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Getting in Early: Lessons of the Collins Submarine Program for Improved Oversight of Defence Procurement

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Abbreviations

ADF	Australian Defence Force
AEW&C	Airborne Early Warning and Control
AIP	Air Independent Propulsion
ANZAC	Class name of the RAN's most recent frigates
ANZUS	Australia, New Zealand and United States Treaty
ASC	Australian Submarine Corporation
ASW	Antisubmarine Warfare
AW	Air-Warfare
AWD	Air-Warfare Destroyers
CDS	Combat Data System
COTS	Commercial off the shelf systems
DE	Destroyer Escort
DSTO	Defence Science and Technology Organisation
IT	Information Technology
ITAS	Integrated Tactical Avionics System
JCFADT	Joint Committee on Foreign Affairs, Defence and Trade
JCPAA	Joint Committee on Public Accounts and Audit
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RFT	Request for Tender
RN	Royal Navy
RNZAF	Royal New Zealand Air Force
SWUP	Submarines Weapons Update Program
UK	United Kingdom
UN	United Nations
US	United States
USN	United States Navy
USS	United States Ship

Major Issues

The Collins submarine has been perhaps the most controversial defence equipment acquisition program since the F-111 purchase of the 1960s. Despite management reviews and performance improvements the controversy continues.

Over recent months the Minister for Defence, the Hon. Peter Reith, has suggested that the Opposition was endangering the orderly planning for the development of the Australian Defence Force by wishing to buy two additional Collins submarines (a claim the Opposition denied). Then in July the Minister himself drew criticism for cancelling the competitive program to supply a new combat system for the submarines, in which a European based consortium had been favoured, on the grounds of Australia, New Zealand United States Treaty (ANZUS) alliance cooperation with the United States (US). The controversy over the submarines appears likely to continue past the forthcoming election and into the following years.

Again over recent months, the operational performance of the submarines has drawn favourable attention due to the success of HMAS *Waller* in Exercises RIMPAC and Tandem Thrust. Indeed, the Collins submarines appear to have outstanding performance in several areas, which may well justify Navy's decision in the mid-1980s to develop a unique design. At that time, none of the designs offered could meet all of the Royal Australian Navy (RAN) objectives, with inability to accommodate its concept for a combat data system being a common shortcoming. However, to be able to operate at the level desired by the RAN, all six submarines will need to complete an enhancement program which, including a new combat system when it is eventually chosen, will add $1 billion to the $5.1 billion cost previously approved for the program.

There remain two areas where the future of the program depends on policy decisions. One is the fate of the submarine construction industry. The second is whether the boats are to have an effective combat system. A successful outcome is required in both for the operation of the Collins submarine to reach expectations.

Unresolved Issue: The Future of the Submarine Building Industry

Deciding to build the submarines in Australia was the most important single act in the history of the program. It was done because it was thought to be the best means of providing efficient and effective support throughout the submarines' service lives. It was

also to provide a basis for improving them over time to meet the demands of changing strategic circumstances. It was known to be a high risk decision and most of the characteristics of the program's development and elements of its subsequent outcome were directly shaped to help manage this risk.

In terms of engineering excellence and production management, the construction of the submarines by the Australia Submarine Corporation (ASC) has been a national achievement in the tradition of the Snowy Mountains Scheme, as an ambitious one-off project. What has not yet been provided is the basis for an ongoing industry which would meet the objectives of the original decision. For this, an operation with a long-term workload base and sufficient intellectual capital to maintain and develop the submarines is necessary. In July, the Government met the first of these requirements by confirming that the cyclic refits, in which each of the six submarines is stripped out and completely refurbished every six years, would be done by ASC. This work is worth $100 million per annum.

In September 1999, Kockums, the European design partner in ASC, merged with the German submarine builder HDW. HDW intended to take up Kockums 49 per cent share of ASC but the Government did not respond positively, instead purchasing 100 per cent control of the company and pursuing alternative options. These were consistently reported as including the desire to have an American submarine builder as part of ASC and to use the restructure and sale of the company as a means of rationalising the Australian defence shipbuilding industry.

Assuring sufficient intellectual property (one of the important elements of intellectual capital) for ASC has become an issue since the Government's takeover of the company. The Government's interest in American participation is not necessarily at odds with the recognition by senior RAN submariners of the ongoing role of Kockums in supporting the Collins class. However, over the period, a degree of suspicion seems to have grown between the American and European industries, based on a fear that American participation would allow them to access modern conventional submarine technology, which at present they do not possess.

As recently as May 2001, the Minister indicated that legal matters surrounding intellectual property remained to be settled. Until the Government is able to resolve the issues of ASC ownership, including access to required intellectual property, it will not be certain whether the objectives of the decision to build the submarines in Australia finally will be achieved.

Unresolved Issue: The Need for a Workable Combat System

One of the recommendations of the report by Malcolm McIntosh and John Prescott on the problems of the Collins submarines, delivered in mid-1999, was that its combat system should be replaced by a proven, off-the-shelf product. This recommendation was accepted by the Government; the evaluation of potential suppliers had reportedly been concluded in

favour of the STN Atlas ISUS 90–55 system when, in July 2001, the Minister suspended the program.

The reason was the Government's desire to maximise opportunities for closer cooperation with the USA on submarines. At the time, the decision created some confusion about the potential impact of ANZUS alliance issues on future Defence procurement. In some areas, it was seen as questioning the balance between the concepts of 'alliance' and 'self reliance', at the centre of the development of defence policy since the 1976 white paper. Further, the decision is likely to delay the program by about a year. As a result of it, the Government will have to manage the risk arising from the situation that, as yet, no combat system is available within the parameters of the policy on cooperation.

The only potentially suitable system, the CCS Mk2, produced by the American company Raytheon, is used by United States Navy (USN) nuclear powered submarines. There are sufficient differences between these and a conventional submarine of the Collins type to make the transition neither simple nor assured. The risks to be managed include integration with the existing systems on the Collins class, modifications to work in the less well-supported environment of a conventional submarine and avoiding pressures to include non-essential system enhancements. A system successfully developed to avoid these problems will be unique to RAN service.

Nonetheless, a trouble-free development cannot be assured. Raytheon, for instance, has been unable to satisfactorily conclude its contract to upgrade the Royal Australian Air Force (RAAF) AP-3C maritime surveillance aircraft, elements of which are now running 42 months late. The lessons of the recent history of Defence procurement are that neither sponsorship by the US Armed Forces nor development by corporate America can guarantee success in systems integration programs.

What Really Went Wrong with the Collins Program

However, the clearest warning to the Government is that the new procurement strategy for the combat system parallels that which underlies the difficulties experienced on the Collins submarine program as a whole. This was the decision to shift the procurement strategy from that of acquiring a proven overseas design to one of developing a unique product which more closely matched its ideal specifications.

In 1985 Navy concluded that none of the designs then available could meet its expectations. Instead of persisting with its procurement strategy and choosing the best available combination of design, industrial package and cost, Navy chose to proceed to a unique submarine design. In essence, it opted to develop a Holden amongst submarines, a design uniquely suited to Australian conditions and with much promise, but carrying much more risk than the more limited but proven off-the-shelf designs.

This was the most important single decision of the program. The period of redevelopment which followed saw the greatest proportional cost growth during the history of the program and also confirmed a reduction in the number of boats it would purchase. Developing a unique submarine, in which most of the systems had unique specifications, guaranteed that there would be developmental problems. Continuing as though the program was a normal production run, with predictable outcomes within a fixed price contract, not only compounded the impact of difficulties when they did arise but had much to do with the persistence of performance problems and establishing the subsequent poor reputation of the submarines.

A more detailed history of the program up to the selection of the Kockums design is provided in a companion paper, *Procuring Change: How Kockums was Selected for the Collins Class Submarine,* Research Paper No.XXX of the Australian Parliament's Information and Research Services.

Only One Amongst Many: Ongoing Problems in Defence Procurement

Yet, in reality, the Collins submarine program is not amongst the worst managed by Defence, in terms of either additional costs or time overrun. At present there are 15 Defence acquisition programs which have exceeded their approved cost by a combined total of $568 million. Even by the worst interpretation of performance, the Collins program would rank twelfth amongst these. Many of the programs are characterised by changes to overseas systems to meet specifications developed by the Australian Defence Force (ADF) for peculiarly Australian requirements. These systems are unique to Australia and typically have proven difficult both to develop and maintain. Within Defence they have attracted the nickname 'orphan systems'.

The desire of the ADF to acquire orphan systems is not a relic of past decades. It has been shown in the ANZAC class frigate helicopter program, for which the platform was selected in 1997 and for which the avionics system is two years late. It is a danger which must be managed in the Airborne Early Warning and Control (AEW&C) program, the contract for which was signed in December 2000, and for which four million lines of unique software are needed. It is also a risk inherent in the Government's new approach to the Collins class combat system.

Neither is it a problem whose effects are confined to the programs themselves. Were, for arguments sake, the AEW&C program to require additional funding to the same extent as the Collins program, it would cost an extra $600 million. Such unprogrammed expenditure would be sufficient to jeopardise the orderly development of the ADF as planned in *Defence 2000*, the defence white paper.

The Need for New Processes of Parliamentary Oversight

The consequences of such situations have attracted criticism from within Defence. The poor management of defence procurement, which has often thus been created, has raised concern in the Government. Cabinet has recognised that the most important decisions affecting the outcome of a procurement program are made at its earliest stages and that waiting until Defence prepares a Cabinet submission leaves it facing a fait accompli.

Accordingly, the Government has now introduced new processes for the development of defence capital equipment proposals. Defence must now make two approaches to government, the initial one laying out a range of options relevant to the particular issue. This gives the policymakers time to intervene in the development of a procurement program before its nature has been set.

This change in policy setting procedures for the Executive Government has not been matched by procedures for parliamentary scrutiny and public transparency. There are Parliamentary committees which have a role that causes them, from time to time, to scrutinise defence procurement programs or the procurement system in general. For procedural and other reasons, they come to the issue too late.

This problem will become increasingly important as Defence implements new procurement procedures such as evolutionary strategies, under which equipment will be bought in smaller, more frequent blocks with changing specifications. To cope with this changing environment and to mirror the Executive's early oversight of equipment project development, the legislature needs a new approach, perhaps one similar to that exercised by the Public Works Committee.

This is probably the ultimate lesson of the Collins submarine program. Nothing will be done to avoid a recurrence of problems in future major defence procurement programs, similar to those that have affected the submarines, unless the past of the Collins program is examined and the lessons learned. The most effective way to reduce the consequences of poor Defence procurement lies in much earlier intervention by policymakers in the development of defence equipment projects. To play its role in this process the Parliament will need to invent new procedures.

Introduction

Earlier this year the Minister for Defence, the Hon. Peter Reith, suggested that the Opposition was endangering the Defence Capability Plan (DCP), which is a central element of *Defence 2000*, the defence white paper. The DCP consolidates the itemised proposals for new equipment, military skills and service life support to enable the development of the capabilities of the Australian Defence Force (ADF). The accusation (denied by the Opposition) was that they intended to build two more Collins class submarines, not included within the tight financial allocations of the DCP.

Enhancing the operational capabilities of that class was one of the programs endorsed by the white paper. Yet, in the middle of 2001, the Minister took a decision (directed by issues of the ANZUS alliance with the USA) which, nevertheless, delayed aspects of that enhancement for at least a year. It also set the Government a new task of managing a range of technological risks of the type that the enhancement program was designed to overcome. Controversies over the submarines will persist until the elections later in 2001 and beyond.

Since its inception, the new submarine program has been a source of controversy. Along with the deployment of ADF units to East Timor it has been a major reason for refocussing government and popular attention on defence. During 1997 and 1998 a succession of leaked stories alleging defects in the performance of the submarines displayed extraordinary ill-discipline (probably associated with disputes over the division of future funding) in the Navy.[1] These leaks went close to compromising national security[2] and, together with others concerning East Timor, forced the Department of Defence (hereafter Defence) to reorganise its internal security operations.[3]

Later, the Minister, reportedly dissatisfied with Departmental advice, commissioned an external review of the program by Malcolm McIntosh and John Prescott. Their critical findings foreshadowed significant reorganisation of that part of Defence responsible for equipment acquisition and was said to have played a role in the removal the (then) Secretary of the Department.

A part of the McIntosh/Prescott report condemned the capacity of the submarines saying, 'the circumstances would have to be extremely serious indeed to risk the submarines in their present state'.[4] Yet a few months later the submarine accompanied the United Nations (UN) forces to East Timor, as a precaution against the possible Indonesian deployment of one of its submarines. In October one of them has been reported as secretly landing

clearance divers in the enclave of Oecussi to prepare the way for the entrance of INTERFET peacekeepers.[5]

It seems that little about the Collins submarine is not shrouded in controversy This paper contends that none of the stereotypes of the popular debate are particularly relevant to the significant defence policy issues that the program raises. Neither does it see the answer to future Defence procurement problems in the institutional and management reforms suggested by McIntosh/Prescott. Their report focused on correctives for the then state of the program and asserted that nothing could be gained by examining its past. On the contrary, nothing will be done to avoid a recurrence of similar problems in future major defence procurement programs unless the past of the Collins program is examined.

In fact, the RAN has told us why the program came into difficulties—it attempted to develop a unique and highly sophisticated design without first building a prototype. To asses the validity of this argument, the paper discusses the development of the Collins program and assesses its performance.

The paper argues that, like most major construction programs, the future course of major defence equipment purchases is determined in the first few per cent of program life and before enough money has been spent to attract the attention of either auditors or the public. It notes that recent changes to Defence procurement procedures by the Government suggest that it has observed this lesson. However, Parliamentary scrutiny and public accountability lag, with no mechanism for the early investigation of Defence equipment programs. Meanwhile, strong evidence suggests that poor acquisition development by Defence remains a risk, not only for the viability of certain programs but of sufficient potential to threaten the Defence Capability Plan if not contained.

The first section of this paper relies heavily upon an analysis of the events that occurred during the early development of the Collins submarine program. These are necessarily discussed briefly. A more detailed history of the program up to the selection of the Kockums design is provided in a companion paper, *Procuring Change: How Kockums was Selected for the Collins Class Submarine*, Research Paper no. 4, 2001–02 of the Australian Parliament's Information and Research Services.

A caveat applies to this paper. It is based on published, or publicly available sources only, and many of these reflect the vested interests of those involved in some way in the program. Attempts can be made to adjust for possible distortions by cross-referencing sources where possible but a fully verifiable analysis of the Collins submarine program will be possible only after the release of classified information, sometime in the future.

Background

Early Days

The Royal Australian Navy (RAN) was not an early champion of the submarine. This was notwithstanding some heroic actions by Australian submarines in the early years of the First World War, in which the RAN's two boats were lost. During the Second World War a major allied submarine base had been established at Fremantle but the RAN operated no submarines in that conflict having, briefly, only an impounded ex-Netherlands East Indies boat which was restricted (even more briefly) to training activities. After the Second World War, the only submarines based in Australia were two Royal Navy (RN) boats, deployed on rotation. Their role was to assist the training of Australian anti-submarine warfare forces. However, in the 1960s Great Britain was less willing to support such deployments and the RAN decided to buy two British Oberon class submarines to replace the RN boats. Two additional Oberons were ordered shortly afterward, all four procured to support the training of anti-submarine forces.

By the time that a fifth and sixth Oberon had joined the RAN in the late 1970s the Service had begun developing doctrine for the use of its submarines as an offensive component of maritime strategy. All Australian submariners were being trained overseas (most in Great Britain) and therefore were exposed to the tactics and doctrine of Cold War submarine operations. However, the sensors, combat systems and weapons that equipped the Australian boats were not of the same ilk as those available to the major Cold War adversaries.

Experience With the Oberon Submarines

The experience gathered during the 1970s by the RAN's submarine arm led to the development of proposals that were to give the Oberons a fully contemporary combat capability. The Submarine Weapons Update Program (SWUP) replaced the boats' sonars and combat data system with new sensors and an Australian developed fire control system. The increased sophistication of data acquisition and handling provided through the SWUP allowed the RAN to rearm its boats with the MK48 torpedo and, later, an under-water-launched version of the Harpoon anti-ship missile.

These were the same major weapons as available to contemporary USN nuclear powered attack submarines. To the RAN's submariners, the successful completion of the SWUP seemed to have taken them through five generations of technology in a single step.[6] Their confidence was confirmed by the boat's performance in exercises, most objectively in those with other navies. One example was during the RIMPAC 98 international naval exercise program off Hawaii. During these, HMAS *Onslow* penetrated the USN defensive screen and 'sank' the nuclear powered aircraft carrier USS *Carl Vinson.*[7]

The High Cost and Limitations of the Oberons

However, by the early 1980s the Oberon submarine was a comparatively old design and suffered a number of deficiencies. Chief among these was that it was very expensive to maintain. Because of the arduous nature of the underwater environment and the absolute importance of safety, a complete refit of each submarine was required after five years service. This required stripping the hull of equipment and refurbishing each individual component before reassembly. In the early 1980s this operation swallowed 1.25 million[8] labour hours and took two years to complete. The cost, at $40 million, was some four times the cost of HMAS *Oxley* (the first of the RAN's Oberons) when commissioned in 1967.

