
Taking the Past to the Future: The Collins Submarine Project and Sea 1000

Derek Woolner

Australia has commenced a project to build a new class of submarine, due to begin entering service in 2025. They are to have greater capability than the Collins class that preceded them, with a strategic potential as launch platforms for land attack cruise missiles and improved tactical flexibility in networked joint operations. Management of this project can be assisted by studying the Collins submarine project, particularly the successes obtained through the Navy's development and maintenance of a robust concept of objectives for the Collins and the Commonwealth's ability to command access to the means to rectify problems when the project was in difficulties. From this perspective, the paper argues that a concept of operations with greater clarity around issues of joint operations needs to be formulated to guide development of the new submarines and that active use of contingency funding can be an effective tool in risk management during their design and construction.

Australia has embarked on an endeavour to build twelve submarines of a new design to replace the existing Collins class boats from about 2025, under the designation Project Sea 1000.¹ Submarines have been an important component of Australia's maritime defence since the 1960s when force of circumstance led to the Royal Australian Navy (RAN) acquiring six British Oberon submarines after a chequered history in the operation of submarines stretching back to 1914. The construction of the Collins submarines marked the first time that Australia had made the transition from one class to another and the new submarine will signal a further increase in the importance of this type of warship in Australia's defence. The new class will have the potential to undertake an important strategic role, with land attack cruise missiles added to their armament. With advances in information technology and communications systems in particular, they should also possess a considerably improved capability for conventional naval engagements while expanding the fleet's capacity to gather intelligence, including around ports of strategic interest.

The task of delivering this capability will be daunting. Submarine design and construction is a challenge but one that Australia has met successfully with the delivery of the Collins class. This project had its problems but they

¹ This paper commences with the government's approval of the project for a new submarine. For a thorough analysis of the factors that would have influenced this decision, see Ross Babbage, *Australia's Future Underwater Operations and Systems Requirements*, Kokoda Paper no. 4 (Canberra: Kokoda Foundation, April 2007).

largely have been overcome. This paper will study the successes and problems in the delivery of the Collins class to identify concepts that should provide useful insights in the development of the new submarines, looking both at factors that contribute to the development of a successful design and the requirements for managing the acquisition of the developed product through the production phase.

Collins Establishes the Foundations

The Collins class submarine project was a very complex and detailed undertaking spanning some thirty years in a period during which Australia changed fundamentally. The project reflected, indeed sometimes anticipated, the changes that replaced an eighty-year heritage of protected, inward looking and often outdated Australian industrial sectors with enterprises having an export oriented and technologically based outlook. The project encouraged many enterprises to seek accreditation to formalised quality standards,² was an early explorer of the potential of information systems and a successful pioneer of modular construction, the effect of which was to open participation to a wide range of Australian companies.

Formally completed in 2004,³ the Collins project delivered a comprehensively updated submarine warfare capability to the RAN, despite problems and some continuing shortcomings. This capability required more than delivery of the six largest conventional submarines of the modern era. It consolidated the deployability of the submarine force by leaving its builder, ASC Pty Ltd (originally the Australian Submarine Corporation—ASC) as the Collins design authority and with capacity for development, building, periodic refit and overhaul. These are supplemented in Western Australia by the operational support of the Collins Systems Program Office at HMAS *Stirling* together with commercial maintenance facilities at Henderson, across Cockburn Sound from the naval base.

With the Collins project, Australia developed its own procedures to warrant and manage the operational safety of its submarines; the indigenous *Subsafe* licensing regime was one of the significant achievements to emerge from the project. Extensive Research, Development and Engineering (RD&E) capabilities (metallurgy, diesel technology and undersea acoustic research in Melbourne; systems research, design, integration and proof testing at Edinburgh), created or enhanced to support the development of the Collins class, remain as significant supports of their operational

² When the Collins program began there were only thirty-five Australian companies certified to Defence quality standards. As the project neared its conclusion in 1998 there were 1500. Peter Yule and Derek Woolner, *The Collins Class Submarine Story: Steel, Spies and Spin* (Melbourne: Cambridge University Press, 2008), p. 48.

³ This was achieved with the Royal Australian Navy's (RAN) acceptance of all six submarines for operational service. The last of the Collins class, HMAS *Rankin*, was delivered a year earlier.

effectiveness. As well, the unique channels of access to United States Navy (USN) subsurface warfare technology, won during the project's most challenging days, remain as an ongoing support to RAN submarine operations through the joint agreement for cooperation on submarine matters signed on 10 September 2001.

The submarines suffered from some well-publicised technical problems. The most prominent was a combat system that did not perform as specified and was initially so unstable that no acceptance trial schedule could be maintained. Other problems included unacceptable noise levels, unreliable diesels, optically unpredictable and sometimes dangerous periscopes, leaky valves and seals, and completely inadequate communications. These deficiencies were overcome through the combined effort of the project team, the Defence Science and Technology Organisation (DSTO), USN expertise and by contractor redesign. The deployment of a replacement combat system, based on the core of the US Navy's AN/BYG-1(V)8 nuclear attack submarine system but retaining many of the features developed to achieve an acceptable degree of functionality from Rockwell's original system, will not be completed until 2013.⁴

The original project, Sea 1114 cost around \$5 billion, which, allowing for inflation, was actually slightly less than the 1987 contracted price of \$3.9 billion.⁵ Overcoming the performance defects needed additional finance, funded under Sea 1429 and Sea 1439, with an additional \$1.2 billion allocated in total. Some \$140 million was spent to rectify the faults identified during the Collins acceptance trials and almost \$500 million was earmarked for the Replacement Combat System (RCS). The rest funded capability upgrades, such as replacing the communications system that had become woefully outdated since its original specification. The delivery of all boats was delayed for a variety of reasons but the six boats were delivered on average within 26 months of contracted dates. Of complex projects only the ANZAC class frigate, which followed the Collins and benefited from the experience, displays a better performance. Even projects that have been considered models of successful project management, such as the Huon class mine hunters, experienced longer delays.⁶

It is, therefore, difficult not to acknowledge the success of the Collins project in building from scratch something never achieved before in Australia, and which required complex processes and advanced technology that few other

⁴ The replacement system had an in service date of 2006 (but did not go to sea until 2008). Defence Materiel Organisation, 'Collins Replacement Combat System', updated August 2008, <<http://www.defence.gov.au/dmo/lsp/collins.cfm>> [Accessed 30 April 2009].

