it would have been more dangerous for me, but a lot has changed now in Vietnam," Luan said. "I've really enjoyed it, and I think my Vietnamese has improved the last couple of days because I've had to use it so much."

Officers of the Vietnam People's Navy were at the *Arunta's* official reception, held on Anzac Day eve. As the Vietnamese Navy officers sampled Victoria Bitter beer and "party pies" for the first time, they gathered around Toan and Luan and were genuinely interested in their impressions of life in the Royal Australian Navy. Many of the Vietnamese guests were aware that a past Vietnamese refugee to Australia, Ms Tan Le, had been honoured with the 1998 "Australian of the Year Award". There was a genuine interest in the success of the Vietnamese community within Australia.

Sub-Lieutenant Vo's and Lieutenant Luan's language skills were very valuable to the visit which the Maritime Commander, Rear Admiral Chris Ritchie AM RAN, has claimed was a "successful ice-breaking exercise in friendship building". Luan's voice was hoarse after two days of shouting in English and Vietnamese as he and Toan became the bi-cultural and bi-lingual link between ships' companies and Saigon Port authorities and workers.

Culturally and in terms of process and formality, operating in Vietnam is even different to other Southeast Asian ports. Everyone was on a steep learning curve as normally quite routine issues such as refuelling, locating provisions and liaising with customs officers was at times complicated. On the third day, with yet another storm brewing off to the south and obviously heading toward the city, Toan moved from HMAS *Perth* to *Arunta* and back again serving as a "go between" during refuelling operations.

After they had disembarked from their tour of Perth, Toan's family was again waiting patiently in a kiosk beside the dock while he ensured the refuelling was under control. When it was, he slipped ashore. Again, he walked across the bitumen with that semi-formal look on his face. And again, when he got near his family the Navy look disappeared to be replaced by the look of an ordinary person jubilant to be back in the arms of his family.

The RAN return to Vietnam was an opportunity for the ships' companies of *Perth* and *Arunta* to mix with the locals and for the locals to gain a better understanding of their Aussie visitors. It was a success for the Royal Australian Navy, for Australian/ Vietnamese relations as well as for the men and women of *Perth* and *Arunta* and for those mentioned in this article it was a busy, but welcomed visit to an old home. Everyone who visited Vietnam now hopes there will be another chance to visit soon.

Next Edition

**Mine Warfare –
Our Current and Future Capability**