Even lesser repairs could be lengthy and costly. Because the RAN did not have the full builder's documentation for the boats in some areas, it was not uncommon for faulty components to be examined in situ before appropriate repairs could be determined.[9] Even so, the RAN was dependent on overseas suppliers for some 85 to 90 per cent of the support for the Oberons.[10]

Importantly, the ageing design of the Oberons limited their ability to utilise the updated weapons to the full.[11] It took longer to recharge its batteries than more modern designs and thereby was more vulnerable to detection of components exposed above the surface. In naval parlance the frequency with which a conventional submarine must approach the surface to recharge its batteries is known as its 'indiscretion rate'. This determines the time a submarine can hunt for targets before retreating to safer waters to recharge its batteries. The Oberons' crew of 63 was, by contemporary standards, comparatively large. This by itself was a problem when recruitment to the submarine branch proved difficult. More importantly, it was a factor which restricted the boats' endurance and indiscretion rate when on operations due to the demands of crew numbers on the submarines' environmental systems (air, water and so on) and stores.

Why the Collins Turned Out as it Did: Trends Set During Early Development

With the Collins submarine program, actions that represented a solution to then current problems were later to become the source of newly developing problems. In this sense, the origins of later problems with the submarines lay in the program's very beginnings. This section discusses the crucial early decisions that were significant in laying the basis for both the achievements and shortcomings of the program. A more detailed history of the selection of the Collins class as the RAN's new submarines, 'Procuring Change: How Kockums was Selected for the Collins Class Submarine', *Research Paper*, no. 4, Department of the Parliamentary Library, Information and Research Services, September 2001 is available. It provides a chronological overview and background to the judgements made in this section.

Complex project management is seldom done well. Research by an international management consultancy firm, involving some 3000 protects, found that only 10 per cent performed better than expected and around 50 per cent failed to achieve their objectives.[12] A little understood characteristic of project management is that a focus on the production and delivery phases of equipment programs misses the crucial aspects governing success. Experience indicates that 90 per cent of the discretionary decisions that affect the outcome of a project are made in the first 7 to 12 per cent of its life.[13] This was no different with the development of the Collins class submarines. In reality, before the contract to develop and build the submarines was awarded to Kockums, the future of the program was largely decided.

The Dominating Influence of the Decision to Build in Australia

One of the decisions most crucial in the outcome of the Collins submarine program was that to build it in Australia. This was an objective of the program as it first emerged in the context of the 1981–82 Budget and was pursued throughout the program's life. A major RAN objective for any new submarine was to reduce the cost of operating the boats. It had rudely discovered the cost of submarine ownership early in its operation of the Oberons, when the refit of the first submarine cost 76 per cent of its purchase price.[14] In planning for its new boats, Navy had concluded that the lifetime operational costs (over about 25 years) of any new submarine would be approximately 250 per cent of its purchase price.

The RAN had already decided that local refit and maintenance of submarines as had been done with the Oberons (rather than sending them back to an overseas builder), was required if the Service's submarine warfare potential was to remain fully credible, since adequate support demonstrated the naval viability of its submarines.[15] However, starting as a new operator of Oberon submarines, the RAN was handicapped with insufficient intellectual property and local component manufacture to allow efficient support to be achieved.

Analysis of the requirements to support effective submarine operations showed that a high proportion of the initial capital costs of any new program would have to be allocated to this area, integrated logistics support. Expenditure for this purpose was calculated to constitute about 25 to 30 per cent of the total capital cost of the program.[16]

Most integrated logistics support was better supplied from local sources than purchased overseas. Operating the submarines successfully required this high degree of initial investment and an ongoing level of specialised industrial capacity. It seemed to Navy's planners that substantial advantages could be achieved through having the boats both built and maintained by the same organisation.[17] As the boats were to be maintained in Australia they would, therefore, have to be built here. Local construction would also provide the additional benefits of new technologies transferred to Australian industry and the broadening of the nation's economic base.[18]

Bi-Partisan Political Support

Navy's position received political support from the earliest moments of the project. To gauge the possibilities for Australian industrial participation in the project, the then Minister for Defence Support organised a briefing session for Australian companies. This occurred on 1 March 1983, with personnel from more than 100 Australian companies attending. At this stage was hoped that more than 50 per cent of the value of the project would be supplied by Australian industry.[19] For the times, when a 30 per cent participation by local industry in a defence procurement project was considered outstanding, this was an ambitious target.

Following further work with industry, the production element of the program's procurement strategy became the construction of the first vessel overseas with the remaining five built in Australia. Later, in May 1985, when Cabinet approved the selection of the two companies left in the running to develop the design, the Government was willing to pay the additional $30 to $40 million required to build the first submarine in Australia in return for the perceived industrial benefits.[20]

It was not only the Commonwealth which supported strongly local submarine construction. State Governments were so anxious to have the construction site located within their boundaries that they established offices within their bureaucracies with the sole task of securing the program. One Premier, John Bannon of South Australia, went to the extent of having himself winched from a helicopter onto the deck of a submarine. The reason for such activity was that, by 1982, Australia was in a severe recession which was particularly damaging to the older manufacturing regions of Victoria and South Australia. The new submarine project was seen not only as a source of employment and a supplement for lost revenue, but as an opportunity to inject new technology which might revitalises the industrial base of the State fortunate enough to host the project.

Consequences

There were two significant consequences of the decision to build the new submarines in Australia. The first affected the terms and conditions under which the submarine was to be built, the second influenced the criteria on which the successful design would be selected.

The Contract a Result of the 1980s Procurement Environment

Major procurement projects usually do not escape the management environment of the period in which they occur.[21] The contract developed by Navy for the procurement of its new submarines was certainly no exception. The fixed-price contract under which the Collins class submarines were bought was largely the scapegoat on which the Macintosh/Prescott Report placed the problems of the procurement program. In retrospect, they saw it as being too inflexible and enshrining an inherent conflict between builder and

customer. However it is unlikely that the program would have proceeded if the fixed-price approach had not been adopted.

The Influence of a Succession of Disasters

At the time of the development of the new submarine project the performance of defence procurement in Australia had consistently approached the disastrous. The 1975–83 Coalition Government had approved a number of locally sourced defence equipment programs. These included the local design and development of a class of minehunter vessels, construction of two American designed FFG-7 frigates and the building of a naval tanker/support vessel of French design. For the RAAF it approved the design and construction in Australia of the Service's next generation of training aircraft.

None of these projects was to prove satisfactory. The minehunters failed to perform to expectations and the program was later cancelled with only two built. The inadequacies of the FFG program prompted studies of restructuring options for the Government-owned dockyards in which they were being built. The support vessel was delivered three years late and at three times the cost of building her in a French yard. The aircraft project was to be cancelled before it had flown.

Fixed-price Contracting as an Apparent Solution

In these circumstances it is not surprising that the RAN sought a completely different approach to building defence equipment in Australia. At the time, the fixed-price structure eventually preferred for the contract seemed the best approach to avoid the then current problems of defence procurement. That the terms and conditions of the contract eventually would come to be held sacrosanct, and obstruct Navy and the shipbuilder from negotiating sensible changes indicated by experience, would later prove significant. However, this was not the problem that seized the attention of program managers in the 1980s. It was not surprising that their favoured solution, in seeking to demonstrate to government that pressing current problems could be avoided, should have given perhaps too little consideration to mechanisms for modifying contractual agreements. These became an issue much later, when correction of production defects became a problem. The nature of the fixed-price contract was not simply due to poor contract definition but to the need to find a credible way of implementing the agreement of all parties, that local production was central to the procurement strategy for the new submarines.

Industrial Credibility as a Selection Imperative

Deciding to build the submarines in Australia had profound consequences for the criteria used to select the winning tenderer. Companies responding to the Request for Proposals were required to provide detailed proposals for the involvement of Australian industry.

This was probably the earliest stage in the evaluation of major defence equipment at which industrial proposals from overseas suppliers had been considered. It is difficult to identify a major ADF capability before the Collins where the short list of the preferred tenderers for final selection of equipment was determined with such reference to factors additional to those of military performance.

A Search for a Break from the Past

Obviously, having a contractor tied to fixed-price conditions would be of little use if the builder lacked the competence to deliver. Further, the test of competence was to be more severe than usual because of the circumstances of the time. Until then, the RAN's usual experience in buying major warships was to build them in its own yards or to buy them overseas. Most of the existing Australian shipyards that were large enough to build submarines suffered from inefficiencies caused by poor industrial relations, under-utilised capacity, antiquated equipment or a combination of each.[22] Hence the favoured approach to implement local construction was to establish a 'green fields' yard, a new building facility in a new location or on the site of a disbanded shipyard, made the more possible by the perception at that time of limited similarity between conventional shipbuilding and submarine construction. Consequently, the company which was to be selected to provide the submarines was seen as needing to be less of a traditional shipbuilder and more of a project manager.

These considerations were made explicit by Commodore Oscar Hughes when he was appointed to lead the new submarine project in 1987. He stated that the eventual winner of the contest would be the group with the best balance of 'capability, industrial involvement and cost'.[23]

Lobbying in Favour of Industrial Capability

Risk in a contractor's capacity to transfer construction to Australian industry equated to risk of embarrassment to the governments strongly identified with Australian production of the submarines. With the extensive involvement of State Governments, lobbying for their participation in the program, there was unprecedented pressure emphasising industrial outcomes in the final selection of the submarines. Nor did the States merely advance their claims for the siting of the construction facility. The South Australian submarine task force was particularly active, sending study teams overseas and reporting to the (then) Department of Defence Support.[24] They argued that Kockums' modular construction techniques were five years ahead of the other European builders,[25] principally because of their integrated use of CAD/CAM (computerised design) techniques in project management of modular construction techniques. The South Australians noted that none of the other contenders were, at the time, fully operational in these.[26]

It appears that some of the competitors for the submarine contract, particularly the more traditional builders, were not ready for this change in emphasis. A consequence is that a design offering superior performance but with poor industrial credibility may have been rejected in the early stages of the new submarine selection. It was certainly the case of the latter of two French bids, offering a nuclear powered boat. This is not to argue that the performance of the Collins submarines does not meet Australia's requirements (indeed the opposite is suggested below). Perhaps some of the problems that were later to affect the design, such as underwater noise at high-speed, might have been avoided more easily by another designer. That, however, was not the sole objective of the program. The subsequent cost of modifying the hull to overcome this problem might be seen as one of the likely consequences (and one acceptable in context) of the fundamental strategy of building submarines in Australia.

Combat Data System

Of the early decisions in the Collins program, the one which was to have the most public effect was that concerning the nature of the vessels' Combat Data System (CDS). It has been the subsequent failure of this system to meet its design requirements that has left the submarines with a severely impaired combat capability. The design of the Collins CDS has been described as dated and inflexible and the management of its software development process has been criticised. Yet the concept for the CDS was developed to avoid such problems. It was a decision mandating the architecture of the future system, made very early in the life of the program, rather than the subsequent management of its development that proved to be the source of subsequent difficulties.

Origins of the CDS Concept

One of the fundamental early decisions made by Navy was that the CDS would be developed separately and supplied under a different contract from that covering construction of the submarines. By the end of 1982, it had decided that the electronic combat systems of the new boats would be fully integrated. Instead of the then standard central computer performing all data analysis, the new submarine CDS would use a data bus to distribute information to a number of smaller computer work stations. Each of these would be capable of acquiring and processing information from whichever of the submarine's sensors was relevant to the current task. This philosophy of distributed processing was expected to improve operational effectiveness and to reduce the lifetime maintenance costs. The latter would result from eliminating the need to cut open the submarines during modernisation programs to remove a bulky mainframe computer, with the system being upgraded instead by substituting new software.[27]

In January 1983, in what was in fact the first step to involve industry with the project, Navy took advertisements calling for registration of interest from suppliers of 'modern integrated combat systems'.[28] By going down this path, instead of holding open the option

of evaluating the best system deployed in a submarine, the CDS itself became a factor in the selection of the new boats. The design of the new submarine would have to be capable of accommodating the independently developed CDS. As experience was soon to prove, few were.

Difficulties in Selecting a Supplier

It was the development of the CDS which also provided the first signs of problems. Despite receiving responses from 5 consortia, no proposal would meet easily the requirements developed by Navy. The most favoured proposal used technology developed for Royal Navy nuclear powered submarines. Not surprisingly, it was reported as costing more than program financial calculations had allowed—to the extent that it would consume approximately 60 per cent of the total project cost, rather than the 40 per cent which had been allocated.[29]

Navy eventually chose a consortium led by the American company Rockwell to develop the CDS. This company had earlier been selected to provide the combat avionics system for the RAN's Seahawk helicopters. The Seahawk system also used a distributed architecture experience with which, it was expected, would assist the development of the Collins system. Rockwell had been one of two companies in final contention for the CDS, along with the Dutch company HSA.

Kockums, the submarine constructor, was more familiar with the latter company and preferred it to be the subcontractor to provide the CDS. Navy however stuck to its strategy and awarded the CDS to Rockwell. In September 1993, when Rockwell's inability to produce a satisfactory system had become a significant risk to the viability of the program, ASC was prevented from placing it in default of its contract and effectively lost control of the CDS sub-contract.[30] Defence lost an opportunity to review the procurement strategy for the CDS and persevered long beyond the sensible to preserve a program which had clearly failed.

Early Assumptions and Subsequent Failure

The RAN was not alone in its 'grand folly'. When building the submarines in Australia first had been suggested, most doubt over the proposal's feasibility had centred on the heavy engineering requirements. The Australian information technology (IT) industry assured the RAN of both the feasibility and inherent advantages of a fully integrated combat system and of its ability to contribute to such a program.[31] Perhaps over confident as a result of the success of its SWUP program, Navy rated the development of the CDS as being of low risk. More concern was felt at the risk involved in the engineering aspects of the program and some other areas of IT, such as the automated submarine control system. It appears that Rockwell itself did not consider the development of a fully integrated combat system as a task it might fail. In the early 1990s it appears to have devoted some

effort in promoting the CDS as a means of upgrading existing conventional submarines, particularly the Russian-built Kilo class.

Moreover, the RAN was not the only navy to think that the future of combat data processing lay with fully integrated systems. The USN specified the same concept for its BSY-1 Integrated Combat System for the US Navy's Seawolf class nuclear attack submarines. This was an even more costly failure than the Collins CDS, absorbing US$1.5 billion before it was cancelled,[32] with the US Service developing remediative adjustments in the late 1990s. These were latter to prove helpful in providing the equipment that allowed an interim system to be installed in HMA Ships *Dechaineux* and *Sheean*. Yet it remains a mystery why the RAN, able to call on the USN in the late 1990s for help, did not monitor progress with the BSY-1 and draw a parallel between American experience and that of the Collins' CDS, which was clearly replicating the former. Instead, Navy sought to preserve this part of its procurement strategy when clear evidence suggested it had failed.

The Critical Point—Failing to Change the Procurement Strategy

Navy's stubborn persistence with the CDS was the more surprising because, in the central area of the program, it quickly abandoned its approach to the development of the program's submarine platform component. At about two years into the life of the program, Navy changed the basis for evaluating the suitability of possible submarine designs.

Original Low Risk Approach

Recognising that the priority given to building the submarines in Australia entailed a high degree of risk, Navy sought to manage risk in the program as a whole by reducing that associated with the design of the submarine and its technologies. When Request for Tender (RFT) documents were issued to industry in May 1983, the requirements for the new submarine emphasised tried and proven designs. Navy stipulated that the selected design should be one already in-service or intended to be in-service by 1986. This would have minimised risk as sea trials would be under way in the parent navy. As a minimum, any designs submitted should be a derivative of submarines with an already proven service performance. Any modification to meet RAN requirements were to be of low risk and cost.[33] There were, in addition, some suggestions that experience of constructing submarines in foreign countries might confer an advantage in comparing bids.

Opting for the Ideal Rather Than the Available

However, the RAN was in no way simply seeking to find the best available design. Issued with the RFT was a comprehensive list of specifications detailing the performance the RAN wanted from its new submarine. These reflected the expectations of Navy that it

should be capable of considerable improvements over the Oberon class. Thus, Navy hoped that (then) established submarine design had advanced considerably.

When the responses of the competing companies were submitted by the end of 1983 it was apparent that the two objectives of proven design and advanced technology were in conflict. No existing design could meet the RAN's expectations.[34] All were too small to meet the specifications, including that they be able to accommodate the independently developed CDS. For the same reason, they were probably unable to provide sufficient engine compartment space and battery storage to allow significant improvements in submerged endurance and indiscretion ratio. The main reason for this was that European boats were designed to sustain a deployment to a distance of about two-thirds that required by the RAN.[35]

At this point Navy made the crucial decision of the Collins class program. Instead of persisting with its procurement strategy and choosing the best available combination of design, industrial package and cost, Navy chose to proceed with developing a boat which more closely matched its ideal specifications.

Cost Escalation and Program Delay

This involved a delay of more than a year[36] and greatly increased the overall cost of the program. At the end of this period of recasting the project's nature, from the end of 1983 until May 1985 when the two contractors to compete for the final design were announced, costs grew by around 73 per cent over those expected when responses were first sought from industry. This was the period of greatest proportional cost growth during the history of the program and also confirmed a reduction in the number of boats it would purchase.

Collins Submarine Program—Changes in Cost and Program Size

First concepts, late 1982	1983, prior to feedback from industry	May 1985, selection of short list	May 1987, selection of the winning tender	December 1999
A 10 boat program at over $100 million each	4 to 8 boats $1.5 billion	6 boats $2.6 billion	6 boats $3.9 billion (June 1986 prices)	6 boats $5.1 billion

Source: *Procuring Change: How Kockums was Selected for the Collins Class Submarine*. Prices are at then current levels, unless specified otherwise.

Coincident with the cost escalation was an increase in risk across all segments of the program. This simply increased the probability that, at sometime, some of section of the program would not proceed as expected. Yet, despite these significant changes, Navy did not alter its procurement strategy. In retrospect, at this point it would have been appropriate to implement what Navy now recognises should have been done, and decide to

build the first boat as a prototype that could have been used as a test bed to eliminate the almost inevitable failures.