⁵ Yule and Woolner, *The Collins Class Submarine Story*, p. 325, footnote 8.

⁶ Mark Thompson, *The Cost of Defence. ASPI Defence Budget Brief 2006–07* (Canberra: Australian Strategic Policy Institute, May 2006), p. 112, Figure 4.11 'The Long Wait', <http://www.aspi.org.au/publications/publication_details.aspx?ContentID=93&pubtype=-1> [Accessed 1 February 2009].

nations had mastered. Yet, despite these difficulties, the class was brought on stream in better time than most other benchmark projects.

Some Ideas on Success

THE BEGINNING TELLS THE TALE: A CONCEPT DRIVEN PROJECT

The Collins project has established a viable basis for the development of Project Sea 1000, which is to build the next class of RAN submarine. Consequently, the most important lessons for the new project must be about how the successes of the Collins project were achieved.

The fundamental insight into the management of that project relates to how its most important objectives were conceived at the beginning. Foremost, the RAN developed a set of performance parameters derived from a strong operational concept. The implications of this concept were vigorously contested⁷ and, indeed, were only finally settled by Cabinet decision in 1985 when selecting the preferred tenderers for the funded project definition study phase of the Collins class acquisition.

The disputes have been presented many ways, as between the choice of larger or smaller submarine designs, military or civilian camps within the defence organisation or a regional strategic focus versus forward deployed operations. In reality, what they represented was the poor integration of the Defence organisation at that time, especially for the task of translating endorsed policy into force structure options.⁸ The development of the Collins project began, after all, only a few years after the Tange reforms had produced a single Department of Defence. The disputes were a waste of time, money and creative energies but they did force the Navy to consistently refine its objectives for the new submarine and produce a concept that was able to support the development of the Collins class from the early 1980s onwards.

The operational concept for the next generation submarine was broadly traditional and, based on Second World War experience that forward deployment in the enemy's focal areas had seen the most effective use of submarines, emphasised long range and endurance. There was, however, a

⁷ In one instance, a Force Structure Committee meeting in August 1981 adjourned while still disputing the size of submarine to be the basis of the program. Considerable work went into papers re-examining the issues until in December 1981, John Moten, in charge of Force Development and Analysis, agreed that the Navy had made its case for large-sized submarines. He then assisted the committee process by completing the Minutes of the August meeting with some "constructed" dialogue showing an agreement forming that the Navy's proposal for large sized submarines was preferred. John Moten, First Assistant Secretary, Force Development and Analysis (FASFDA), 'Navy 1114—NCSM', Minute, 23 December 1981.

⁸ This is a problem of no small longevity. Improved arrangements for performing this transition are introduced in the recent Defence White Paper. Department of Defence, *Defending Australia in the Asia Pacific Century: Force 2030*, Defence White Paper 2009, (Canberra: Department of Defence, April 2009), p. 69.

contemporary twist in that the Navy had achieved considerable success in gathering intelligence with the Oberons off—and sometimes in—the approaches to the ports of Cold War opponents. Consequently, the Navy's performance parameters were not just relevant to the unlikely circumstances of unlimited warfare, but represented an ongoing capability that contributed to deterrence in peace-time whilst retaining a latent wartime potential. Analysis of factors such as transit times to operational areas, required time on station and optimum crew endurance indicated the required mission range and duration. These factors in turn, indicated the stores, including weapons, that needed to be carried.

Improvements in submerged endurance and indiscretion rate (that is the ratio of the time that the submarine needed to be near the surface and operating diesel engines to recharge its batteries, compared to the time it is fully submerged) increased the time that could be spent around operational areas and improved the value of the mission's yield. The Oberon class suffered from a limitation of its generator set; it could not both proceed at speed and provide the maximum charge rate for its batteries. To improve performance, a large generator set was specified for the new submarine. These factors indicated the need for a large submarine, a design indeed larger than any conventional submarine then available. This outcome was further supported by the requirement for a large hull to mount the latest generation of sonar arrays. These, and particularly the towed array sonar, provided long-range targeting data that allowed the performance of the sub-launched Harpoon anti-shiping missile to be fully exploited. Analysis of its operational environment and technical requirements therefore provided a firmer outline of the new submarine.

These objectives would not have to be forged in a vacuum; they aimed to exploit developing opportunities. Submarine technology had advanced considerably since the design of the Oberon, itself the final extrapolation of the Type 21 U-boat, the ultimate in German Second World War submarine technology. Since the Oberon had been designed diesel engine power-to-weight ratio had improved by about 250 percent, with reduced fuel consumption. Battery energy density was almost 30 percent greater. This improvement in energy efficiency could now be applied to a less demanding task as the modified teardrop shape of modern submarine design reduced submerged water resistance by about 70 percent.⁹

Furthermore, the growing application of information technology for then novel purposes also seemed likely to influence the physical nature of the future submarine. The Swedish Navy had built submarines with an automated control system replacing a multitude of valve wheels and pipes.

⁹ The preceding discussion reflects many of the points made in, Captain Graham White, 'Justification of Capability for the new construction submarine', *Minute*, 18 January 1985, cited in Yule and Woolner, *The Collins Class Submarine Story*, p. 31.

The conceptual combat system seemed likely to do the work of many crew members. Together, such applications promised to reduce crew numbers from the sixty-three of the Oberon to something around fifty. This was not just advantageous for recruitment and retention in the submarine arm—of concern even in the early 1980s—but would reduce the hotel load (that is, the amount of space, stores and power required to support the crew) of the new submarine, thus providing an even greater improvement in performance.