Failure to Acknowledge Higher Risk

By the end of 1984 reports of concern about the cost and risks of the program were emerging from the Russell Headquarters of Defence. The then incoming Minister, Kim Beazley, ordered an internal review of the project. This eventually reconfirmed the new direction of the program, apparently on the predictable arguments of operational and strategic requirements.[37] From what has been reported, the thrust of arguments against the emerging redirection of the Collins program appear to have centred on reasons for returning to the smaller and cheaper existing submarine designs. We do not know whether Defence considered, once the strength of Navy's operational and strategic reasoning prevailed, if a concomitant change in procurement strategy was inevitable.[38]

Whatever the reasons for failing to change the procurement strategy,[39] the impact on the program was to be profound. Navy now had a program, endorsed by Defence, with high risk factors in almost every facet of its development. In essence, they had opted to develop a Holden amongst submarines, a design uniquely suited to Australian conditions and with much promise, but carrying much more risk than the more limited but proven off-the-shelf designs. The need to achieve greater performance in certain areas to improve the usefulness of the submarines may have justified this decision. However, the failure to understand or to communicate its implications had the most profound influence on the development of the new submarines and for the Service became the root of both subsequent problems and much public grief.

Achievements and Problems: Pointers to Decision Making?

Over the years of contentious debate about the Collins class submarines there have been many suggestions as to what has gone wrong with the program. This section looks at various aspects of the procurement program to judge whether these contributed to the problems subsequently encountered when the boats were introduced into service.

A Significant Achievement: Building the Submarines in Australia

One argument about the Collins submarine program is that it was a mistake to build the boats in Australia and that it would have been preferable to build them overseas. This paper has already demonstrated that there was little interest in building the boats other than in Australia. It has also been suggested that this decision had significant consequences for the outcome of the program. However, building in Australia was not a factor that handicapped the program.

Performance of World Standard

Firstly, it must be understood that submarine construction is an extremely complex and difficult business. Even yards which have been building submarines for decades cannot produce perfect product at all times. An example of this is the recent withdrawal from service of all 12 RN Swiftsure and Trafalgar class nuclear attack submarines because of problems in the their nuclear reactor cooling systems.[40] The Collins submarines were, in fact, delivered to the RAN more efficiently than the last of the Australian Oberons, which were built in United Kingdom (UK) yards with considerable experience of the task. This Oberon was delayed for several years after the builder fitted cabling incorrectly. Contract liability required its complete removal and recabling.

The Australian Submarine Corporation (ASC) site at Outer Harbour in South Australia was established in 1989 at a cost of $100 million.[41] Since then it has produced all submarines without a major mishap and worked up to a capacity for delivering one submarine per year. This is a faster rate than was achieved by the Dutch and British yards in delivering their boats that were contenders for the Collins class program.[42] Of the transplanted submarine building programs, only the South Korean Chang Bogo, an HDW Type 1200 design barely one third the size of the Collins, is able to match this rate of production. This would tend to suggest that the evaluation of Kockums' production methods made early in the project was correct and that the Swedes proved capable of transplanting them to Australia.

Unusually High Self Reliance

The Collins class program was unique in building all the boats in Australia and almost all from scratch. All other programs to transfer construction of a submarine design to a second country have involved building at least the first and usually more, at the designer's yard. The majority have made heavy use of sub-assemblies of prefabricated components which continue to be produced in the designer's yard. For the Collins program only the bow section of the first boat was manufactured in Sweden. This in fact, told the tale of the quality of Australian production, since this section was shown to have an unacceptable number of welding defects which appeared nowhere else in the program. In order to assure HMAS *Collins'* longer term serviceability, these were repaired by Australian welders at the ASC plant during a subsequent maintenance cycle for the submarine.

Fostering Australian Industrial Expertise

The program has also contributed to improving the quality of Australian manufacturing on a national scale. The ASC's Adelaide facility is an assembly yard, building submarines from components provided from across Australia. When the submarine project began there were only 35 Australian companies certified to the quality levels required for defence work. By 1998 there were 1500.[43] Not all of this can be credited to the submarine project

but, together with the contemporary ANZAC frigate and other programs, naval shipbuilding does appear to have provided for sections of Australian industry the modernising influence claimed by its proponents at the beginning of the submarine program in the early 1980s.

In the process of building the Collins class, ASC has successfully integrated many areas of technology which are equal to, or better than, that existing elsewhere. One of the areas originally thought to be of highest risk, the automated submarine management system has met requirements, leading the RAN to claim the Collins as the 'world's first "fly by wire" submarines'.[44] This system is in advance of any used on American nuclear submarines and has won praise from that Service. The American and British navies refused to share details of the anechoic tiles (of rubberised, sound absorbing material, glued the outside of the hull) used by their submarines to help reduce the effectiveness of active sonar surveillance systems. Accordingly, the Defence Science and Technology Organisation (DSTO) then developed tiles for the Collins which exceed the performance of those used by the northern hemisphere navies.

Finally, it cannot be thought insignificant to exceed the goals originally set for local content of the new submarine project. Seventy per cent of the value of physical work and 45 per cent of its electronics was performed in Australia. Thus, of the $5.1 billion cost of the original program, $4 billion was spent in Australia.[45] At its peak, the project supported 7500 jobs in Australia.[46]

Some Disasters Avoided: How the Other Competitors Fared

One of the ironies of the Collins program is that pursuing the original procurement strategy would not have resulted necessarily in more positive assistance for submarine production in Australia. None of the other contenders had trouble-free programs and their subsequent history reinforces the conclusion that Kockums was the right builder to select at the time.

The lead boat of the Dutch submarine design, Walrus, was launched at the end of 1985 but caught fire the following year whilst being fitted out by the shipbuilder. All her internal fittings and cabling were destroyed and completion of the Walrus was delayed for three years. The British Type 2400 suffered a three year delay, largely due to faulty torpedo tube hatches and safety concerns with the power plant.[47] During early evaluation of the Collins program the Type 2400 had been promoted on the grounds that its operation by the RN would benefit the RAN through access to continuing in-service development. However, in 1994 the British Government scrapped the Type 2400s to save money. They were eventually purchased by Canada, which has removed the British weapons control system and is retrofitting those from the Canadian Oberons which the Type 2400 is replacing.[48]

Two of the Thyssen TR 1700 class were built for Argentina in the contractor's German yard and kits for four more were shipped to Argentina. Twelve years after the

commissioning of the first submarine, the first Argentinian built boat was only 52 per cent complete. The yard was then sold, work on the submarines abandoned and the parts retained for spares.[49]

Not even HDW, with the most extensive record of overseas sales and production programs can guarantee success all the time. Part of HDW's credentials in bidding for the Collins program was that it had signed an order (in December 1981) to supply four submarines to the Indian navy, two them to be built in India. In the event, these two submarines were delivered five and six years late, cost twice as much as the two built in Germany and were the subject of disputes about the adequacy of technical support from HDW and the costs of spare parts and support packages.[50] Proposals to build a further two HDW submarines in India were never pursued, India instead turning to the purchase of the Russian-built Kilo (despite subsequently assessing them as inferior in performance to the HDW submarines[51]) as the means of developing its submarine capabilities.

Past Glory; Present Problem?

Whilst the building of the submarines in Australia is a demonstrable success, it is yet to be seen if that process will achieve its policy objectives. That is, whether having built the submarines in Australia will prove to be an effective basis for supporting them throughout their service lives.

The Threat of Declining Workload

If anything, ASC's productivity has proved painful. With a program of finite length and no major construction work to replace it, continued employment of the highly skilled workforce (as relevant to the ongoing support of the submarines as to their construction) is difficult. By May 1999, at the launch of the fifth boat, *Sheean*, ASC projected that its 1000 strong workforce would be cut to 500 by the end of the year. With production drawing to an end, the viability of ASC depended on securing contracts for the first cyclic refit of each submarine. Scheduled for every six years of the submarines' lives, the first of these, for HMAS *Collins*, was due in 2001 and would be worth around $100 million.[52]

This approach was placed in doubt several weeks later when the McIntosh/Prescott report suggested that all support work associated with the submarines, including the refits, should be done in Perth.[53] ASC's response was that such an approach would lead to the yard closing in two years, when the construction program was expected to be completed.[54] In the event, work to correct the defects of the class was given priority over the sixth submarine, which was delayed till late 2001. In the meantime, however, the prospect of building two more submarines, which had persisted in the program as a continuously delayed option, was finally scotched. The Government's white paper did not support the development of a new variant of the submarine that had been in the Department's planning cycle.[55]

The Government Decides to Award Ongoing Refit Work

Since all the RAN's submarines are based in Western Australia, logic suggests Perth should be the site for depot level maintenance. Navy has adopted this position, which involves placing about $40 million of work a year in that area.[56] The cyclic refit of the submarines, however, is another matter. This involves a complete removal and reassembling of the components inside the submarine. As such, it is a difficult and potentially costly exercise for which, in most cases, the yard which built the submarines should be best placed.

This, in any case, is the logic which appears to have won against the advice in the McIntosh/Prescott report. In letters to the Premiers of South and Western Australia in July 2001, the Prime Minister confirmed that the Government considered ASC best placed to carry out major maintenance of the submarines, including 'full-cycle refits'.[57] Assuming the that ASC continues to perform the work satisfactorily, this decision should generate revenues for the company worth about $100 million per year over the life of the boats and allow it to maintain its expertise.

A Future with the US?

In the two years between the suggestion that cyclic refits might be performed in Perth and the Government's decision otherwise, the structure of ASC has changed dramatically. By mid-2001, the Government was the sole owner of ASC and was holding it for future sale, preferably as a catalyst in the rationalisation of the Australian defence shipbuilding industry.[58] Awarding the submarine refits to ASC provides a cash flow that will help that objective. However, the Government's handling of ASC ownership over the last two years has made access to intellectual capital the central issue concerning the long-term support of the submarines.

The Buy Out of Kockums

For some time, the Government had been considering ways of selling its 48.5 per cent share in ASC (held through the Australian Industry Development Corporation). The McIntosh/Prescott report commented on the Government's potential conflict of interest as both customer and part owner of the contractor.[59] The ongoing problem was the Government's preoccupation with the sale of Australian Defence Industries, which it wholly owned and the decline of ASC's market value as its major income stream reduced. Then in September 1999, in a complex reshuffle of northern European corporations, Kockums was merged with HDW. Although HDW's immediate concern was to buy up Kockums' 49 per cent shareholding in ASC,[60] the Government exercised a contractual option and assumed full control of ASC in November 2000. A price was not mentioned at the time but, shortly before, HDW had been negotiating at about $50 million for the sale of its ASC share holding.[61]

Throughout the 14 months before the Government purchased ASC, the Minister often asserted that the primary objective of any future arrangements at ASC was to ensure the rectification of the submarines' faults and the best option for their long-term support. This remains the objective for what is now the intended sale of the company. However two years after Kockums, the design authority, changed hands the future of ASC remains unclear.

The American Option

All that can be said with confidence is that, although the Australian building site remains a part of this structure, the European design authority is not. The task force that in 2000 worked on future structure options for ASC was asked to seek ways of involving both European and American companies. However, an increasing range of reports has identified the US company Electric Boat as the likely source of the submarine expertise in a privatised ASC, with some claims that it is expected to buy a share of up to 40 per cent.[62] It is not clear how this position arose but a combination of ongoing conflict between Navy and Kockums and a preoccupation with USN assistance in rectifying the submarines' problems, may have contributed.[63]

Risks in the Tension Between US and European Suppliers

Whatever the reasons, there is a significant risk in this approach to the sale of ASC. This is, simply, that Americans do not build conventional submarines. The issue is probably not so much whether an ASC relying on American expertise might find it difficult to manage cyclic refits. More important is that the Americans have no technology base in conventional submarines and no research into leading-edge technologies, such as Air Independent Propulsion. They will be limited in their approach to upgrading the submarines over the remaining 25 years of their operational lives.

The RAN appears to recognise the risk in this situation. In early 2001 relations between Kockums and the RAN were strained after the RAN had shipped one of the company's propellers to the USA. Commodore Paul Greenfield, Director General of Submarines, acknowledged that Kockums, as the designer, had a very important role in the future support of the submarines and hoped that the formerly strong relationship between Navy and Kockums could be restored.[64] The problem is that European submarine designers might be as wary of entering arrangements that include an American company[65] as American officials have been enthusiastic in urging the exclusion of Europeans from aspects of the Collins program (see below, 'Back to Square One—Replacement Program Abandoned').

Does Australian Have Access to Sufficient Intellectual Capital?

Whatever the discussions between the parties, there is an appearance that the Commonwealth does not have access as yet to sufficient intellectual property rights to ensure that ASC can be effective. McIntosh and Prescott argued that the contract for the submarines ought to cover all necessary intellectual property rights to cover ongoing support requirements.[66] Yet in early 2000, when the then Minister appointed John Prescott to provide advice on options for the future of the company, he included the issue of continuing access to intellectual property throughout the operational lives of the submarines.[67] By year's end, when the Commonwealth announced its outright purchase of ASC, one of the strategic factors still to be addressed was securing 'access to necessary technologies'.[68] Six months later, the current Minister said that among the issues still being worked through were legal issues such as intellectual property and the design authority.[69]

Until a resolution can be achieved which provides ASC with the intellectual capital it needs, both to maintain the submarines and to upgrade them as might be required by changing strategic circumstances, the ultimate viability of the strategy to build them in Australia will remain unproven. Accessing appropriate intellectual property, maintaining the skills base and other aspects of the intellectual capital[70] ASC needs to be efficient, therefore, remains one of the risks to be overcome before the shipbuilding aspects of the program can be called a complete success.

Performance

The Collins Class are very large submarines by the standards of conventional boats. Displacing 3051 tons on the surface, they are the second largest class of conventional submarine built since the Second World War. Only the Japanese—who have been builders of large conventional submarines since the 1970s—come close to the Collins, with the Oashio class displacing 2700 tons.

The bulk of the Collins class submarines has been criticised for driving up the cost of the program (partly true since hull cost rises with displacement), largely due to the RAN's desire for a boat with considerable range. However, bulk is not necessary to achieve long range in submarine design. Thirty years ago, the Soviets were able to achieve a 20 000 mile range in their Foxtrot class and the Indian Shishumar, Italian Sauro and Pakistani Agosta B classes have more or less comparable range to the Collins on about half the displacement.

The Performance Advantages of Size

Rather than range, the bulk of the Collins design confers advantages for submarine operations which probably justify the boast that it is among the best performing conventional submarine platforms in the world. The crucial challenge in submarine design

is to provide sufficient volume to accommodate equipment, stores and weapons, living space for crew, machinery spaces for propulsion and as much volume for battery storage as possible. Greater displacement provides the basis for that. At one level adequate hull volume equates to endurance and that for the Collins' is more then adequate. Design endurance is 90 days, though a notional standard patrol is only 70 days, thus allowing a submarine to be deployed on station at 2500 nm for seven weeks.[71]

Range and Endurance

The volume can be used for fuel oil storage tanks (greater range—11 500 nm, surfaced for the Collins) or improved crew and systems accommodation (better performance of duties), but it can also be used for propulsion and batteries. The Collins class has sufficient installed power to make them, with a reported maximum speed of 24 kts,[72] among the fastest conventional submarines ever built. Maximum speed, however, is not usually a relevant performance measure for conventional submarines, as it quickly exhausts battery capacity.

In 1944 Germany perfected high performance conventional submarines by providing greatly increased battery space and adding the snorkel (basically, an air tube which extends above the water's surface) to allow them to be recharged whilst submerged. Since then, increasing battery storage has been one of the objectives of conventional submarine development.

Submerged Endurance and Indiscretion Ratio

Most importantly, sufficient volume for large electrical storage capacity allows a reduction in the submarine's indiscretion rate (for which, see 'Experience with the Oberon Submarines'). The necessary corollary to take full operational advantage of this is the capacity to recharge the batteries in an acceptable time. For this, large hull volume also helps, for it provides the space and ease of layout for large diesel engines and generator sets.

Collins uses generators rather than alternators and has a combined generation capacity of 4.2 megawatts. This gives it amongst the most impressive platform dynamic performance available, an important area of performance advantage over, for instance, the most commonly used Third World submarine, the Russian-built Kilo.[73] With four times the submerged endurance of the Oberons, a Collins can recharge its batteries in about one hour at a speed at which an Oberon would have little power reserve for electrical generation; in general, it can recharge its batteries almost four times faster than the Oberon class.[74]

The result of this combination is that the Collins is already close to the type of submerged performance that will only become available to other conventional submarines if radical

new Air Independent Propulsion (AIP) systems prove successful. Australia's DSTO tested two forms of AIP in the mid-1990s to assess the advantage they might give the new Australian submarines. On sea trials of HMAS *Collins*, the combination of large battery storage and high generator capacity was shown to allow the submarine to maintain an energy cycle under patrol conditions which required it to snort (running its engines whilst submerged, by use of a snorkel) for 'less than a few minutes' in every 24 hours:

> Sea trials of the first-of-class have proven that the Collins as it is now can stay submerged for such a long time, and have such a low rate of indiscretion, that a refit of an AIP system is not really needed and would simply not have any cost benefit.[75]

Accordingly, the Australian AIP project was dropped in mid-1996.

It is unlikely that a submarine mast exposed on the surface for only a few minutes will be detected in time to initiate an attack. Hence, a Collins submarine should be able to remain undetected within its patrol area for extended periods without having to withdraw to safer waters to recharge batteries. This not only enhances submarine operations but can over exert opposing forces by imposing higher rates of Anti-submarine Warfare (ASW) operations.

The Collins' high submerged endurance can be accessed throughout a deployment. In comparison, AIP systems are limited in practical operations by the comparatively limited volume of oxidant that can be carried. As well, being able to drop the AIP option saved the project the estimated refitting costs of $100 million.

Noise Control and Stealth

The Collins class are intrinsically quiet submarines. Equipment is isolated from the deck with vibration absorbing fittings and the whole deck assembly is similarly isolated from the hull. Consequently, noise caused by vibration radiating into the water is reduced to such low levels that early testing revealed the Collins to be quieter than background ocean noise,[76] a finding confirmed by more recent tests at a highly sensitive acoustic range in the US.[77]

The noise characteristics of a submarine can be further masked by operating at great depth, hopefully hiding beneath a 'thermal' layer, a mass of water with temperature, density or salinity characteristics different to the surrounding ocean is so that they disrupt the normal radiation of sound. With a diving capacity greater than 300 metres the Collins class is well equipped to make use of these tactics. The acoustic performance is further complemented by the use of Australian designed anechoic tiles, fixed to the external surface of a submarine to absorb some of the energy radiated by active sonar systems. Unlike the tiles used by British and American submarines, these do not often fall off.

The level of noise generated by a submarine varies with the mode in which it is operating. The very low levels of noise noted above are achieved in the 'patrol quiet' mode of

operations, where the submarine is 'crawling around' at 3–4 kts on battery power and the crew are observing strict noise control procedures. In other modes, different sources of noise are introduced. When the submarine is snorting, the vibration of its diesel engines creates considerable noise. When it is travelling at high-speed the flow of water over the hull and cavitation around the propeller creates a different source of noise. These latter two cases are dealt with below.

Impressing the Americans

It is the inherent stealthiness of the Collins class, due to its low noise signature in the patrol quiet mode, which has recently attracted international attention. During the RIMPAC Exercise off Hawaii in 2000 HMAS *Waller* 'sank' two USN nuclear attack submarines. It repeated the dose during Exercise Tandem Thrust off north Queensland in May 2001, 'sinking' two American amphibious assault ships in waters of between 70–80 metres depth, barely more than the length of the submarine itself.[78] The Collins class was a for the of described by Vice-Admiral James Metzger, Commander, US Seventh Fleet as 'a very capable and quiet submarine that would challenge any naval force in the world today.'[79] The Americans were also impressed by the Collins class' manoeuvrability, confirming claims made for the design during project evaluation,[80] and which had been said to exceed contracted requirements in practice.[81]

That these achievements were recorded by *Waller*, reinforces the claims for the inherently good stealth characteristics of the design. *Waller* is one of the class which has not yet been modified to overcome the shortcomings noted in the McIntosh/Prescott report. By exploiting these characteristics, *Waller* was able to perform well under exercise conditions and 'was able to operate in a way that did not expose her faults.'[82] This mode of operation was classical submarine warfare, covert patrolling of a designated area at 3–4 kts, until unwary adversaries strayed in her way.

What *Waller* could not do was demonstrate the unusual degree of mobility her propulsion system allows, because of noise generated by the hull. Nor could she demonstrate the ability to use long range anti-shipping weapons, because of the failure of the combat system.[83] In fact, *Waller* came close to being able to demonstrate very little in the exercise. In May the crew had to call for assistance from a Brisbane suburban IT repair company to fix 'scanners',[84] so that the submarine could continue its deployment to the exercise area. Nor was she herself invulnerable. *Waller* was detected and 'sunk' during Tandem Thrust, a reminder, at least, that submarines are no more invulnerable than any other weapon of war and that a great number of submariners have died in combat.

Problems, Deficiencies and Failures: Shortcomings in Performance

Against this, the Collins class suffers from a collection of publicised deficiencies sufficient for the RAN not to commission the boats as normal into full naval service. These were

enumerated in the Macintosh/Prescott Report.[85] Over their early years, the boats suffered from a constant stream of breakdowns, numbering in the hundreds per year[86] and of sufficient intensity to threaten the RAN's ability to maintain crew levels and, in the medium term, to maintain its submarine warfare expertise.[87] In mid-1999, the RAN's submarine arm had only 37 per cent of the number of qualified submariners it required. Although recent figures show a decided improvement in recruitment and the Navy now has 55 per cent of its complement, it will not be until 2006 that it will meet its personnel requirement.[88]

In general terms, the failures of the Collins class can be grouped under the heading of components, noise and the CDS. A common thread in these defects is their origin in the unique specifications set for the submarine by the RAN, often in areas where relatively standard and well proven equipment might have been thought adequate or where experience indicated significant risk.

To avoid being overly prescriptive, it should be noted that not all problems with the submarine conform to this simplified criteria. To be fair to the Service, defects appear to have originated with, or been exacerbated by, the attitude of various of the contractors. On the other hand, the attitude of some component vendors appears to have had a significantly beneficial impact on the outcome of the project. For instance, Schneider, the manufacturer of the electric motor, acknowledged problems with the motor in early trials and fixed these at its own cost.

Component Failures

Most of the components used in submarine building are made by specialists who produce a range of equipment to meet the requirements of different designs. Many problems with submarine performance are not issues of design but of poorly performing or incorrectly specified components. Unless a submarine has truly revolutionary performance requiring the development of new components, most of these problems should be rectified by simply switching components or suppliers. This, in fact, was done to rectify a problem with the original propeller shaft seal which was allowing excessive water into the hull.[89] Similarly, a noise problem caused by squeaky hydraulic actuators on the after hydroplanes was overcome by replacing the actuators.

Uniquely Specified Sub-Systems

However many of the problems with the Collins submarines do not appear to have originated with standard components. The boats' propeller produced excessive cavitation,[90] which is a source of unacceptable noise, and was brittle. (Submarine propellers are not exactly 'components', in that they require a level of technology which little more than a decade ago placed them highly amongst the targets of Soviet espionage.) The RAN specified that the propellers be made of Sonoston, a material that promised to reduce noise

through its low resonance characteristics. However, it proved liable to crack with only small changes in operational profile and difficult to manufacture to the extent that the propellers had to be hand finished. As multi-axis, computer controlled machine tools are needed to manufacture low noise propellers, it is not surprising that those of the Collins were too noisy and needed replacement too frequently.[91]

A component failure that can be linked similarly to the RAN's development of unique specifications is that of the Collins' search and attack periscopes.[92] These required 'capabilities well beyond anything then available'[93] and were provided by Pilkington-Barr and Stroud, a leading submarine periscope manufacturer and a company whose product is fitted to high performance RN nuclear-powered submarines. The Collins' periscopes suffered from excessive vibration and optical characteristics that were both a hazard to boat safety and an Operational Health and Safety danger for the crew. This is a result of specifications that were not fully evaluated[94] and it is difficult to believe that the RAN could not have selected an existing, proven design which would have performed adequately.

The Diesel Engines

Essentially ,conventional submarines are diesel powered electricity generation systems. However, in conventional submarines this process nearly always occurs underwater, which greatly complicates all aspects of the activity. The Collins class suffered problems across the range of diesel engine functions. The diesels produced excessive vibration and attendant equipment failure, ranging up to a damaged crankshaft in one case. From the delivery of HMAS *Collins* till October 1998, more than 750 diesel defects were recorded. The maritime industry bench markers, Lloyds Register, found the performance of the engines to be uniquely bad amongst its class of diesel engine applications.[95]

The Nature of Diesel Engine Problems

Part of the problem was caused by the engines ingesting excessive water (submarine operations require seawater to be used as ballast in the fuel tanks as fuel is consumed). Some of it to the recommendation by the engine designer, Hedemora, of an inappropriate engine operating speed. More stemmed from diesel exhaust flow problems, as the exhaust gasses are expelled underwater to mask the boat's presence. Yet other difficulties lay with excess consumption of lubricating oil. Head gaskets have been blown because of use of a turbo charger (exhaust pressure operation) in the new submarines rather than the supercharger (mechanical operation) more traditional for submarine diesels. The gear train appears to have design flaws that adversely affect reliability.

Since propulsion is at the heart of a submarine, the problems of the diesel generation system affect performance. Procedures to circumvent the water contamination problem involve leaving 30 per cent of the fuel oil in the tanks.[96] This (together with a lubricating

system problem, which now may be solved) prevented the class from demonstrating its specified range and endurance. The extreme vibration produced by the engines would have endangered the submarine whilst it was snorting, passing into the water as noise that would have alerted enemy forces over long distances.

Deficiencies a Consequence of Overall Design Objectives

The difficulties with the diesel engines are linked to the Navy's desire for an outstanding submerged performance from its new boats and the consequent large size of the class. To meet the high power demand entailed, the design originally was to use four diesels.[97] At some later stage, three engines of comparatively large volume were preferred. Whilst this arrangement had the elegance of arranging all three abreast, the selected engine subcontractor, Hedemora, had not developed submarine diesels of this size before. This lack of experience led to an inappropriate engine speed being recommended.

In these cases, the Navy's pursuit of its ideal, not just of the submarine itself, but of its systems and, in some cases how those systems were produced, compromised what was otherwise a basically adequate package. Defects were exacerbated where the feasibility of unique components was not tested.[98]

Hull Generated Noise

This is perhaps the most peculiar of the problems 'suffered' by the submarine. It is also an area of significant dispute. There is an argument that the problem is not 'real' in a contractual sense. ASC has maintained that it is not responsible for hull generated noise above 12 kts because the contract cited no performance requirements in this area and, therefore, the submarines were not designed to meet them.[99] There is also dispute as to whether adequate steps were taken to test the design for performance in this area. The McIntosh/Prescott report expresses surprise at the apparently minimal testing of the design,[100] while the Navy asserts that 'a comprehensive tank testing program did occur'.[101]

Why Submarines Usually Proceed Slowly

It is not usual for a conventional submarine's noise signature at high-speed to become such an issue. They generally operate slowly and cautiously when likely to be in the vicinity of enemy aircraft, ships and submarines. No submarine at speed is at its quietest and stealth, the over-riding advantage they possess, must be maintained at least until an attack can be initiated.[102] Conventional submarines cannot afford to move too quickly within the vicinity of hostile forces because their battery endurance is low and they would soon be forced to snort and risk detection. A snorting submarine generates greater noise levels (turbulence from the snorkel mast and reciprocating, explosively driven diesels, compared to the rotating electric motor) which are many times more detectable than the submerged

boat. Just as importantly, such noise also reduces the effectiveness of the submarine's sonar systems, thereby degrading its ability to detect hostile shipping. Nevertheless, HMAS *Collins* was detected by an obsolescent Royal New Zealand Air Force (RNZAF) Orion ASW aircraft during exercises off Darwin in 1997.[103]

There are parts of a mission profile, such as quickly loosing depth, transiting to or from a patrol area or for escape when brought under attack, where speed could be a useful attribute. With the exception of loosing depth, this potential has been limited by the practicalities of technology. Submarine operations may require the boat to change depth quickly for a variety of reasons and high-speeds can be reached during such manoeuvres. Not only would noise induced by poor flow characterises increase the risk of detection but it has raised, in the Collins case, the possibility of collision with another vessel if the manoeuvre were performed near the surface.[104]

There seems little reason why the level of concern should be as sharp in other areas. Previous generations of conventional submarines had little power available for recharging batteries if snorting at high-speed. The common transit speed for the Oberon class was around 8 kts. Neither is speed necessarily a good defence. For instance, the Thyssen TR 1700 class (which at 25 kts lays claim to be the fastest conventional submarine around) can sustain this pace for a distance of only 20 miles.[105] This is not likely to be a good tactic if opposed by surface ships with embarked ASW helicopters. Like all types of military equipment, submarines have to be operated within their technical limitations and navies are differentiated by their skill in extracting optimum performance within these limits.

Sources of Noise at High-Speed

The hull flow noise generated by the Collins at high-speed comes from the nature of its casings and fin, and from the interaction of the turbulence they generate with the propeller. The casing is a fibre class structure built on top of the pressure hull, projecting above the water and mounting the fin (often incorrectly referred to as the conning tower). It covers external equipment and houses some of the sonar arrays. There are indications that the design of the casings gave higher priority to maximum sonar performance rather than hydrodynamic efficiency.

The Collins class today is marked by a 'dimple' just behind the bow where the large casing covering the bow sonar is fared into the rest of the structure. This forms an obvious point of disruption to flow and was not a feature of early models of the submarine. At some stage of the design, a larger sonar array was apparently thought more important than maintaining the smooth flow of water around the bow.[106] The main deck casings are also designed for optimal sonar performance, and are rather slab-sided as the three differential ranging sonars they contain (the convex panels located equidistantly down each side of the casing) operate best when installed vertically. Originally, Kockums chose to end the deck casings with an abruptly rounded-off design. This generated vortices at speed which were

passed through the propeller, increasing cavitation and, consequently, noise. This problem has been reduced significantly by a more finely tapered ending to the deck casing and modifications to the shape of the fin.[107]

An Outcome Influenced by Other Objectives

This preference in design, allied to the fact that Navy had specified no noise performance for the submarine at speeds in excess of 12 kts, must have indicated to Kockums that high-speed characteristics were not a central element of the design. Nonetheless, by the time that the first-of-class trials were underway, Navy had changed its mind and considered the issue of noise at speed of sufficient importance not to accept the submarines as designed.

As mentioned above, the Collins class is considered extremely quiet when operating in the patrol quiet state, the predominant mode of submarines under combat conditions. In addition, the design of the Collins' power plant has ensured that its mechanical noise increases very little with speed.[108] Reports that a USN evaluation of the Collins' noise profile concluded that the submarine was as noisy as 'an underwater rock concert' have been denied by the submarine Project Office, which claims that there was no 'secret' USN report.[109]

It may be that the dynamic capabilities of the Collins design led Navy to re-conceptualise the extent of tactical mobility that was possible with a conventional submarine. This would then have demanded that the noise problem at speed, previously under-emphasised, be solved. Unfortunately, by having ignored this area in the contract, the Navy found itself in a dispute with ASC and having to pay, from the Defence budget, the costs of the comparatively simple modifications required to improve the situation.

The Combat System

If the prototype analogy is to be applied to the Collins class program, the CDS would be the model that crashed and burned on impact. There is now no doubt that the most critical failing affecting the submarine is this system. The program to rectify the failings of the submarine has now identified changes that will bring them up to approximately 80 per cent of capability. Achieving the remaining 20 per cent depends on replacing the present CDS with a system of adequate performance.[110]

Failure of the Original System

Throughout the 1990s both the RAN and ASC have struggled against the failure of the CDS. System specifications and contractor conditions were continually eased to make possible some progress with the rest of the program. In August 1991, Rockwell was allowed to adopt a two-stage delivery so that trials could commence on the lead submarine while the system was perfected. In September 1993, ASC attempted to place Rockwell in breach of contract

for its failure to perform and 'because, in ASC's opinion, Rockwell was unlikely to achieve the outcomes contracted'.[111] ASC was not allowed to follow this course. Yet, by the end of post-delivery trials on HMAS *Collins* in early 1997, the system was still unsatisfactory.[112] Moreover, the requirements for the system had been reduced, with many features removed.

Despite such attempts to simplify the functioning of the CDS, it still does not work in that it cannot process all the data available from the submarines' sensors and tends to fail when trying to interpret such data as it can access. Some of the early problems may have related to the quality of work performed by Rockwell.[113] However Boeing, on inheriting the problem in 1996 with its takeover of the former company, threw its US systems engineers at the problem and still could not make it work.[114] In the tracking, classification and display of sonar contacts the Collins CDS is less effective than the SWUP system of the Oberons.[115] Ironically, some of the sub-systems developed for that program are part of the partial augmentation fitted to the CDS of submarines *Dechaineux* and *Sheean*.[116]

Agreement on Need for a New System

There has been for some time a consensus that satisfactory performance is not possible with the existing CDS, no matter how heavily modified.[117] Notably, both American and British navies have now abandoned attempts to develop integrated combat systems. It appears to remain unstable, as demonstrated by the need to repair *Waller* en route to Exercise Tandem Thrust. The (then) Head, Submarine Capability Team, Rear Admiral Briggs, has argued that continuing with the original CDS, augmented with US supplied components, is unsupportable in the long-term:

> the critical path is the combat system, and also the most expensive single item. [The original system augmented with US equipment is] a system that's based on flawed foundations ... It's cheaper, in any sort of sense over the medium-term, to replace this combat system with *current generation technology equipment*.[118]

This was the conclusion reached by McIntosh and Prescott. They recommended that work on the old CDS be wound down and procurement of a new combat system 'using only proven in-service systems' commence.[119] This course was eventually approved by the Government and tenders called to provide 'an off-the-shelf, open systems, modular and proven system.'[120]

Selection of a Preferred New System

The ISUS 90–55, produced by the German company STN Atlas, was judged to be the best of the four leading combat systems evaluated. The second was the American company Raytheon, offering the CCS Mk2. The ISUS system was adjudged clearly superior to this at all stages of the evaluation and met or exceeded the RAN's functional requirements without need for modification. None of the other contenders did so. The Raytheon system,

which was being developed for USN nuclear submarines and would not therefore suit a smaller conventional boat, was still under development.[121]

Back to Square One—Replacement Combat System Program Abandoned

On 9 July Minister Reith cancelled the evaluation of new combat systems for the Collins submarines. At the same time he cancelled the evaluation for supply of a new heavyweight submarine torpedo, in which a European consortium was well placed due to the reported superiority of the German DM2A4 torpedo over the American Mk48 ADCAP in shallow waters.[122] In this latter case it appears that there is to be no competitive selection of a preferred weapon; instead 'a new arrangement will be developed'[123] under a cooperative agreement between Australia and the US.