GETTING IT WRONG

Unfortunately, success does not attend the early formulation of objectives simply because they are clear sighted. The Collins combat system owed as much to experience as the requirements for the Collins platform. As the Collins objectives formed, the RAN was implementing the Submarine Weapons Update Program (SWUP) to modernise the combat systems of the Oberons, which had an almost Second World War vintage manual command arrangement. The SWUP introduced a computerised system and the latest generation of submarine sonars. Integrating the acoustic data was complex and it took some changes of equipment and much RD&E effort but, when perfected, the RAN Oberons became the first conventional submarine capable of operating the USN's nuclear attack submarine weaponry of Mark 48 torpedoes and Harpoon sub-surface launched anti-shiping missiles. The SWUP also consolidated the capacity of the Submarine Warfare Systems Centre (SWSC), both to sustain advanced electronics and to research further developments.

The Navy was convinced that the SWUP, sustained by the expertise of the SWSC, gave it the most advanced combat system in a conventional submarine.¹⁰ In an era where systems mostly came with the platform in a package dictated by the shipbuilder, it feared that this superiority could not be sustained by any combat system likely to be incorporated in an existing design. Opinion within the SWSC was that the combat system for the new submarine would have to be developed as a distinctly separate component within the acquisition program, a radical approach that led to the combat system supplier being issued a contract separate from that to supply the submarine.

A functional specification for the new system was written with the expertise of the SWSC that envisioned a substantial performance increase over the SWUP standard. The upgraded Oberons could track two targets simultaneously;¹¹ the functional specification called for much more and

¹⁰ This conclusion was reinforced when the evaluation team assessed the combat systems of the British Type 2400 and Dutch Walrus submarines then being introduced to their home Navies. Both were adjudged to be less capable than the SWUP system. Yule and Woolner, *The Collins Class Submarine Story*, p. 70.

¹¹ Paul Dibb and Commodore Terry Roach, 'Collins: The Submarine We Had To Have', *Financial Review*, 17 February 1999.

wanted tracking to be performed automatically. Further, display consoles were to be multi-tasked, each capable of performing any task and accepting all data sources. Richard Brabin-Smith, participating in the selection process from the civilian side, thought there was greater risk with the combat system designs than with those for the platforms and questioned the sense in the specifications being so demanding. “100 auto tracks! Whom are we fighting”, he asked and, whilst acknowledging that the designs offered were state of the art, wondered “what is the priority of this for Australia’s strategic circumstances?”¹²

The RAN was aware both that some aspects of the specification pressed against the boundaries of technology and that no one had built anything like it. Nonetheless, personnel at the SWSC were convinced that they had identified the direction of systems development and that their specifications outlined the combat system that would be needed in the 1990s. The RAN was not alone in this conviction, the USN pursuing a contemporaneous and equally fruitless path with the combat system for its Seawolf class nuclear attack submarines (SSN).¹³ In fact, there was little information on which to proceed. There was no accepted working definition of distributed processing, the architecture that was to be specified for the new combat system and Ada, the required computer language, existed only as American development specifications. Both of these features proved to be significant weaknesses of the Rockwell system developed for the Collins class.

Despite these warnings, the evaluation of systems offered to the project became a classic case of familiarity reducing the threshold of risk perception. The success of the SWUP appears to have led to over-confidence in both the SWSC’s ability to generate feasible objectives and the Navy’s ability to assess the compliance of responding tenders. The Tender Evaluation Board’s assessment of the competitors was logically structured and objective, yet familiarity with the consortium led by Rockwell¹⁴ caused the Board to abandon its dry and technical impartiality and adopt an enthusiasm seldom seen in formal government reports. The Board’s report softened the awareness of other participants (such as the Augmented Defence Source Selection Committee to which it reported) about the dangers inherent in the approach the project was about to take

Rockwell has designed a new system ... [That] is a logical follow-up-system to the ... SWUP combat system. In view of the technical and management strengths of the consortium members, the technical risk for the design and

¹² Richard Brabin-Smith, FASFDA to Chair of the A/DSDC (Augmented Defence Source Selection Committee), Minute, 20 January 1987. Brabin-Smith was later to become Chief Defence Scientist and Deputy Secretary, Strategic Policy.

¹³ The USN spent US \$1.5 billion on the BSY-1 system before it was cancelled.

¹⁴ The other major US company in the consortium was Singer Librascope, a central participant in the SWUP project. Former SWSC personnel had also moved to join an Australian firm involved in the consortium.

development and production of the proposed system *is assessed as low*.
[emphasis added]¹⁵

The faith placed in both the technology and the capacity of international technology leaders to deliver it, proved unfounded. The Collins combat system was to fail in architectural concept, technical capability and supplier's corporate structure.¹⁶ Acceptable performance was not achieved until its architecture was changed, with data processing broken out from its original pathways and routed through new American and Australian applications introduced with DSTO assistance after the Navy sought help from the USN.

There was surprisingly little questioning of the combat system concepts during the developmental stage of the Collins project. Apprehension was focused on the physical task of the design, engineering and construction of the submarine platform and the ceaseless debate about this aspect of the project appears to have contributed to a stronger performance in this area. In contrast, the combat system was too little scrutinised, not just in the conceptual phase but also during its later development where, for significant periods, the project lacked qualified personnel to second into the supplier's organisation.

Neither was the management of the combat systems delivery assisted by the contractual structure provided for that purpose. The Rockwell consortium had a separate contract with the Commonwealth to supply its system but was identified as a subcontractor to ASC in the latter's contract with Commonwealth. Rockwell wanted to be a prime contractor and, according to many, behaved as if it were.¹⁷ When ASC grew concerned that the combat system was failing and in 1993 attempted to exercise its contractual status to declare Rockwell in default it was forbidden to do so by Defence. Not surprisingly, thereafter ASC left to the Commonwealth, now in a weakened contractual position, the responsibility of managing Rockwell's system.

In general, the Collins combat system had demonstrated many similarities with the acquisition programs for software intensive systems that were to follow. Those features that came to be replicated were a desire to process centrally input data from too large a range of sensors and then attempt to simultaneously distribute and concurrently display so much data that it exceeded the system's capacity to exchange information and, lastly, to remove human expertise from the loop at too early a stage. These

¹⁵ New Construction Submarine Project, 'Report of the Tender Evaluation Board on the Response Received to Request for Tender No. T 61/72521X', 14 September 1984, p. 6-45 in Yule and Woolner, *The Collins Class Submarine Story*, p. 70.