The Minister's reasoning was that 'a comprehensive arrangement with the US Navy on submarine issues is in Australia's best strategic interests' [124]and he went on to note that the Australian and US navies were entering a 'Statement of Principles arrangement' to maximise cooperation on submarine matters. The Minister's statement does not discuss details about the selection of the combat system nor the STN Atlas proposal. The Statement of Principles was signed on 11 September. Part three covers cooperation in research, development and engineering and includes reference to research and development projects aimed at maximising commonality in the development of software for a "common combat system".[125]

The US Influence

Instead, the factors behind the cancellation can probably be seen in reports beginning in mid-2000 and persisting through 2001, that US officials from the Secretary of Defence down were urging Australia not to select the STN Atlas system. The American argument was that they would reconsider their assistance to the Collins, concerned that STN Atlas would be in a position to appropriate American intellectual property. This is a reasonable concern but STN Atlas already had satisfied the Defence selection panel on this matter with regard to both systems already on the submarines and to those proposed, such as the new heavy torpedoes.

The USN's Program Executive Officer, Submarines, Rear Admiral Phil Davis, had been particularly active in supporting the augmentation of the combat system in *Dechaineux* and *Sheean*.[126] Even some American commentators described US pressure over the restructuring of ASC, the selection of new heavy torpedoes and the choice of the combat system as 'heavy handed'.[127] The Chief of Navy, Vice Admiral Shackleton, was reported as supporting the American position, opposing other areas of Defence which had recommended the ISUS system as the best suited to fill the need for a new combat system.[128]

Moving Against the Trends

The Government's apparent acceptance of the American position might disturb some European manufacturers dealing with Australia. The Americans risk being seen as having a double standard. When the Federal Court found against Kockums plaint that sending a propeller to the US contravened its intellectual property rights, it did so on the grounds that they were protected by a confidentiality agreement with the US Government. European defence equipment manufactures might see their position as compromised. Whilst a US guarantee is supposed to be sufficient to satisfy European concerns about third party transfer of intellectual property, their management systems are not sufficient for the US, even when certified by the Australian Defence Department.

Furthermore, the new position on the combat system repudiates a string of assurances that the project would not automatically be awarded to an American company. For instance, Rear Admiral Briggs gave such assurances in July 1999 when discussing options arising from the McIntosh/Prescott report.[129] He repeated these in September 2000 when discussing the evaluation of bids to supply the new system.[130] Notwithstanding a recent decision to purchase the Army's new attack helicopter from Europe, such developments could deter European involvement in future Australian defence programs where ANZUS alliance issues appear to have a priority.

Growth of Multinational Approaches in Defence Systems

Such a perception could create difficulties for Australia should it result in reduced competition for major ADF equipment programs. For the process of multi-national systems integration is a commonplace overseas. An apposite example is the Israeli Dolphin class submarine. An HDW design built in Germany, it is controlled through the ISUS 90–55, similar to the system offered the RAN. This has not prevented the Israelis from procuring the land-attack version of the American Harpoon missile and operating it through the ISUS system,[131] which also integrates the input from indigenously developed sensors, usually developed from the Israeli experience of operating US equipment in combat.

The same multi-national character is commonplace in the consortia now supplying these military systems. The ISUS system has been referred to as the 'German' proposal. However, STN Atlas itself is 49 per cent owned by British Aerospace Systems (BAeS) and the ISUS consortium included Australian and American companies. Nautronics was to be the Australian systems integrator, BAeS Australia and Sonartech Atlas (60 per cent owned by STN Atlas) the sonar specialists. Lockheed Martin, American developer of the combat system for the next generation of US nuclear submarines, was to have integrated the (American) weapons.[132]

Consequences for Australian Industry

If consortia such as this are to be ineffective bidders for major Defence equipment where alliance circumstances allow US objection, the range of effective options to meet ADF capability development programs will be reduced. The same will also be true of options for Australian industry wherever acceptable prime contractors are reduced to US companies only. One of the fears arising from the cancellation of the new combat system, which has not yet been clarified publicly, is that it might result in the expulsion of Sonartech Atlas from the Collins program.[133]

Shortly after the Minister's announcement, Defence informed STN Atlas that it should cease all work on the Collins class.[134] This included its Australian subsidiary Sonartech Atlas. Sonartech has been involved in the enhancement program with sonar products it developed for the Oberon SWUP. As such, the company represents a considerable national investment in effective submarine operations. There are suggestions that Defence has reversed its position. Yet, the prospect that the suspension of the weapons system program could have led to the expulsion of an Australian company already involved and, thereby, to a reduction of indigenous expertise, represents very tangibly a conflict between national self reliance and the US alliance.

Issues of Wider Strategic Concern

The issue of self reliance versus alliance lies at the heart of the Government's decision on the combat system in a way that has not been addressed in the subsequent debate. Some commentators claimed it was an historic break from self reliance as an element of defence policy, which has been a developing theme since the 1976 White Paper.[135] The Minister's response appears to indicate that the decision extends no further than as a means of improving the submarines.[136] However, there are clearly other forces at play.

The American Need for More Submarines

One is the extent of direct, high level pressure by the US Government on Australia. At a meeting on 1 May 2001 US Defence Secretary Donald Rumsfeld told Mr Reith bluntly that selecting a European system could lead to interoperability and technology transfer problems.[137] Whether such claims about interoperability are true or not,[138] the Americans have interests in gaining access to effective operational submarines. The USN submarine fleet was run down at the end of the Cold War, and currently operates 56 tactical submarines. However, roles for submarines are increasing and the USN is finding that it often has insufficient boats to meet demands. Recent reviews indicate a need for up to 68 tactical submarines by 2015.[139] Many doubt that the US will be able to fund an expansion of this size and USN mission planning problems would be eased a little through access to effective Collins submarines.

Submarine Operations with the US

The extent to which Australia should accommodate the US within the context of the alliance is a matter of judgement, which may well differ with circumstances. There may well be temptations (and perhaps some benefits to morale) to send the Collins to the far ends of the north Pacific to assist the Americans. Experience has taught that overmuch involvement in such operations can lead to neglect of requirements for operations closer to home. Being able to provide assistance to the US requires preparation but it does not require commonality of equipment. The US Commander-in-Chief Pacific, Admiral Blair, has stated that the essentials of interoperability are agreements on standards and software applications, and commonality of doctrine and training, rather than being an issue of hardware.[140]

Regular exercise opportunities such as Exercise Tandem Thrust are, of course, one way of developing commonality in doctrine and training. If the USN has identified increased alliance cooperation in submarine matters as important, a more formalised approach could be adopted. Over recent years, Australia has strengthened its alliance arrangements with New Zealand by funding the long-term deployment of RNZAF Sky Hawk fighters at Nowra, to train in air defence tactics with the RAN. Given the current focus of the USN on littoral warfare (that is, naval warfare close to an opponent's coastline, where conventional submarines are held to possess an advantage) it is possible to conceive of a similar arrangement, whereby the USN would fund Australia to provide experience for American naval units in operating against conventional submarines.

Such an arrangement would probably be the most effective way of increasing interoperability between Australian submarine forces and USN. It is also possible to think of it having positive advantages for the RAN. A long-term posting to the United States may well prove a positive aid in recruiting submariners. Perhaps, if the USN found such an arrangement had sufficient long-term viability, it could lead to a mechanism for funding additional Collins submarines.

Risks to the Defence White Paper Structure

The decision to suspend the combat system competition implies that the Government is placing increased emphasis on the ANZUS alliance. Some media reports suggest more, claiming that the purpose of the decision extends to making interoperability with the US the 'principal focus for the Navy in the future.'[141]

If so, this has implications for the policy outlined in its own white paper, *Defence 2000*. The Defence Capability Plan, at the heart of *Defence 2000*, derives from a logical set of processes linking Australia's strategic objectives to defence strategy and thereby, through force structure priorities, to decisions on equipment types. In none of these steps does interoperability with American naval forces received mention as a force structure determinant.[142] Whilst mentioning that access to technology through the American alliance entails a need for closer integration and interoperability,[143] the basis of Australia's military

strategy is that forces intended to defend Australia will be useable for wider strategic objectives.[144] If issues invoked under the ANZUS treaty are now to intercede in the selection of equipment contractors, the long-term viability of the capability development process may well need reconsideration.

Return to the Challenges of the Past—High Risk with Lock-in

Apart from these issues, which are significant enough, the decision on the combat system is repeating history. The Government has changed the procurement strategy for the combat system. It had endorsed the recommendations of McIntosh/Prescott, that a new combat system be sought 'using only proven in-service systems'.[145] It is now switching from this option to seeking a capability which has yet to be proven. It has as yet no fall back position to safeguard the capability of the submarine fleet. These are significant issues, which the Government will need to work through with its new supplier.

It is reasonable to expect that this will be Raytheon. There is no official endorsement of this position but no alternative contractor meets the Government's new alliance-centred criteria. Lockheed Martin was eliminated early in the evaluation of new combat system options. Raytheon, having bought the original combat system work from Boeing in 2000, to position itself for the new program, has the advantage of day-to-day contact through its maintenance work on the Collins class.[146]

Areas of Risk

The Ministerial statement says nothing about specific alternative means of replacing the submarines' weapons systems, just cancelling the program as it existed. This is because a combat system with USN backing and suitable for a conventional submarine does not exist. Raytheon's modification of its CCS Mk2 system to suit the Collins was obviously not sufficiently advanced to win an open Ministerial endorsement. Subsequently, it was acknowledged that the implementation of the new combat system program would be delayed by a year from the proposed date of 2005–06.

On an assessment of the public information, much needs to be done to develop an effective combat system. The USN has many systems, components, protocols and programs of advanced capability—in a nuclear submarine. The CCS Mk2 is derived from the BSY-2, which was itself a classical case of a system based on incremental development rescuing the situation after the failure of the revolutionary but flawed BSY-1 but is still optimised for use on a nuclear submarine.

Differences Between Nuclear and Conventional Submarines

The difference is significant. A USN attack submarine displaces over 7000 tons, has a crew of over 130 and virtually unlimited power and hotel services. The Collins class

displace 3000 tons, was designed for a crew of 42 and when submerged is totally reliant on batteries for propulsion, power and habitability for periods which must commonly be stretched to three or four days. In disassembling the CCS Mk2 and restructuring it for the Collins, Raytheon faces the risks of:

- integration failure—the boat's existing sonars, other sensors and its existing IT systems may not interface easily with the CCS. Raytheon has failed to integrate systems in the AP-3C maritime aircraft update and is running 42 months behind with the operational management system, producing a delay of 36 months in the AP-3C program[147]

- miniaturisation—functions will have to be integrated so that more can be performed by less hardware and fewer crew; not an easy objective. The RAN specified that the Integrated Tactical Avionics System of its ANZAC frigate helicopters should be operated by two crew instead of the three used in USN service. The program is two years late and Litton, the system developer, lost so much money that it sold its military division

- capability creep—incorporating too many features for the system to handle without overload. Rockwell was never able to incorporate the nice but not essential features of the original CDS in a workable system. The greatest risk for Raytheon here is an assumption, held in some quarters, that the submarine combat system is the first stage of the integration of the RAN into the USN's proposed multi-spectral C3I network. Much of this will be over-ambitious.

The Critical Importance of Local Support

Such questions of effective project management are important. However, they encompass only a few of the issues that need to be addressed so that the decision on the new combat system can become effective long-term defence policy. The nature of technological change on IT systems means that purchasing the physical entity is not as important as acquiring the intellectual capital around their technology and operation. This is related to, but not simply the same as, purchasing the intellectual property incorporated in the design and construction of the system.

The Primary Importance of Intellectual Capital

The intellectual capital collected around a military system includes the knowledge of how it works but also how:

- its capabilities are best exploited

- its use affects the conduct of military operations

- it is to be maintained at an operational level, and

- it can be developed to extend military advantage.

Developing intellectual capital around these objectives requires an amalgam of personnel skills, industrial capacity, and the organisational structure and doctrinal concepts of the operating Service, formally captured and transmitted as knowledge. The development of superior intellectual capital is one of the reasons why a military force can defeat another using similar equipment or can continue to achieve superior performance from systems whose origin may be decades old.

The Atlas Proposal for Building Intellectual Capital

These may appear abstract concepts. They can be illustrated by the STN Atlas proposals for implementing the new combat system, made before the Government suspended it. At its basis was Atlas' willingness to trade all ISUS intellectual property, including source code and design data and to establish a through-life-support capability in Australia.[148] This was supported by Navy planning designed to build Australian intellectual capital. A research and development cycle was planned to foster local ideas that could exploit the open systems architecture of the ISUS 90, which allows integration of non-proprietary Commercial off the shelf systems (COTS) components. With the introduction of the system, a software support facility would have been established to develop and manage the RAN's submarine combat system intellectual capital.[149] This is a practice which the RAN has followed with most of its combat systems and which has made possible successful, locally based developmental programs such as the SWUP for the Oberon submarine.

The American Route Not Guaranteed

The lessons of recent history are that neither sponsorship by the US Armed Forces nor development by corporate America can guarantee success in systems integration programs. In fact, over ambitious proposals sponsored by the ADF have frequently been enough to defeat them both. The McIntosh/Prescott recommendation to refit the Collins class with an off-the-shelf combat system featuring use of COTS technology represented a means of getting operational boats with very few of these risks. The Government has chosen to pursue a different path and must now develop a procurement strategy that not only minimises considerable risk but also embraces those elements of personnel, industry and Service support policy which will be required to make the new submarine combat system an ongoing asset for the RAN.

The problem is, that in addressing these areas of risk, the Minister's decision has placed the future of the Collins class in the hands of a supplier who does not have as yet an operational system, let alone one proven by Service use in conventional submarines. Should problems develop, there is no body of operational experience on which to call. If the supplier can not meet requirements, the words of former Defence Minister Moore may

still come to be true: 'these things will be damn near 20 years old before they're properly going'.[150]

Where the Problem of the Collins Submarines Lies

Examination of the issues surrounding the Collins submarine program supports the view that there is nothing as wrong with it as the way in which it was handled. Early in the project's history, the objective of selecting a proven design was changed to the development of a unique submarine, specially designed for Australian circumstances. As it also had unique specifications for even standard items of equipment such as diesel engines and periscopes, almost all areas of the project carried a high risk. And because the specifications were unique, the consequences of failure were compounded. Since few other naval services operated anything similar, the research and development needed to overcome any shortcoming would fall largely on Australian resources.

An Inappropriate Procurement Strategy

The RAN has argued that there was no alternative but to develop a unique design as nothing else would suit Australia's requirements. Whether or not this view is disputed, it is clear that this point marked a distinct change in the project's direction and that the procurement strategy was no longer appropriate. With the level of risk the program was carrying it was almost inevitable that something would go wrong. There can be little dispute that a better procurement strategy would have been an alternative where the first-of-type was thoroughly tested before further procurement decisions were made, and the production phase entered thereafter.

Instead, by running a high risk project as if it was a normal production program, Navy established an environment in which, instead of the trial and error progress expected of a prototype (and, in fact, experienced by the Collins class) orderly progress was one of the measures of adequate performance. Thus, for instance, the launch of the first boat on a schedule developed six years earlier became important, even though it was, in reality, some six months from completion. This led to the sections of HMAS *Collins* being welded together when they were 80 per cent, rather than the requisite 95 per cent, complete and contributed to compounding problems of quality control in the early history of the program.[151] In the early days of the project, developing a prototype would have been criticised as taking additional time. In the light of hindsight it can be seen that moving into normal production mode too early has involved just as many delays.

Problems That Could Have Been Ameliorated

Had the program been designed around a prototype-style development, many of its subsequent problems would have been better managed. While there would have been higher

initial expenditure and perhaps some costly failures, these would probably have been overcome more quickly than at the slow pace actually experienced in the Collins program. The approach adopted served to dissuade ASC from rectifying faults which appeared well into the production process, since they affected its profit margin. If the receipt of a production contract for the remaining five submarines depended on satisfactory progress with the first, this probably would not have been the case.

As a consequence, there would have been less disputation over different readings of specifications as these would have been refined during prototype testing. A fixed price building program would have delivered an operational submarine against these standards. Further, the concerns of the Auditor-General, that excessive funding was advanced before contractor performance was certified, would have been ameliorated by more clearly earmarking funds for research and development and for production.

This, of course, is the benefit of hindsight. It is probably unrealistic to have expected the Project Office of the mid-1980s to have concentrated on risks other than that they would have felt to be the most dangerous, creating doubt on the project's viability in the mind of government. For the outlook of those times the way to avoid this particular problem was the type of fixed price contract which the Navy generally followed until 1999.

Consequences of Mistakes

As it is, by adopting an inappropriate procurement strategy the program is running 2 years behind schedule. Although well-managed within its fixed cost schedule, additional expenditure is required to enhance the operational capabilities of the submarine. In mid-2000 Rear Admiral Peter Briggs estimated that it would take an additional $1 billion to bring the submarines up to the level required for operations, including around $400 million for a replacement combat system.[152] And, in addition, there have been outright losses against public expenditure. When Boeing inherited the submarines' combat system work the project carried a fixed price of $500 million. When it sold its submarine business to Raytheon, $1.2 billion (70 per cent of it spent in Australia) had been paid in trying to make a dysfunctional system work.[153] The submarines will struggle on with this system for at least another five years, but the CDS will never reach the level of capability required.