¹⁶ The effects that the dysfunctional corporate structure of the Rockwell consortium had upon the development of the combat system are discussed in Yule and Woolner, *The Collins Class Submarine Story*, p. 154ff.

¹⁷ *Ibid.*, p. 160.

characteristics were echoed in the objectives of the Kaman Super Seasprites' Integrated Tactical Avionics System and the Recognised Air Picture supposed to be produced by Project Vigilare, the project to provide the ground-based component of the Australian air defence system.

In contrast, the Collins Ship Control and Management System (SCMS) was developed with minimum drama and has performed as expected. As it was central to the performance and safety of the class, there was appropriate concern that this system for the automated control and monitoring of the submarines should perform as intended. A complex system, the SCMS used nineteen computers (with the same Motorola processors as the combat system) around the boat to monitor over 5000 data points—in fact, checking every piece of equipment on the boats as well as controlling their function. It was an extrapolation of the system developed by Saab Instruments for Swedish submarines and escaped attempts to reconfigure it other than as an adaptation to the demands of the larger Australian design. Although not without problems in development, which were mostly a result of poor management structure,¹⁸ the SCMS met its objectives and has performed reliably in service.

The contrasting fortunes of Rockwell's combat system and the SCMS highlight the inherent risk of undertaking systems development by predicting future performance benchmarks and developing, *ab initio*, the combination of sensor inputs, transmission links, data processing and logical assessment outputs to provide a uniquely new capability. Rather than the attempt at a state-of-the-art system for the Collins class, an alternative might have been to migrate a variant of the SWUP system, evolved to process data from the new sensors, to the Collins. In the light of similarly sobering experience in the acquisition of other military systems, a generally preferable option would appear to lie in developing plans to achieve the maximum performance of systems through evolutionary development and, where technology has advanced, staged upgrading of their constituent elements.

Concept of Operations and Australia's Next Submarine

Initial work on the RAN's next generation of submarines was approved in October 2008, with \$4.67 million allocated for studies that will look at areas such as "battery technology and conceptual designs for weapons and payload handling and storage".¹⁹ The Defence Materiel Organisation (DMO) has begun a global search for design, propulsion, weapons and sensor

¹⁸ *Ibid.*, p. 162-3.

¹⁹ The Hon. Greg Combet MP, Parliamentary Secretary for Defence Procurement, *The National Interest-Challenges of a Submarine Building Industry*, Address to the Submarine Institute of Australia, 6 November 2008, p. 5.

systems and an "internationally recognized independent submarine design consultant" will be appointed to assist in early design activity up until 2011.²⁰

This activity should yield important information on the current state of conventional submarine technology and sharpen insight into the problems of applying it to a new design. Yet that information will not of itself identify the characteristics needed in Australia's next submarines, nor even indicate how these features should be determined. If the foundation of the success of the Collins project was Navy's thinking about what it wanted from its next submarine, the most important question for the Collins' successor is: what concepts will underlie Sea 1000?

The battle over the concept of operations for the Collins class appears to have established the physical baseline for Sea 1000—design criteria will be long range and endurance, extended submerged endurance and a high weapon load, indeed one larger and more versatile now that land attack cruise missiles have been added to the next submarines' inventory. These characteristics are already enough to indicate that the next submarine will again be a large, conventionally powered boat and, as such, a unique Australian design.

However, the nature of warfare has moved a considerable distance since the early 1980s and the crucial issues informing the concept of operations for the next submarine do not primarily concern the physical characteristics of the submarine platform, but rather its role in the interconnected battle space of joint operations. This is most obviously a consideration when dealing with submarine operational areas within the range of other Australian Defence Force (ADF) force elements, but it even intrudes into the nature of their use in far distant regions.

The ADF has for some years focused on increasing its military effectiveness by improving the capacity of all force elements to work together, either in solely Australian operations or in coalition with foreign military forces. A central concept that underpins this objective is Network Centric Warfare (NCW), which aims to interconnect information, primarily from sensors, through command and control arrangements to the force elements required to achieve results in the area of operations. This endeavour is important because it offers a major increase in combat effectiveness and, since it has the potential to provide a greater awareness of events in areas where the ADF is operating, because it also should allow consideration of a wider range of engagement options.

Traditionally, conventional submarines have not been a central element in joint operations. Their limited tactical flexibility has made them poor at

²⁰ Ibid.

responding to the changing nature of engagements²¹ and their reliance on stealth for survival has meant that submarines seldom communicate with other units while on operations.²² The Collins class' excellent submerged performance has somewhat reduced its handicap in tactical situations and modern digital communications can be operated to complicate the task of detection. Nonetheless, conventional submarine performance has, heretofore, provided little incentive to develop operational procedures for their use in support of joint operations. Therefore, the Defence White Paper released in May 2009 appears to envisage a major performance improvement for the next class of submarine, allocating to it roles—to “defend our approaches” and “protect ... other ADF assets”²³—previously successfully performed only with the sustained speed and endurance offered by nuclear powered submarines.

While further improvements in performance should be expected from the new design, it is highly unlikely that the next submarines class will be sustaining SSN speeds while remaining submerged indefinitely, so one must assume that the increased effectiveness needed to perform such role is seen as coming from the development of the NCW concept within the ADF.

Together with satellites and high altitude unmanned aerial vehicles, conventional submarines can gather intelligence from close to an opponent's military bases and thereby provide command with a timely awareness of developments. If necessary, this can translate into "targeting quality data"²⁴ for jointly operating units through the RAN's planned Knowledge Command and Control enabler that will underpin its *Future Maritime Operating Concept 2025* (FMOC). The issue of secure two-way communication between submarine and other units when needed, preferably over considerable distance, then is central to the design and development of the next submarine class and the White Paper confirms that they will be equipped with “very secure real-time communications”.²⁵ This is a minimum if the concept for deploying sub-surface launched cruise missiles is not to be limited and inflexible.

However, a central question still needs answering: can a forward deployed conventional submarine provide the near real time data flow needed to add to the combat effectiveness of joint operations, since "increases in combat

²¹ Both the United States and Japan deployed submarines at the Battle of Midway but they could neither anticipate the movements of the fleets nor match the manoeuvre speed of the carrier groups and were, consequently, ineffective.

²² In the Second World War, German U-boats during the Battle of the Atlantic used radio to assemble 'wolf packs' to attack merchant convoys at night. This procedure had to be abandoned once the Allies had deployed enough escorts and the comparatively simple technology of radio direction finding to begin destroying large numbers of German submarines.

²³ Department of Defence, *Defending Australia in the Asia Pacific Century: Force 2030*, p. 64.

²⁴ Royal Australian Navy, *Plan Blue 2006*, <http://www.navy.gov.au/Publication:Plan_Blue_2006> [Accessed 4 May 2009], p. 5.

²⁵ Department of Defence, *Defending Australia in the Asia Pacific Century: Force 2030*, p. 70

power from being a networked force are derived from the quality and timeliness of shared information",²⁶ without abandoning the stealth on which depends the safety of conventional submarines? Stealth is also important in submarine operations because it evokes a disproportionate response from opposing forces, which can have a strategic effect should it be possible thereby to vitiate the opponent's efforts. In contrast, stealth also provides nations with "deniability" that their forces are involved in any untoward activity. Deliberate communication may be an effective means of triggering disproportionate response but is altogether antithetical to deniability. Of course, the greatest benefit of a submarine's stealth is to allow it to attack the enemy in areas where no other platform could survive. It is the relationship between this rather more direct use of a submarine's capabilities and using it to expand the potency of a naval task group that needs further thought.

There seems to be a general Defence expectation that "submarines will be increasingly incorporated into task groups as the technological advancements in NCW allow geographically distant assets to be centrally coordinated by the task group commander",²⁷ and the White Paper sharpens this a little by nominating "gathering battlespace data in support of operations"²⁸ as one of the roles of the new class. Current thinking within Defence is that utilising submarines as data nodes will happen since "for the Navy, NCW will largely be an evolution of existing practices".²⁹ This may be so for the RAN's surface and air assets but there is little sign in the FMOC of existing practice that can be "evolved" for submarines.³⁰

This divergence suggests that more thought needs to be given to a fundamental issue at the root of the concept of operations for the RAN's future submarines, well before designs are sketched out. The issues involved can be addressed adequately by scientific research and evaluation, for which the ADF and DSTO are well equipped. Nonetheless, the consideration will be complex as the outcomes will influence not only choices

²⁶ Department of Defence, *NCW Roadmap* (Canberra: Defence Publishing Service, February 2007), p. 5.

²⁷ *Ibid.*, p. 55.

²⁸ Department of Defence, *Defending Australia in the Asia Pacific Century: Force 2030*, p. 70.

²⁹ *Ibid.*, p. 34.

³⁰ The Future Maritime Operating Concept mentions networked submarine systems only in the context of fixed underwater sensors but, even in this limited context, notes "the under sea environment presents significant challenges for communications that must be overcome to enable networked, area denial systems". (That is, for anti-submarine warfare, not for submarine operations.). Later, it states "Technologies are enabling higher data transmission rates across greater distances, the *limitations of the water column being acknowledged*." (emphasis added): Australian Defence Force, *Future Maritime Operating Concept—2025: Maritime Force Projection and Control* (Canberra: Defence Publishing Services, January 2007), p. 12, 13.

on information technology and communications requirements for the new submarines, but will extend to other systems and even to hull design.³¹

Because the Australian operating environment is very different from that of other conventional submarines, the RAN's concept of operations for the new class will not necessarily yield design solutions with wide international acceptance. For instance, there is a general assumption that because they are in extensive use overseas, Air Independent Propulsion (AIP) systems will be a requirement for the Collins successors. AIP systems are important for small European submarines operating in heavily patrolled waters on deployments lasting about a working week. They may not necessarily be useful for Australian submarines deployed over thousands of nautical miles on seventy-day operations. AIP systems are heavy and occupy hull volume (always at a premium in submarine design), or space under the casing, also at the expense of other functions, such as launch canisters for cruise missiles.

Kockums designed an AIP installation for the Collins but it added ten metres (and additional cost) to a seventy-eight metre boat. DSTO tested two forms of AIP system in the mid-1990s, but trials of HMAS *Collins* were to prove that its high generator capacity and large battery storage provided an unequalled performance and allowed the RAN to develop operational procedures for an energy cycle under patrol conditions that required "less than a very few minutes" in every twenty-four hours to adequately recharge the batteries. On balance,

Sea trials of the first-of-class have proved 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.³²

Consequently, further research on AIP was dropped. With the next class likely to be another large design, with volume for even more battery space made available by improvements in systems and with greater performance from advances in electrical generation and storage technology, one can expect an even better submerged endurance than achieved by the Collins

³¹ For example, it is generally expected that the use of 'robotic' Unmanned Underwater Vehicles (UUVs) will be a feature incorporated into the new submarines' design and the concept is endorsed in the White Paper. These UUVs have been seen as enabling real-time intelligence transmission from forward areas (as well as tasks such as mine laying). However, UUV development is as yet so nascent as to require considerable thought on their physical construction, systems capabilities and operational procedures, let alone the requirements that they may impose upon the submarine design. Therefore, a more considered assessment of the ability of submarine deployed UUVs to meet RAN requirements within a reasonable time scale might be less sanguine about their performance and could possibly argue that the new submarine project would benefit from their exclusion.

³² Jons Janssen Lok, 'Australia Rethinks AIP for Collins Class Boats', *Jane's Defence Weekly*, 17 July 1996, p.15, quoting Captain Paul Greenfield, RAN, then New Submarine Project representative at ASC.

class. Whatever the design outcome, the point to note is that the availability of a technology does not by itself indicate that it will be the best option for achieving the RAN's objectives. These can only be understood in the context of the concept of operations for the new class of submarine and the evaluation of where effort and cost will best contribute to achieving the Navy's aims.