An Excellent Potential Yet to Be Realised

Against this, the Collins appears to be a good design with a performance perhaps verging on the revolutionary in one or two areas. Its submerged endurance, low indiscretion ratio, stealth at slow speed and a potential tactical mobility far greater than earlier generations of conventional submarines, indicate that it can become the strategic asset it was intended to be. Moreover, with the backing of an efficient building organisation, the submarines should be better maintained and more effectively adapted to meet emerging circumstances than was possible with the Oberons. However, achieving this potential still requires successful

modification of the existing boats. Moreover, reaching the full combat potential of the submarines requires that they have a new combat system which works. Finally, achieving the potential for through-life-support of the submarines will depend on the quality of the Government's work in creating a private entity to run ASC.

The Collins submarine is not a lemon. It is simply that the way the program has been handled has left a bitter taste in the mouths of many associated with it. In contrast, it is important for Australian naval strategy that the submarine be made to succeed. It is also important that it be seen as not a uniquely bad example of defence procurement but a pointer to endemic problems in the current nature of defence procurement.

Why the Collins is Important—Australia's Declining Surface Navy

Defence 2000, the defence white paper contains an historically bold commitment to sustain a 3 per cent per annum real increase in defence expenditure. Yet, large as is this increase (now totalling an additional $31 billion over 10 years), such is the cost of modern defence equipment, that the capability development program outlined in *Defence 2000* allows for numbers in some areas of the ADF to decline. One of these areas is the RAN's surface combatant fleet and the consequences should lead the Service to rethink its role and doctrine.[154]

Reduced Planning Objectives

In *Defending Australia*, the 1994 version of the defence white paper, the objective for the surface combatant force was the provision of 17 major vessels (that is, of frigate size or greater). In *Australia's Strategic Policy, 1997*, this was reduced to 14. *Defence 2000* represents a further reduction of proposed surface combatant strength. In effect, the 3 DDG (guided missile) destroyers operated by the RAN until the turn-of-the-century have been retired without replacement. Its 6 FFG (guided missile frigates) are to be replaced in the next decade with 3 [possibly 4] Air-Warfare Destroyers (AWD). By around the mid-2010s this will give the RAN a fleet of 11 [*possibly* 12] surface combatants.

Along with this goes a reduction in capability. In 1999 the fleet consisted of 3 capable AWD (the DDGs), 6 limited capacity Air-warfare (AW) frigates (the FFGs), and the last of the obsolete Destroyer Escort (DE) class being replaced by the first ANZAC class frigates. After the refit program currently under development, the FFGs will provide a comparatively good AW capability till the mid-2010s. After that the fleet, as presently planned, will be 3 AWDs and 8 ANZACs, the latter with improved self protection (specifically against anti-shipping missiles) but no AW capability (the Navy having tried for this but finding that the hull was just too small).

The significance of this reduction has been recognised. The Maritime Commander, Rear Admiral Geoff Smith has been reported as 'hoping' that the AWD program might be

extended to 6, to maintain the 14 vessel fleet and allow the RAN the geographic coverage it requires.[155] However, *Defence 2000* contains no reference to additional units and has identified no funding for such a program. The prospects of the RAN acquiring further vessels will depend on some future defence white paper.

Declining Fleet Numbers

Yet it is doubtful that the RAN could use any additional combatants even if it could fund them. In fact, over the period from 1986 till now, the strength of the RAN's surface combatant fleet has steadily dwindled. In 1986 it was 12. At most times during the 1990s it was 11. In 1999–2000 the number of commissioned vessels was nine, with *Warramunga* yet to be commissioned but with *Brisbane* waiting to be paid off.

The most significant factor behind this trend is that Navy, more apparently than the other Services, cannot recruit and retain sufficient personnel to crew more vessels. In the context of the 1999–2000 Budget the RAN acknowledged that it could not reach its personnel targets for at least another 3 years.[156] By 2000–2001 the situation had deteriorated further, with Navy estimated to be 1100 [almost 8 per cent] below its nominal strength.[157] Among the areas where the RAN is under strength, surface combatant billets are over-represented. By 1 July 1999 it already had deficiencies of almost 200 (19 per cent) in its Seaman Officer establishment and 184 (20 per cent) in sailor combat systems operators.[158]

Implications for Policy and Naval Doctrine

Because surface combatants have been central to the RAN's force structure, the declining numbers and comparative power of its fleet will have implications for Navy and for defence policy. These will extend to the highest levels of alliance policy. Commonly, deployment of naval forces is seen as a prime (in some cases, easy) option in support of alliance commitments. Restrictions on the availability of a limited number of AWDs and the inherent limitations of the ANZAC frigates mean that this option will be trickier to exercise after 2015.

Historically, navies weak in traditional surface warships have been forced into alternative areas of naval warfare to protect their maritime interests. Amongst these have been underwater warfare and, especially, submarine warfare. In such circumstances the RAN will have to review a number of options, including its doctrine on submarine operations. The importance of effective operational submarines in projecting Australian maritime power is likely to increase into the next decade.

To some extent it appears that the conventional wisdom about *Defence 2000* is that it provides the wherewithal to allow defence 'business as usual'. Whilst this white paper is a significant document, it does not provide sufficient finance to allow all areas of the ADF to continue to be organised as they have been in the past. The RAN, in particular, will

have to grasp the significance of this and give adequate priority to the current rectification and future development of its Collins class submarines. In future decades they are likely to be Navy's most significant strategic force.

Why the Collins is Important—The Collins Syndrome and Australian Defence Procurement

The public commentary on the Collins submarines has probably convinced most people that it is an unequalled defence procurement disaster. On the contrary, this is not the case in terms of either cost increases or time slippage and, compared to some of the worst, the Collins submarine program ranks as a comparatively well managed defence acquisition project.

The Worst Defence Procurement Programs

Currently, Defence is managing 15 procurement programs which have run over budget by $5 million or more over the last five years. It has 21 which are six months or more behind schedule (See Appendix 1). If, although wrongly, it is assumed for the sake of argument that the $1 billion to be spent on enhancing the Collins submarines represents a 20 per cent cost overrun,[159] the program ranks twelfth in comparative cost overrun. It is also twelfth in terms of time behind production schedule.

The total real cost increase of all these programs was $568 million.[160] This is more than was estimated as the cost of the new combat system for the submarines and about the size of the AusLAV program to equip the army with wheeled armoured vehicles. It is also about half the figure given by the Minister as the cost of two new submarines that, he has argued, the ALP would like to order if in government. The Minister has gone on to observe that the cost of this ($1.2 billion) would destabilise the Defence Capability Plan—the centrepiece of the defence white paper.

Poor Management and the 'Orphan Systems' Syndrome

On this scale then, the consequences of poor financial management of defence projects must be a concern. At their root, many of them suffer from the same problems as the submarine program. In common with the Collins submarines these struggling projects exhibit two critical characteristics. They have all incorporated significant changes to what appears to be reasonably suitable military technology, to specifications which Defence claimed were necessary to meet peculiarly Australian requirements. Typically, these changes result in uniquely Australian systems which prove difficult to develop and maintain. Most commonly this syndrome, which again is typical of the Collins submarine program, affects electronic systems. In Defence such programs are known as 'orphan systems' since they have no close equivalents in the world.

Neither is the Collins program a relic of a previous age when defence project management was less sophisticated. Defence procurement programs of a much more recent vintage than the submarines are in equal or more difficulty.

A Recent Example—The ANZAC Helicopter Program

In January 1997 the Kaman SH-2G(A) Super Seasprite was selected as the helicopter to operate from the ANZAC frigates. The program was to include the Kongsberg Penguin anti-shipping missile. These were not new aircraft, but ex-USN equipment which had been sitting in the American desert. However, the RAN specified a unique combat data system, the Integrated Tactical Avionics System (ITAS) for its Seasprites. This was to allow it to operate the helicopters with a crew of pilot and tactical officer, rather than the 3 man crew in USN service.

As originally approved in the 1995–96 Budget, the Seasprite program was to have provided 14 helicopters and their Penguin missiles at a total cost of $763 million. But the Project Office had made errors with foreign exchange rates and the program exceeded its approved price by 25 per cent. Consequently, helicopter numbers were reduced by 20 per cent and the missiles were transferred to a new program, worth 12 per cent of the original program budget. Nonetheless, by June 2000, the approved cost of the program had risen by 26 per cent to $969 million.

More significantly, the systems integration sub-contractor, Litton International, was not able to provide software to operational standard. This means that the aircraft cannot perform its naval missions. The problems with systems integration and software development for the ITAS, estimated to have added about $100 million,[161] were a major reason why Litton sold its military systems division in 2000 to Northrop Grumman. The latest estimate of the time required to fix the problems is 2 years, with provisional acceptance of the aircraft with working software put at January 2003.[162]

The Implications for the White Paper of Poor Acquisitions Management

It could be expected that the additional costs of these poorly managed acquisition programs have been incorporated in the Defence Capability Plan, as many cover a period of up to five years. Unless they have been, the Capability Plan could be considered compromised to the extent of the additional costs. These include the $1 billion for enhancement of the Collins submarines.

Yet given, as the Minister suggests, that the defence budget for new equipment over the next 10 years is so finely balanced, the management of defence acquisitions must improve considerably over its recent record. There remain many programs where risk can be assessed as high and where the financial implications of poor performance would be significant. For instance, were the cost of the AEW&C aircraft program to increase by the

same amount as the Collins submarines, $600 million would have to be found within other areas of the Defence Capability Plan in the period up to around 2008.

Identifying High Risk Programs-the Example of the AEW&C Program

Indeed, an examination of the AEW&C program shows that it carries a high level of risk. A characteristic of the development of uniquely Australian systems, displayed by the Collins, is that their estimated cost rises steeply between the various developmental stages of the project. There are significant increases between the approval for early conceptual studies and the subsequent issue by the project Office of its preferred specifications, against which equipment providers are invited to bid. There are further increases between approval by government of the preferred supplier and the signing of a contract. As the program cost increases, the date for in-service delivery recedes.

Cost Increases in the AEW&C Project

These stages can be seen clearly in the AEW&C aircraft program. When project definition studies commenced in 1994, the estimated cost was $1 billion, with an in-service date of 2000.[163] Five years later, when Boeing had been selected to supply the AEW&C force, the estimated cost had risen to $2 billion to supply seven aircraft, the first in 2004–05.[164] In mid-2000 the project was frozen pending the completion of the defence white paper because of Cabinet's concern about the impact of its rising costs on an over-pressured defence budget. By this time contract negotiations had pushed the total program cost to $3.4 million.[165] The program was approved in the white paper but for a current approved cost of $3.11 billion it will supply only four aircraft from 2006 onwards but which will not be operational until 2008.

Obviously, the decline in the exchange rate between the A$ and US$ has contributed something to this increase in cost. However, during the period from mid-1994 to December 2000, the A$ has lost just under 19 per cent against the US$,[166] clearly less than the increased cost of the AEW&C project. Furthermore, the variability of exchange rates against the US$ has significance which goes beyond the issue of costs.

Risk Factors in the AEW&C Program

The AEW&C program is open to the risks of other struggling defence acquisition programs. Four million lines of software code unique to Australia will have to be written for its electronic systems. Australia has no domestic operational experience to assist the development program and the user organisation, No 2 Squadron, is being created within the Project Office. The AEW&C is currently an orphan system. Australia was the first and remains the only customer for the Boeing design. The hope was that it offered sufficient

advances to be purchased by other nations, thus spreading development costs and creating a market big enough to justify Boeing's continued support of the system into the future.

At one stage Turkey was to be a customer but a combination of severe currency devaluation and contract disputes are likely to prevent an order for some time.[167] Indeed, it is a problem that the Boeing aircraft is aimed at countries needing a cheaper alternative to the more complex early warning aircraft. Unfortunately, many of these are also amongst those countries whose currencies are more likely to devalue against the American dollar, making the system less affordable.

Although over countries (South Korea has been mentioned) will probably buy some of the aircraft, it is not yet established that the numbers sold will be sufficient for Boeing to afford an ongoing program of system development. Managing the AEW&C program to overcome high risk factors and avoid their financial implications is likely to remain important for the future viability of the Defence Capability Plan.

Internal Criticisms of Defence Procurement Management

There is growing awareness within Defence that the demonstrably poor management of risk in its equipment programs must be controlled. Air Vice Marshal Ray Conroy, responsible for aerospace procurement, has noted the poor performance of programs in his area which, he observes, involve many of the largest of the world's aerospace companies failing to manage software and integration. However, he also noted that the root of the problems was the excessive scope of the specifications that were being set for these companies. In essence, this is a management problem, as senior officers are not exercising sufficient discipline over project officers during the course of project development.

Too Many Uniquely Australian Systems

As a consequence, Conroy saw the need for a concerted campaign to reduce the number of uniquely Australian developmental projects. He argued that the military significance of the performance difference between the off-the-shelf standard model and the special-to-Australia development model should be debated, saying that project development rarely involves surveying what is already available and assessing how closely that could meet Australia's defence concepts.[168] He also made a point important to remember for policy management. Once the scope of the program has been approved and the best contractor selected, the effectiveness of program management is beyond the control of Defence. The most active role of the Services at this stage will be preparation for introduction of the equipment and, in effect, the Defence Project Offices can only monitor the performance of the contractor. Just how effectively they can do even this will already have been determined by the quality of contract negotiations.

Government Changes to Procurement Procedures

The former Minister for Defence, John Moore, has made somewhat less complimentary comments about defence procurement. The Minister's concern was that very senior officers were pressuring their more junior Service colleagues to amend contracts after they had been signed. 'In no small way that has contributed enormously to failure of projects, certainly cost and time overruns.'[169]

The former Minister's attitude reveals something of the dissatisfaction with many aspects of defence management felt by the Government over recent years. This became focused in the period through which the National Security Committee of Cabinet was considering issues leading up to the production of the defence white paper. They concluded that one problem of critical importance to the Government's oversight of the procurement process was the point at which Ministers were brought into the decision making process. This traditionally was when Defence processes had refined the project to the point of requesting an approximate number of specific military systems, for instance, seven early warning aircraft. Cabinet decided that, in terms of government's policy options, this amounted to a fait accompli, at which point the scope, dimensions and cost of the program were largely fixed.[170]

Early Involvement in Project Development

The Government has therefore changed the process to assert its role in deciding the policy that underlies acquisition options. Defence must now make at least two approaches to government in developing procurement programs. The initial submission lays out the broad parameters of the proposal, the range of relevant procurement options, timing for development of options and requirements for developmental expenditure. The Government can then allocate priority to, or provide other policy guidance on, the set of options that Defence can begin to develop for acquisition proposals.[171]

The important feature of this approach is that it gives the policy makers time to intervene in the development of a procurement program before its nature has been set. Cabinet can indicate the boundaries on the setting of specifications and thereby have the potential to control the scope of a project that would otherwise have grown in size and complexity and, therefore, cost. Once the nature of a project has been decided there is little opportunity to reduce its cost and potential risks significantly—a very large submarine is always going to cost more than one of medium size and a unique new software project will be inherently more risky than an already commercially available product.

Increasing Transparency: Towards Improving Defence Procurement

Roles of Parliamentary Bodies

This change in policy setting procedures for the executive government has not been matched by procedures for parliamentary scrutiny and public transparency. The Parliament has available to it the services of the Auditor-General, who is an Officer of the Parliament. The Joint Committee on Public Accounts and Audit (JCPAA) has a statutory responsibility to consider every report of the Auditor-General and can choose to examine specific cases in greater detail, holding of public hearings and issuing reports on its findings. It also has a role in relaying the Parliament's priorities for investigation to the Auditor-General.

However, both bodies can investigate the efficiency of public administration (in this case defence acquisition programs) only after processes have been approved and put in place. Indeed, from 1998 into 1999 the JCPAA conducted such an inquiry into the Collins submarine program on the basis of an Auditor-General's report but more than a decade after government approval of the program. Whilst, in the past, it has conducted several reviews of defence procurement procedures and recommended numerous changes, there are no procedures which make it easy for the Committee (or for the Auditor-General) to review the early stages, before Government approval, of specific acquisition programs.

The Defence Sub-Committee of the Joint Committee on Foreign Affairs, Defence and Trade (JCFADT) also has at times considered the efficiency of defence procurement in general and the efficacy of some particular acquisition programs in particular. For instance, in 1989 it examined the procurement strategy for providing the RAN's counter-mine warfare capability. The Sub-Committee recommended a change in procurement strategy that has been credited as important in the development of the Navy's new Huon class mine hunters. Whilst the Defence Sub-Committee could convene hearings into, for instance, options for meeting the procurement of new fighter aircraft, the realities of time and constrained numbers mean it would be unable to scrutinise regularly the development of defence procurement programs and to maintain its policy focus.

A Need for Increased Capacity

A Parliamentary body is needed that will allow the Legislature to scrutinise proposed procurement strategies for defence procurement programs. Such a role is likely to become more extensive and protracted in future as approaches to procurement diversify. For instance, Defence will increasingly implement evolutionary procurement strategies, where equipment will be bought in smaller blocks with changing specifications (rather than in a single order) in an attempt to adapt more rapidly to the pace of technological change.

Soon after it was created, the Commonwealth Parliament established by legislation the Public Works Committee to oversight the construction of public works. The Committee has legislative powers to examine proposals to construct facilities and recommend for or against their acceptance. In the early days of the Commonwealth, public works were amongst the greatest outlays of the new nation on government property. Today, that position is held by major defence acquisition projects. It is therefore appropriate that the procedures adopted by the Executive, in an attempt to improve the quality of policy-making in this area, should be mirrored by a committee of the Legislature.

There are several ways that such a body could be established. A new committee could be established by resolution of both Chambers of Parliament or, better still for a Government intent on improving public administration, by legislation. This latter could either establish a new statutory committee or perhaps by amendment, a subcommittee of the Public Works Committee, concurrently changing the name and role of the committee. Failing such a move, either the JCPAA or the JCFADT could take up the role on at least a partial basis with, perhaps, the former investigating ways in which the Auditor-General might be involved at a more early phase of the development of defence acquisition programs.

The lesson to be learned from the Collins submarine program is that the procurement strategy determines the outcome from very early in the program and that subsequent interventions can be only more or less corrective of a path already set. The Commonwealth Government appears to have learnt the lesson that disaster can be avoided only by controlling the early stages of project development. What is now needed are parallel procedures to ensure that parliamentary scrutiny and public accountability can be set on an equal basis.

Conclusions

The Collins class submarines will probably go on to become, to adopt the image used by Allan Hawke, Secretary of the Department of Defence, the F-111s of their day—plagued by development difficulties but destined to become a significant capability for Australia's defence.[172] The most significant difference between the two is that the hull life of the submarines will not allow extension of the Collins class' service life to the extent that has now proved possible with the F-111. The corollary is that delayed enhancement of the submarines will have more significant effects on Australia's defence capabilities than what ever was the parallel with F-111.

The controversy surrounding the program has led to many assertion of where its problems lie. This paper contends that the Collins program is not unique amongst defence procurement programs and that its problems tell us much about large defence acquisitions.

The nature of most of these is determined in their early stages when the sponsoring Service defines the characteristics of the equipment and the usually precise and often demanding specifications controlling how it is to be supplied. While relevant organisation

and efficient management, as suggested by McIntosh and Prescott, are necessary to the effective production of defence equipment, these are not likely to change the course of a program once it is set. Defence equipment tends to be expensive and its production risky; if an expensive option is chosen to meet defence objectives and risks are involved the outcome will be expensive and things may go wrong.

The most compelling lesson that can be learnt from the Collins submarine program is the importance of selecting the procurement strategy to suit the nature of the project. In hindsight, at the point where it was decided to develop a unique design for the new submarines, was the time to change procurement strategy. As the class also had unique specifications for even standard items of equipment such as diesel engines and periscopes, almost all areas of the project carried a high risk. And because the specifications were unique, the consequences of failure were compounded.

What Navy now recognises should have been done, first building a prototype as a test bed to eliminate the almost inevitable failures, would have been more appropriate. In the early days of the project, this approach would have been criticised as taking additional time. In the light of hindsight it can be seen that moving into normal production mode too early has involved just as many delays.

It is important that the Collins submarine be seen as not a uniquely bad example of Defence procurement but a pointer to endemic problems in the current nature of the system. It is one which has assisted government focus on the need to improve Defence procurement processes and it has changed them to assert its role in deciding the policy that underlies acquisition options. Recent policy changes give government some capacity to influence judgements such as those on the Collins procurement strategy. Yet there is much evidence from within Defence that the drive to institute programs dependant on uniquely Australian systems remains strong. In these circumstances, procurement programs carrying high degrees of risk will continue to evolve.

The most critical deficiencies in the management of these circumstances lie in the mechanisms of higher level national policy making to review inherently risky approaches at a stage sufficiently early to influence the direction of procurement programs. What is now needed are procedures to ensure that parliamentary scrutiny and public accountability can play a role in such mechanisms.

Endnotes

1. David Lague, 'Out of the deep', *Sydney Morning Herald*, 25–26 November 2000.
2. Malcolm McIntosh and John Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, Canberra, 20 June 1999, p. 7. The authors note the

critical nature of safeguarding a submarine's noise signature and that they are 'astonished and appalled' by the information leaked.

3. Several people, both civilians and officers, were involved in the leaks which, together with security breaches concerning the East Timor situation, led to the creation, in May 2000, of the Security Investigation Unit, a new unit in Defence. Lincoln Wright, 'Leakers allowed to leave Defence', *Canberra Times*, 16 May 2001.

4. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 14.

5. 'Collins sub's first mission off Timor', Telegraph, 30 June 2000, quoting *Peacemakers—Interfet's Liberation of East Timor,* by John Hunter Farrell.

6. Graham White, Captain RAN, 'Our Submarine Arm and the Future', *Fleet Maintenance Bulletin*, Issue 18, 1984, p. 4.

7. Graham Davis, 'Submarine will stay in-service', *Navy News*, 19 October 1998, p. 3.

8. 'New boats will require shorter refits', *Defence Industry*, 10 October 1984, p. 2.

9. P. Lewis Young, 'The Royal Australian Navy's New Submarine Selection' *Asian Defence Journal*, August 1984, p. 50.

10. Kenneth Davidson, 'Navy determined to build submarines in Australia', *The Age*, 17 January 1985.

11. Graham White, 'Our Submarine Arm and the Future', op. cit., p. 7.

12. Robert Cooper, 'Project Management in Australia', *Sea Australia 2000*, conference proceedings presentation 22.3, The Institution of Engineers Australia, Sydney, February 2000.

13. ibid.

14. '$9.2 million submarine costs $7 million to refit', *Sydney Morning Herald*, 8 February 1973; Frank Cranston, 'Submarine refit slow and costly', *Canberra Times*, 9 February 1973.

15. Many navies have submarines in their Order of Battle. By itself, this does not indicate that the navy can use these boats on military operations successfully. They must be fully maintained, not just so that they can submerge safely but so that minor defects in systems and components do not prevent the boat from performing its mission or generate noise that would make them easy to locate and destroy. For instance, Indonesia kept many Soviet-provided submarines in its Order of Battle after the fall of the Sukarno Government but it soon became apparent that their maintenance was not a priority of the Indonesian armed forces. Their credibility as a military threat had lapsed long before they were scrapped.

16. Graham White, Captain RAN, 'Submarine Project Overview', *An Approach to Carrying Out Major Projects in Australia*, The Institute of Engineers Australia, Canberra, September 1984, p. 57.

17. ibid, pp. 59–60.

18. ibid, p. 58.

19. 'Submarine Project', *Canberra Times*, 1 March 1983; Tom Ballantyne, 'Navy pushes Aust Share in submarine project', *Sydney Morning Herald*, 1 March 1983.

20. Frank Cranston and John Jesser, 'Companies chosen to design submarine', *Canberra Times*, 22 May 1985.

21. Robert Cooper, 'Project Management in Australia', op. cit.

22. An exception was the private firm of North Queensland Engineers and Agents (NQEA) who, at the time, were successfully completing the Fremantle patrol boat program.

23. Deborah Snow, 'Two contenders in submarine project still operational', *Financial Review*, 25 September 1985.

24. South Australian Submarine Contract Task Force, *RAN new construction submarine project. South Australian delegation visit to submarine builders*, submission to the Department of Defence Support, 12 September 1984, p. 9ff.

25. ibid., p. 2.

26. ibid., p. 6ff.

27. Graham White, 'Our Submarine Arm and the Future', op. cit., p. 8.

28. 'Government to call tenders for new submarines', *Canberra Times*, 26 January 1983; 'New submarines for the RAN', *Navy News*, July 1983, p. 9.

29. 'Multi-national combat system package in front?', *Defence Industry*, 7 November 1984, pp. 1– 2.

30. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 12 and p. 23; 'ASC's early complaint on combat system', *Australian Defence Report*, 17 August 2000, p.7.

31. Andrew Johnson, 'Viability of Combat System Development in Australia', *An Approach to Carrying out Major Projects in Australia with Reference to the New Construction Submarine Project*, The Institution of Engineers, Australia, September 1984, p. 61ff; G. H. Raymond, 'The Capabilities of Australian Industry for the Development, Production and Support of the New Construction Submarine Combat System, ibid., p. 71ff.

32. Brian Clarke, 'Awaiting Government's sub-mission', *Australian Financial Review*, 30 June 1999.

33. Letter from W.L. Owen, Capt, RAN (ret.) quoting verbatim clause 2.23.4.1.3 of the tender. Cited in P. Lewis Young, 'The Australian new submarine selection', *Asian Defence Journal*, December 1987, p. 30.

34. A.W. Grazebrook, 'New subs must be built here', *Pacific Defence Reporter*, February 1984, pp. 42–43.

35. The Collins class can maintain a 42 day patrol after deploying 2510 nm (see, 'The Performance Advantages of Size'). A design that is typical of the level of technology submitted in the early stages of the Collins submarine program is that of the French designed Agosta 90B of the Pakistani Navy (the variant ordered by Pakistan has been modernised). At around the 1510 tonnes (surfaced) it is also typical of the size of most of the

early responses. The Agosta can maintain a 40 day patrol after deploying 1680 nm to the patrol area. In Australia's region of defence interest, potential patrol areas are more distant than this. Richard Scott, 'Agosta 90B Surfaces for the Pakistan Navy', *Jane's Navy International*, May 1999, p. 37.

36. Frank Cranston, 'Delay likely on submarines', *Canberra Time*s, 7 August 1984.

37. Hugh White, 'Two chosen to design submarine', *Sydney Morning Herald*, 22 May 1985.

38. An insider of those times has published a critique of the decision-making processes involved in the early stages of the new submarine project. Mike Gilligan, 'What the sub report did not say', *Canberra Times*, 30 July 1999.

39. It has been suggested to the author, by people involved in the early stages of the program, that any change in Navy's approach to the program would have confused perceptions about it and risked a rejection by Cabinet. Certainly, there have been occasions when Defence and ADF personnel have thought that explaining the realities of defence procurement to politicians was too dangerous a risk. There may well have been an element of this in decisions made within the Collins program in the early 1980s. However, it is equally likely that the significance of changes to the selection criteria simply were not grasped. The capability development areas of the ADF have long been used to specifying changes to otherwise adequate overseas designs to meet the unique operational environments of Australasia. These at times have been excessive and have greatly complicated management of the procurement program. It could be just as likely that the Collins program was seen as merely a more extensive manifestation of this approach.

40. Richard Scott, 'Safety checks force UK submarine recall', *Jane's Defence Weekly*, 1 November 2000, p. 4. The Trafalgar class SSN HMS *Tireless* suffered a leak in its primary coolant circuit in May 2000, which was first thought to be faulty work. Subsequent investigation prove it to be a generic fault with all RN attack submarine nuclear power plants.

41. 'Collins submarines visionary', *Australian*, 7 November 1997. Quoting Ross Milton, Corporate Affairs Manager, ASC at the award to ASC of the 1997 National Engineering Excellence Award by the Institution of Engineers Australia.

42. Some caution should be taken when comparing building rates for submarines. These often reflect issues other than the capacity of the submarine builder. Some nations adopt a policy of producing boats at a reduced rate because it sustains the industry. Nonetheless, the ability to achieve such high productivity in a new yard which was introducing leading-edge technology to Australia, is a significant achievement.

43. 'Collins submarines visionary', *Australian*, op. cit.

44. David Lague, 'Out of the deep', op. cit.

45. 'Tomy Hjorth in spirited defence of Collins class submarines', *Australian Defence Report*, 17 February 2000, p. 11.

46. Gregor Ferguson, 'ASC chief warns of job losses', *Australian Defence Magazine*, May 1999, p. 31.

47. Andy Miller, 'Time for sub's critics to let the truth surface', *Sydney Morning Herald*, 31 May 1999.

48. Ian Kemp, 'Victoria, formerly Unseen, departs', *Jane's International Defence Review*, November 2000, p. 12. The Canadians acquired the former RN submarines on a lease/purchase arrangement for US$405 million. However the equipment of the submarines was apparently not considered up to standard, for as well as replacing the weapons control system the Canadians are fitting new communications, electronic support measures and towed array sonar.

49. Richard Sharp, Captain (RN), ed., *Jane's Fighting Ships 2000–2001*, Jane's Information Group, Surrey, 2000, p. 10.

50. Comptroller and Auditor-General, *Report of the CAG on the Ministry of Defence*, Year ended 31 March 1989, available at: http://www.cagindia.org/reports/defence/1990_book1/contents.htm

51. Comptroller and Auditor-General, *Report of the CAG on the Ministry of Defence*, Year ended March 1996, available at http://www.cagindia.org/reports/defence/1997_book1/contents.htm

52. Gregor Ferguson, 'ASC chief warns of job losses', op. cit.

53. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 32.

54. Paul Statick and David Eccles, 'Construction base may close in two years ', *Advertiser*, 3 July 1999.

55. See, for instance, the entries for 2000–2001 and 2002–2003 in, Department of Defence, *Defence New Major Capital Equipment Proposals 1998–2003*, Canberra, 1998.

56. Samantha Maiden, '$2 billion bullseye', *Advertiser*, 26 July 2001.

57. ibid. This is one area of bipartisanship between the major parties, Opposition leader Beazley agreeing with the decision on the same grounds. 'Subs job right, says Beazley', *West Australian*, 2 August 2001.

58. After more than a decade of historically large shipbuilding programs, the workload for the Australian industry is due to decline over the next few decades. There will soon be too many construction facilities for the available workload. A solution that was 'floated' in the McIntosh/Prescott report was that one of the major east coast shipbuilders might close their yard, buy the AIDC equity in ASC and do both surface ship and submarine work in the modern facilities at Osborn: McIntosh and Prescott, op. cit., pp. 33–34. If anything, the concept has become broader now that the Government owns ASC outright. Defence Minister Reith recently stated that 'The Government's sale of the Australian Submarine Corporation will create an opportunity for industry to rationalise naval shipbuilding in Australia'. The presently favoured option is to sell ASC to a consortium controlled by one of the major Australian ship builders but including a foreign submarine constructor, facilitated by the Government offering work on forthcoming surface vessel construction as well as the submarine maintenance work: Ian McPhedran, 'Staying Afloat', *Advertiser*, 29 June 2001.

59. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 38ff.

60. Gregor Ferguson, 'New Kockums-HDW Entity Eyes Australia's Submarine Builder', *Defense News*, 11 October 1999.

61. Lincoln Wright, 'Germans "want $50m" to sell submarine share', *Canberra Times*, 10 August 2000.

62. Robert Garran, 'Navy locked into US aims', *Australian*, 11 July 2001.

63. The McIntosh/Prescott report contains several references to the adversarial nature of the relationship between ASC and the RAN, which had worsened in the period from the launch of the first submarine up until 1999. This contrasted with a noticeably close relationship in the earlier years of the program. The underlying factor in both situations appears to have been financial. Whilst the submarines remained unacceptable to the RAN, and therefore on the 'books' of ASC, they eroded the company's profit base. Earlier, generous advance payments and the closeness of the Navy Project Office to ASC allowed the company financial flexibility, both of which were criticised as excessive in *New Submarine Project, Audit Report No. 22 1991–92*, the first report on the project by the Australian National Audit Office. The McIntosh/Prescott report commented that the involvement of the USN in the remediation of the submarines would limit the future role of Kockums. McIntosh and Prescott, op. cit., p. 30.

64. 'Court allows sub prop modifications', *Australian Defence Report*, 26 April 2001, p. 9.

65. A.W. Grazebrook, 'Tough job for the ASC task force', *Asia-Pacific Defence Reporter*, June–July 2000, p. 52.

66. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 39.

67. Geoffrey Barker, 'Defence costs prompted Moore to assert control', *Financial Review*, 11 February 2000.

68. The Hon. John Moore, Minister for Defence, Senator The Hon. Nick Minchin, Minister for Industry, Science and Resources, The Hon. John Fahey, Minister for Finance and Administration, 'Commonwealth takes full direct ownership and control of the Australian Submarine Corporation', *Joint Media Statement*, 9 November 2000.

69. 'Uncertainty prevails with vital Collins class submarine issues', *Australian Defence Report*, 26 April 2001, p. 1.

70. Intellectual capital is now considered the most important element in the success of organisations. Intellectual property, that is, knowledge held by the organisation in forms such as inventions, for instance, is one of the elements of intellectual capital. However, access to the expertise of staff, knowledge of the requirements of customers and appropriate systems to manage this knowledge are also required to build an organisation's intellectual asset base.

71. Tom Muir, 'Collins-class submarines–on the fast track', *Naval Technology*, February 2000, p. 7.

72. David Lague, 'Out of the deep', op. cit. Accurate comparisons of the speed of conventional submarines are difficult. Most official accounts simply claim a top speed of 20 knots submerged. Depending on conditions, this can easily vary a few knots in either direction.

73. After years of experience, the Indian navy found the Kilo to be 'highly underpowered' and assessed it as inferior in combat capability to its HDW-built submarines. Consequently, in the early 1990s the Indian navy proposed an upgrade program for the Kilos costing 500 per cent more than the purchase price (with, admittedly, costs of Russian defence equipment generally being lower than that of Western alternatives). Comptroller and Auditor-General, *Report of the CAG on the Ministry of Defence*, Year ended March 1996, available on the Internet at http://www.cagindia.org/reports/defence/1997_book1/contents.htm

74. Jerry Pratley, 'Collins sub supreme: navy boss', *West Australian*, 18 June 1999, quoting Captain Ric Shalders, RAN, then Commanding Officer, Australian Submarine Squadron.

75. Joris Janssen Lok, 'Australia rethinks AIP for Collins class boats', *Jane's Defence Weekly*, 17 July 1996, p. 15, quoting Capt. Paul Greenfield, RAN, then New Submarine Project representative at ASC.

76. Joint Committee on Public Accounts and Audit, Report 368, *Review of Audit Report No 34 1997–98, New Submarine Project Department of Defence, June 1999.* Transcript, 5 March 1999, p. PA88. Evidence from Mr Garry Jones, Deputy Secretary, Acquisition, Department of Defence.