In such evaluation a central issue will be the nature of the combat system for the new submarine. The current assumption, underwritten by the sobering experience of the Collins combat system, is that whatever appears in the new submarine will have evolved from the process of providing the Collins Replacement Combat System (RCS). This is certainly the view of the Chief of Navy, Admiral Russ Crane:

through our close association with the USN we have a very powerful and capable combat and weapons system that will evolve to meet future threats and embrace new technologies as they come along. ... one of our options would be to spiral off this for the next generation of submarines. I would go so far as to suggest that the future version of the US SSN combat system, weapons and I add possibly sensors to this equation, might form the pre integrated [military off the shelf] option we put to Government for what we all know is the highest risk element of projects such as this.³³

While this is an appropriate strategy, more is needed to ensure that the new submarines will have a combat system suited for 2025, especially if requirements dictate their more extensive participation in joint operations. Reserving space for additional operators in the design will allow for less dependence on complex systems where integration fails or appears highly risky. A more vigorous development of the RCS over the rest of the Collins service life will be helpful. The Collins RCS retains more of the old Rockwell design than is generally appreciated. It was originally intended that it would combine the tactical and fire control elements of Raytheon's USN SSN system, combined with an STN Atlas interface to process data from the existing sonars. However, to reduce costs the sonar processing solutions from the combat system augmentation program of 2000 were retained.³⁴

Because of such weaknesses in the evolutionary growth path towards a combat system for the new submarines, upgrades for the Collins combat system, such as Sea 1439 Phase 6 for their sonar, assume an added importance. Additional expenditure and RD&E on these programs will be justified where they assist development of a more mature system for the new

³³ Vice Admiral Russ Crane, Chief of Navy, 'Submarines in Australia's Future Maritime Defence—Chief of Navy Perspective', Chief of Navy Speech to the Submarine Institute of Australia Conference 2008, 6 November 2008, <<http://www.defence.gov.au/media/SpeechTpl.cfm?CurrentId=8420>> [Accessed 30 April 2009].

³⁴ As Bob Clark, one of the most experienced systems experts involved with the Collins class, commented: "we should have changed the name of the project at the time from Replacement Combat System to something less grand as we really only replaced tactical and fire control and augmented the sonar". Yule and Woolner, *The Collins Class Submarine Story*, p. 308.

class of submarine. The viability of this approach has been strengthened by the RAN and DSTO being established as the design approval authority for the RCS and by the considerable advances in DSTO's systems analysis capabilities, most recently added to by the creation of the Defence Systems Integration Technical Advisory.³⁵

Doing the Impossible: Building Submarines in Australia

HOW THE IMPOSSIBLE WAS ACHIEVED

A clear view of operational objectives was only one feature of the early planning that underpinned the outcome of the Collins project. The planning differed significantly from processes of the day in considering all aspects of the acquisition strategy concurrently with development of the Required Ships Characteristics (RSC). This was not so much an attempt to streamline the development of the project as it was a recognition of a fundamental element of military efficiency, that capability cannot be enduring unless it is sustainable.

The project team under Captain Graham White did not formulate the issue as bluntly as this but the Navy fully realised that the efficiency of its submarine force was impaired by unsatisfactory support arrangements. The RAN had experienced difficulty maintaining its O-boat fleet as time had passed. Through-life-support was never easy with designs of the Oberon era and the periodic refits performed at Vickers' Cockatoo Island Dockyard in Sydney Harbour were complex and expensive,³⁶ with overseas suppliers providing 85 to 90 percent of support.³⁷ With the Royal Navy preoccupied by nuclear boat operations it was increasingly difficult for the RAN to get British advice and support. With the Falklands War, this all but ceased.

The capability of the RAN's submarine force was directly linked to its availability and the operational availability of the new submarine would be best enhanced with through-life-support provided by the local industry that an Australian build program would create. This would represent an operational benefit outweighing the additional cost entailed. Later, Paul Dobb was to note that the six Collins submarines would be the equivalent of nine

³⁵ This is a joint DSTO and DMO group, established to evaluate and assist projects involving complex systems integration. The Hon. Warren Snowdon MP, Minister for Defence Science and Personnel and the Hon. Greg Combet, Parliamentary Secretary for Defence Procurement, 'New initiative to improve systems integration', Defence Media Release 008/2009, 22 January 2009.

³⁶ The refit of HMAS *Oxley*, the first of an Oberon submarine in Australia, cost 76 percent of its purchase price. Oberon submarine refits generally took two years to complete. '\$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.

³⁷ Kenneth Davidson, 'Navy Determined to Build Submarines in Australia', *The Age*, 17 January 1985.

or ten Oberons, increasing the RAN's potential operational presence to simultaneous patrols in three separate areas.³⁸

Although the early conceptual work of the RAN was critical to the success of the Collins project, the decision to build the boats locally determined the nature of the project more than anything else, for it fundamentally changed the nature of its development. Once it was agreed to build in Australia, all management concepts had to be changed to fit. The project was no longer a traditional capability acquisition program but now had to balance the objectives of naval capability, industrial development, complex project management, parent navy responsibility and through-life logistics support and planning in equal part, all to suit uniquely Australian requirements and all developed afresh.

The early work of the project team and supporting elements within the RAN, particularly under Bill Rourke as Chief of Navy Materiel, involved considerable effort within Australia and overseas to understand what would be involved in local construction. This enabled the project team to clearly define the challenge and allowed them to identify the responses required when industry was approached. Thus, responders to the first tenders were asked not just for offers of equipment but for concepts for and details of its construction in Australia. Unsurprisingly, implementation was difficult and controversial, for not all of the tenderers understood how serious was the RAN's insistence that local construction was an integral part of the project.³⁹

What made construction in Australia possible was the ability of the project team to conceptualise the task in a way completely different from the conventional. When Graham White began his work, the general attitude outside the RAN was that submarines could not be built in Australia.⁴⁰ This was in part because of the perceived complexity of submarine construction but also a result of the appalling record of traditional shipyards in Australia. These were characterised by poor productivity and an inability to maintain schedules, created by poor management conditions often resulting from irregular and intermittent workloads. Consequently, labour relations were

³⁸ This improved capability was due to a combination of factors, of which the improved support arrangements were one. The designs of the German and Swedish contenders were developed to reduce maintenance requirements and submarine systems had, in general, become more reliable than those of the Oberon generation. Paul Dibb, *Review of Australia's Defence Capabilities* (Canberra: AGPS, 1986), p. 123.