77. David Lague, 'Out of the deep', op. cit.

78. Operating in shallow waters is a supreme test of a submarine's capability. Submarines are more difficult to conceal in shallow water. Instability in the control of a boat and limitations on its capacity to react to changing hydrodynamic situations can result in it being forced near the surface or even broaching, that is, being forced through the surface.

79. 'Collins subs world class, says US', *Advertiser*, 1 June 2001.

80. See, Derek Woolner, 'Procuring Change: How Kockums was Selected for the Collins Class Submarine', *Research Paper*, no. 4, Department of the Parliamentary Library, Information and Research Services, September 2001, in the section 'Strengths of the Shortlisted Companies'.

81. Terry Plane, '"World-beater" to blow rivals out of the water', *Weekend Australian*, 14 November 1998. The article quoted Commander Melvyn Jones, Commander of HMAS *Waller* during trials before her commissioning into the RAN. Commander Jones' support of the boats is interesting because of his previous service on an RN nuclear-powered submarine and command of two Upholder class (Type 2400) RN conventional submarines.

82. David Lague, 'Out of the deep', op. cit., quoting Rear Admiral Peter Briggs who was in charge of the program to rectify the faults of the Collins class.

83. During an overseas tour of duty in 2000, HMAS *Collins* successfully fired a sub-Harpoon off Hawaii. *Collins* has a partially augmented CDS whilst *Waller*, with the original system, is less capable.

84. Janine Little, 'Computer guru called in to repair submarine', *Bayside Bulletin* (Cleveland), 15 May 2001.

85. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit.

86. ibid., p. 6.

87. ibid., pp. 14–15.

88. Trevor J. Thomas, 'Briggs delivers!', *Australian Defence Business Review*, 19 January 2001, p. 11.

89. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 4.

90. ibid., p. 7.

91. ibid., pp. 8–9. These facts help explain why Kockums went to the Federal Court seeking to injunct the delivery of one of its propellers to the US Navy, on the grounds that it would compromise Kockums' intellectual property rights. Publicity that the propellers did not work confused the difference between the effectiveness of the design, the on board environment in which it operates and the failings of the material that the shipbuilder was forced to use.

92. ibid., pp. 9–10.

93. 'ASC's early complaint on combat system', *Australian Defence Report*, op. cit., p.7.

94. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., pp. 9–10.

95. ibid., p. 6.

96. ibid., p. 5.

97. Oscar Hughes, Rear Admiral RAN, 'The New Submarine Project', *Maritime Studies*, No. 37 November and December 1987, p. 34.

98. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 23.

99. 'ASC's early complaint on combat system', *Australian Defence Report*, op. cit., p. 8.

100. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 23.

101. 'Admiral strongly rebuts criticism of submarines', *Australian Defence Reporter*, 25 May 2000, p. 16.

102. In fact, at times in the past, submariner training has so ingrained this approach that it has become a problem. For example, shortly into the war against Japan, most USN submarine commanders had been replaced, largely because their caution prevented them attaining a position, given the slow speed of a submarine operating stealthily, from where they could attack enemy shipping.

103. Matthew Horan, 'Noisy subs can't defend themselves', *Advertiser*, 25 May 1999.

104. ibid. This is the argument of Commodore (Ret.) Mick Dunn who argued that the flow noise around a Collins quickly surfacing could sufficiently affect the boat's sonars to not provide warning of the presence of other craft. This argument was dismissed by the then Chief of the Navy both on grounds of probability and of the noise problem of the class not being sufficiently bad. However, recent experience has shown that such accidents do occur, even when involving competently operational submarines.

105. Richard Sharp, Captain (RN). ed., *Jane's Fighting Ships 2000–2001*, p. 10.

106. This difference can be clearly seen by comparing the conceptual sketch of the submarine appearing in the 1991–92 Audit report with the bow-on photograph in the 1997–98 report. Australian National Audit Office, *Audit Report No 22, 1991–92, New Submarine Project*, p. xii and, *Audit Report No. 34, 1997–98, New Submarine Project*, p. xii.

107. 'The Collins get well program', *Australian Defence Intelligencer*, December 1999, p. 5. Following tests of the modifications on HMAS *Collins* its commander described it as significantly quieter than before; 'Collins passes that the test', *Advertiser*, 20 October 1999.

108. David Lague, 'Out of the deep', op. cit.

109. Millar, 'Time for sub's critics to let the truth surface', op. cit.

110. 'RAN Collins submarines now on track', *Asia-Pacific Defence Reporter*, December–January 2001, p. 13.

111. 'ASC's early complaint on combat system', *Australian Defence Report*, 17 August 2000, p. 7.

112. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 11.

113. Roy Eccleston, 'Better late than never', *Australian*, 18 May 1998. Eccleston cites anxiety created within DST0 by the quality of some of Rockwell's early work on the CDS.

114. 'Future of Boeing's Submarine Combat System in Question', *Asian Military Review*, May 1999, p. 45.

115. ibid., p. 13.

116. Tom Muir, 'Collins-class submarines on the fast track', op cit.

117. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 28.

118. Tom Muir, op. cit., p. 6, (emphasis added).

119. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 28

120. 'Sonartech Atlas leads bid for a new Collins Combat System', *Australian Defence Report*, 17 February 2000, p. 9.

121. Robert Garran, 'German firm "won" sub bidding contest', *Weekend Australian*, 14 July, 2001, quoting a leaked report from the project evaluation team.

122. A. W. Grazebrook, 'Tough job for the ASC task force', op. cit., p. 52.

123. The Hon. Peter Reith MP, Minister for Defence, 'Submarines Combat System', *Media Release* MIN 244/01, 9 July 2001.

124. ibid.

125. The Hon. Peter Reith, MP, Minister for Defence, 'Australia and US sign submarine cooperation statement', *Media Release* MIN 354/01, 11 September 2001, attachment, 'Statement of principles for enhanced cooperation between the United States Navy and the Royal Australian Navy in matters relating to submarines, p. 5.

126. 'Signs point to US solution for Collins', *Australian Defence Intelligencer*, July 2000, p. 7.

127. A. B. Baker III, 'World Navies in Review', *US Naval Institute Proceedings*, March 2001, p. 33.

128. Ian McPhedran, 'US to upgrade our subs', *Herald Sun*, 10 July 2001.

129. Rear Admiral Peter Briggs, Head-Submarine Capability Team, *Press Conference*, 23 July 1999.

130. Daniel Cotterill, 'Collins submarines on comeback trail', *Australian Defence Magazine*, September 2000, p. 5.

131. 'First Dolphins move in on Israeli navy', *Jane's International Defence Review*, 9/1999, p. 8

132. 'STN Atlas shortlisted for COLLINS combat system replacement', *Australian Defence Report*, 6 July 2000, p. 6.

133. Sonartech Atlas supplied two sonar processing systems as part of the 'fast track program' to provide an initial operational capability with HMA ships *Dechaineux* and *Sheean*: 'Sonartech Atlas awarded COLLINS sonar systems contract', *Australian Defence Report*, 25 May 2000, p. 14.

134. Lincoln Wright, 'Germans in line for compensation over submarine tender', *Canberra Times*, 13 July 2001.

135. Robert Garran, 'Navy locked into US aims', *Australian*, 11 July 2001.

136. Craig Skehan, 'Reith to talk to shunned German tenderer', *Sydney Morning Herald*, 13 July 2001.

137. Jason Sherman, 'Rumsfeld Lobbies Australia on Sub Choice', *Defense News*, 14 May 2001, p. 40.

138. For some counter arguments, reflecting the STN Atlas position see; Graeme Dunk, 'The Collins combat system', *Asia-Pacific Defence Reporter*, December/January 2001, p. 14–15.

139. Robert Holzer, 'Utility of Subs Rises as Targeting Grows More Precise', *Defense News*, 10 April 2000, p. 17.

140. Dunk, 'The Collins combat system', p. 14.

141. Robert Garran, 'Navy locked into US aims'. op. cit.

142. In fact, supporting the US role in maintaining global security is a component of Australia's fifth and lowest ranking strategic objective: Department of Defence, *Defence 2000 Our Future*

Defence Force, Defence Publishing Service, Canberra, December 2000, p. 32, available on the Internet at: http://www.defence.gov.au/whitepaper/docs/WPAPER.PDF

143. ibid., p. 35.

144. ibid., p. 46.

145. McIntosh and Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, op. cit., p. 28

146. 'Raytheon grows its sub interests', *Australian Defence Intelligencer*, April 200, pp. 6–7.

147. Air Vice Marshal Ray Conroy, RAAF, 'Address', *Defence + Industry 2001 Conference*, Table, 'AST Project Review', available on the Internet at: http://www.dmo.defence.gov.au/DMO/function.cfm?function_id=100#group48 The figures given by Conroy relate to the original contract schedule. They differ from those shown in Appendix 1 because the latter shows slippage against revised contract criteria.

148. Graeme Dunk, 'The Collins combat system', op. cit., p. 15.

149. Tom Muir, 'Collins-class submarines-on the fast track', op. cit., pp. 7–8.

150. Robert Garran, 'Doubts over subs delay fix', *Australian*, 20 December 1999. The occasion was when Cabinet decided to not proceed with the new combat system till after the (then) forthcoming defence white paper.

151. Roy Ecclestone, 'Better late than never', op. cit.

152. 'Collins submarine background', *Australian Defence Report*, 26 April 2001, p. 2.

153. Gregor Ferguson, 'Boeing sells Australian Naval Business to Raytheon', *Australian Defence News*, 2 May 2000.

154. Royal Australian Navy, *Australian Maritime Doctrine*, Defence Publishing Service, Canberra, October 2000.

155. Ian Bostock, 'USA to offer Australia scaled-down Arleigh Burke class destroyers', *Jane's Defence Weekly*, 20 December 2000 p. 12.

156. Department of Defence, *Portfolio Budget Statements 1999–2000*, *Defence Portfolio*, May 1999, p. 23.

157. Department of Defence, *Portfolio Budget Statements 2000–2001*, *Defence Portfolio*, May 2000, p. 20.

158. Australian National Audit Office, *Retention of Military Personnel*, *Audit Report* No. 35, April 2000, p. 32, available on the Internet at: http://www.anao.gov.au/

159. The Collins program technically is not over budget, although it could be argued that the cost of overcoming its shortcomings represents additional expenditure that was not budgeted. How much of the rectification program is in this category is difficult to say, as some elements are for expansion of the boats' capabilities that would have been funded separately regardless of the fortunes of the program. ASC claims that a more accurate figure for cost overrun is 12 per cent: Lincoln Wright, 'Five years and $1 billion extra to fix subs', *Canberra Times*, 4 August 2000.

160. Of course, being a very large project, even comparatively modest cost overruns for the Collins submarines will cost the Defence budget more than the sum of these more minor projects.
161. Peter la Franchi, 'RAN forced to accept substandard Seasprites', *Flight International*, 31 October 2000, p. 19.
162. Senate Foreign Affairs, Defence and Trade Legislation Committee, Defence Portfolio Additional Estimates Statements, Debates, 21 February 2001, AVM Conroy, p. 85.
163. Gregor Ferguson, 'Australia May Get AEEW Wish', *Defense News*, 6–12 June 1994, p. 30.
164. 'Boeing team 737–700 and MESA radar wins $2b AEW&C Project', *Australian Defence Report*, 5 August 1999, p. 4.
165. Peter La Franchi, 'Budget cuts Wedgetail numbers', *Flight International*, 25 April–1May, 2000, p. 16.
166. Based on exchange rates of 68.34 and 55.4 for July 1994 and December 2000, respectively.
167. Burak Ege Bekdil, 'Turkey-Boeing Deal Stalls', *Defense News*, 25 June–1 July 2001, p. 10.
168. Ray Conroy, 'Address', *Defence + Industry 2001 Conference*, op. cit.
169. Peter La Franchi, 'Australian Minister admits project has major problems', *Flight International*, 21–27 November 2000, p. 18.
170. Lincoln Wright, 'Defence spending: bigger say for Moore', *Canberra Times*, 25 May 2000.
171. Rear Admiral Chris Ritchie, RAN, 'Future Defence Capabilities', *Defence + Industry 2001 Conference*, 27 June 2001, available on the Internet at: http://www.dmo.defence.gov.au/DMO/function.cfm?function_id=100#group48
172. Allan Hawke, Secretary of the Department of Defence, *Money Matters*, Address to the Royal United Services Institute of Victoria, 27 April 2000, p. 8.

Appendix 1—Major Capital Equipment Project Delays or Cost Overruns

Real cost increases with reasons for variations

Project No	Project Name	Current Approval $m	Real Increases $m	Variation	Reasons for Variation
SEA 1446 Phase 1	Collins Class—Interim Minimum Operational Capability	225.2	128.5	133%	For remedial work on submarines
AIR 5279 Phase 2	Computer Aided Maintenance Management	58.8	32.4	122%	For essential changes to make system easier to use, to develop computer-based instruction package and to cover increased implementation costs
DEF 444 Phase 1	DEF 444 (Classified)	113.0	54.0	92%	Additional functionality
AIR 5333	2CRU/3CRU (Control and Reporting Units)	186.6	81.6	78%	To cover redeveloped acquisition strategy following inability of contractor to deliver the units, and additional functionality included Tactical Data Link 16
AIR 5232 Phase 2	Air Navigational Trainer	38.5	14.8	63%	To meet additional cost associated with replacement of HS748 aircraft. Also, underestimate of cost for prime contract, maintenance and spares
JP 2042 Phase 1A	Bluefin (Classified)	26.8	10.1	60%	Additional operational requirements
JP 2027 Phase 2	Amphibious Transport (LPA)	99.8	36.3	57%	Enhanced capability such as Kanimbla medical facilities, compartment modifications and waste disposal
SEA 1418 Phase 1	Maritime Ranges	32.7	11.4	53%	Underestimate and scope changes

Project No	Project Name	Current Approval $m	Real Increases $m	Variation	Reasons for Variation
SEA 1397 Phase 3	NULKA Missile Decoys	59.3	15.8	36%	Underestimate due to complexity of technology in building production model
AIR 5398 Phase 1	Air-to-Surface Weapon System	406.1	97.9	32%	Underestimate due to complexity of integration and support effort required. Tendered prices for AGM 142 missiles higher than originally planned
AIR 5400 Phase 1	Air-to-Air Weapons	293.8	58.0	25%	Due to higher than expected costs for integrating and testing the Advanced Short Range Air-to-Air Missile (ASRAAM) on F/A-18 and establishing maintenance support. Also, increased costs associated with AIM 120 medium range missile
SEA 1160 Phase 1 and 2	Pollution Control Ship Fitted Equipment	55.5	7.1	15%	Replacement of ozone depleting substances in ship-fitted equipment to comply with *Commonwealth Ozone Protection Act 1989*
JP 5195 Phase 3B	Global Positioning System NAVSTAR	43.6	5.5	14%	Part of New Government Initiatives in late 1996 to enable issue of global position system receivers to Army sub-unit level
AIR 5369	Airlift Simulators Project	72.4	8.2	13%	Enhanced functionality for tactical-flying training and capability enhancement for electronic warfare simulation
AIR 5397	Airspace Control Communications	59.8	6.4	12%	Costs of essential integration work with existing equipment, resolution of interference problems, additional spares and engineering changes

Projects with delays against schedule in excess of six months

Project Number	Title	Slippage of SD(1) against current contract schedule (months)	Contract Signed
AIR 5186	Australian Defence Air Traffic System	59	29 November 1995
AIR 5279 Phase 2	Computer Aided Maintenance Management System–Version 2—Phase 2	48	24 December 1996
JOINT 5195 Phase 2	Global Positioning System Navstar ADF Aircraft	46	14 June 1996
AIR 5232 Phase 2	Navigation Trainer	41	18 September 1997
AIR 5046 Phase 3C	Black Hawk Flight Simulator	38	20 February 1996
JOINT 65 Phase 4	Parakeet	37	21 March 1994
SEA 1229 Phase 2&3	Active Missile Decoy	36	15 August 1996
AIR 5397	Australian Military Airspace Control Communications System	35	25 June 1996
AIR 5276 Phase 2	P3-C Update Implementation	26	24 January 1995
LAND 53 Phase 1B	Ninox—Night Fighting Equipment	22	29 October 1997
LAND 52 Phase 4	Medium Recovery Vehicle	20	22 August 1995
SEA 1114	New Submarine	18	3 June 1987
LAND 116 Phase 3	Bushranger—Procurement of Infantry Mobility Vehicle	18	1 June 1999
SEA 1405 Phase 1 and 2	Seahawk Electronic Support Measures/ Forward Looking Infra-Red	16	31 March 1998
SEA 1411 Phase 1	Anzac Ship Helicopter Acquisition	15	26 June 1997
AIR 5375 Phase 1	Tactical Air Defence Radars	12	11 August 1998
AIR 5401 Phase 3A	Medium Tactical Airlift	11	15 January 1999
SEA 1555 Phase 2	Minehunter Coastal Acquisition	9	12 August 1994
JOINT 1 Phase N&Q/B96	Harpoon Missiles	9	11 June 1997
JOINT 5195 Phase 3B	Global Positioning System Navstar Ground Force Sets	8	24 December 1998

Notes

1. ISD is In-service Date.

2. Covers cost increases in current projects in excess of $5 million that have been approved over the last five years.
3. Cost increases are shown against the current project approvals at December 2000 prices (instead of the original approvals) in order to get a true comparison.
4. Progress of projects is usually assessed against the current contract baseline rather than the original estimated schedule.

Source: Senate Foreign Affairs, Defence and Trade Legislation Committee, *Answers to Questions on Notice*, Department of Defence, Additional Estimates 2000–2001, 21 February 2001, Question 26, pp. 55–57.