³⁹ Jim Duncan, the leader of South Australia's effort to become the site for the production of the Collins, commented in his diary in 1984, "VSEL (commonly known as 'Vickers' and who were the British contenders) are bitter that they are being beaten by a production technology ... They claimed Canberra is obsessed with production technology rather than submarine technology." Yule and Woolner, *The Collins Class Submarine Story*, p. 56.

⁴⁰ The attitude that submarines could not be built in Australia was not confined to government and was accepted by some of the most powerful industrial figures. Brian Loton, then Managing Director of BHP, responded to White that, "we can't do these things in Australia—give up on the idea". Yule and Woolner, *The Collins Class Submarine Story*, p. 47.

appalling and capital investment inadequate. Naval construction projects were based on designs from a variety of sources and the transfer of intellectual property and production planning had been patchy at best. The early years of the Collins project coincided with an economic recession so severe that it changed Australia's manufacturing industry.

Those involved with the Collins project, particularly with the state government efforts to gain production work, played a major role in changing Australia's industrial landscape. This was necessary, because the project team had come to see that producing the Collins class was not shipbuilding but the project management of a complex assembly task. On their inspections of world submarine construction the project team and state government task forces were able to see a tangible example of this approach in the modular construction technique demonstrated convincingly by the Kockums submarine construction facility at Malmo.⁴¹

However, if modular construction was to be introduced to make feasible the building of submarines in Australia, the selection criteria would again have to be radically altered. Modular construction allowed the project team to verify that Australian industry could build, or develop the capacity to build, the components and structures needed to complete a submarine, but it required tender respondents to present a management system that allowed the reliable and efficient assemble of those components into an effective submarine. The formulation of this concept was assisted by the innovative approaches to production management, site arrangements and industrial relations that were becoming available. By the early 1980s, information technology was spreading into industry, with the realisation that the consequences would be considerable. As the Collins project developed, these influences spread from design to production management and on to the development of logistics, training and through-life-support planning. The South Australian submarine task force for one did not miss the potential of computers to support design and manufacturing processes, and argued that Kockums construction techniques were five years ahead of their European counterparts, and two years ahead of American constructors such as Newport News.⁴²

Deciding that the RAN's next submarine would be built with modular construction changed the project and made feasible what was previously considered impossible. Hence the concept underlay much of the success of building the Collins class. The project acquired naval vessels with 70 percent Australian industry content at a time when Defence struggled to get

⁴¹ Ibid., pp. 50-1.

⁴² 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. Newport News, then building the later series of Nimitz class aircraft carriers, had adopted Kockums' computer based management system and reported that they had reduced production costs by up to 25 percent.

a 10 percent offset in major acquisition contracts with overseas prime suppliers. It underlay the construction of ASC as a facility capable of turning out a submarine per year, better than most overseas submarine constructors and barely believable in an environment where extensive construction delays had been endemic. The success of the concept provided the basis of support for Australia's submarine force for the life of the class and widened the base for RD&E, with small Australian companies supplying components as diverse as the DSTO developed anechoic tiles, and data management systems used in remediating the defective combat system.

THE PROBLEMS THAT GO WITH THE VERY DIFFICULT

As good as it was, the production aspects of the Collins program suffered from a number of problems, some of which were inherent in the approaches that made the project a success. These highlight a number of cautions for the management of Sea 1000. The Collins project's initial risk control strategy was to select a design that, at the least, was based on a submarine in service or in the process of entering service with the parent navy. However, the RAN, having decided on the design criteria discovered that, as we now know, no existing design could meet its requirements. This being so, the assessment teams rigorously determined the probability, cost and other considerations in raising the deficient aspects of each design to the standard of the RSC. The very logic of the processes for adjudicating the best combination of platform and systems performance, industrial program, price and schedule appears to have obscured the project's move away from its risk management strategy.

It is now obvious that the project had clearly become a developmental vehicle for a unique class of submarine and that the acquisition strategy no longer reflected the nature of the project. This development was compounded by a deteriorating economy where the government's fiscal priority was to reduce its spending. The project insisted that, for the integrity of the RAN's submarine capability, the performance of the Collins class should not be compromised and, consequently, project funding was thinly spread in other areas. Significantly, given the history of the project, this action only left a designated contingency fund of 2.5 percent to rectify any faults that emerged. Usually, a 15 percent contingency is allocated for complex engineering tasks and it is ironic, that the total of the funds subsequently allocated under new project designations to rectify Collins performance shortcomings and modernise equipment amounted to a margin of some 20 percent over the fixed contract price.

The Collins problems were fixed in any case by the usual public finance procedure of raising new appropriations. However, the lack of an adequate contingency with agreed process for disbursement to overcome deficiencies in the delivered product contributed to antagonistic relations between customer and supplier that threatened to jeopardise the project's outcome. The rising dust from the resultant confrontation convinced politicians and

public alike that something must be wrong, and this attitude further damaged the project.

The Collins project was notable for the use of a fixed price contract. This was very much a product of the times as it was a model intended to avoid the problems of significant cost overruns that were a feature of preceding acquisition projects. The contract model was later held to be too inflexible and responsible for many of the difficulties that emerged later in the project and slowed action to fix the problems.⁴³ Nonetheless, it is probable that the disputes over fixing the Collins shortcomings had a more direct link to the money that could not be forthcoming because of the inadequate allocation for contingencies. In fact, far more significant to the course of the project was the belief underlying the fixed price model that a contractor's signature would see it taking responsibility for the risks and the obligations required to discharge the contract. The assumption proved to be by no means guaranteed, as developments during the life of the project proved capable of defeating the intent of any legal obligation, regardless of earlier agreement between the participants.

A dominant issue that frequently undid the intent of the contract was industry politics. The term is used here not in the sense of intrusion by industrial entities into the public political process but of problems arising from the conflicting agendas of the participating companies. This factor was difficult to avoid since the commercial bodies involved would always have their own interests to safeguard, regardless of their conjoint participation with others to meet the Commonwealth's objectives.

A casualty was to be the Collins combat system, where the politics of protecting commercial interests were to prove disastrous. Rockwell and Singer Librascope may have been members of the successful consortium but their separate commercial goals placed them as competitors in the world outside the Australian project. After the contract was awarded, Rockwell, wanting to avoid advantaging its competitor, asked the inexperienced junior consortium member Computer Sciences of Australia to write the combat system software. Singer drew its own conclusions, delivered on its obligations early and effectively left the consortium—its expertise (an important factor leading to the consortium becoming preferred supplier) was not available when, later, the combat system failed to meet requirements.⁴⁴

As noted above, Defence exacerbated the industry politics that had compromised the combat system's development when it refused to support ASC in its desire to default Rockwell for non-delivery on its sub-contract. The action supported Rockwell's desire to be directly responsible to the

⁴³ Malcolm McIntosh and John Prescott, 'Report to the Minister for Defence on the Collins Class Submarine and Related Matters', Canberra, 20 June 1999, p. 22.

⁴⁴ Yule and Woolner, *The Collins Class Submarine Story*, p. 159.

Commonwealth and encouraged it to seek variations to its contractual obligations. It also sent a message to ASC that, since Defence had failed to support it in enforcing the Commonwealth's own contract, ASC should leave it to Defence to ensure that the combat system met the RAN's requirements. Yet, in complete contrast, at an earlier date the project office had intervened in the industrial politics of the initial ASC consortium when it acted to remove Chicago Bridge and Iron (CBI) from the company. CBI was a large American project engineering company with a profitable history of building turnkey projects for other companies to operate. Its philosophies did not sit easily with those of Kockums and in the late 1980s the submarine project office had identified the friction between the two as threatening the planning and coordination of the early industrial development of the project. By March 1990 CBI had sold its 20 percent share in ASC.⁴⁵

There is a more definitive manifestation of industry politics, where market imperatives remove a contractor altogether, causing turbulence and delays and (often of significant consequence) the loss of the expertise and dedication of foundation commercial personnel. Of the original ASC consortium, Wormald (then one of Australia's leading technology developers) ceased to exist early in the life of the project when it was taken over by market speculators in a period of cheap finance, and dissolved soon after when economic conditions soured. Thus, years before a boat had been launched, the nature of the consortium building them had totally changed. Similarly, Rockwell's US parent left the military systems market in the 1990s, selling its interests to Boeing, who were thereby flick-passed the problems of the Collins combat system. Kockums itself was acquired by its old competitor, HDW, triggering a government take-over of ASC, which whilst allowed under the contract, was nonetheless completely against the direction of general economic policy under the then Coalition government.

Then again, even with the best of will, a company might find its technological capacity rendered insufficient by the changes that inevitably occur over the lifespan of most major acquisition projects. There was an element of this in the dispute that occurred between Kockums and the Commonwealth over the need to improve the cavitation performance of the boats' propellers. Even cooperating to the fullest, Kockums could not hope to compete with the output from the project's access to the USN's underwater technologies, or even to be in a position to assist the absorption of that highly classified information into the Collins design. Notwithstanding, Kockums retained a responsibility to safeguard its shareholders' interests and its continuing roles in the project and thus initiated protracted legal action, the most publicised part of which was to challenge the RAN's dispatch of a Kockums designed propeller to the United States. Ostensively about the competing rights of Kockums and the Commonwealth to the former's intellectual property, the

⁴⁵ Ibid., pp. 181-2.

event was a classic example of the consequences of growing misalignment between project requirements and an entity's industrial political pressures.

The lesson is that ultimately the Commonwealth cannot leave it to suppliers to solve problems in major defence acquisition projects. The acquisition cycle of most major military systems is generally over ten years and is out of balance with the rapid growth expectations formed within commercial markets over the last few decades. It is unlikely that all of the industrial participants initially contracted at the beginning of Sea 1000 will still exist when the last boat is delivered in the 2030s. Neither can it be guaranteed that those that remain will possess at the end of the project the same comparative technical excellence that justified them being selected. Yet it is at this point, when the product has reached a stage where its performance can be assessed, that leading technical expertise will be most needed.

In truth, it is only the Commonwealth that has an abiding interest in the objective of a project over the whole period, namely that it continues to meet the needs of the ADF. For commercial entities the economy and commercial factors are dominant. One feature that stands throughout the Collins project, especially during the period where its problems were being overcome, is that the Commonwealth must command its own access to the means to rectify problems if it intends to have projects achieve their objectives.

BUILDING SEA 1000

The project to construct a successor to the Collins class has the significant advantage of being able to call on the considerable infrastructure and experience created in building those submarines. With the responsibility for conducting the periodic refits of the Collins submarines, ASC has retained a substantial portion of its skills base, as submarine refit is in many areas no less an exacting task than their construction. Although ASC does not have the capacity to design the new submarines, its technical capabilities have been sustained through responsibility for the design modifications for such programs as the new submarine heavyweight torpedo. Because of the highly integrated positioning of equipment within the submarine pressure hull, the design of modifications must take account of implications for the disbursement of other equipments, the dynamics of hull balance and of other factors such as the submarine's magnetic signature. It was because of such requirements that the Commonwealth negotiated with Kockums to transfer the submarine design authority to ASC at the conclusion of the Collins build program. This situation provides a more solid basis for proceeding with the new project than could have been dreamt of when Graham White and his team initiated work on the Collins class.

There has lately been something of a campaign questioning ASC's performance of its long-term maintenance contract.⁴⁶ From this has emerged an argument that the construction phase of Sea 1000 is now open to competition and that companies may therefore push ASC out of the running, provided only that they use facilities adjacent to those occupied by ASC in Port Adelaide. The government contends that this will ensure that the cost of the new submarines will be reduced through competition.

There is some sort of sublime nonsense here. The production technique of modular construction will certainly make it possible for other companies to build components of the new submarines or even to assemble completed boats, if there is justification for an accelerated delivery schedule. Yet a lesson that can be clearly drawn from the Collins project is that project development, management and accountability can be lodged only within one industrial entity, and that to defuse that authority is asking for trouble. On the one hand, the government's principal card in the industrial developments for Sea 1000 is that it retains ownership of ASC. As such it is unlikely that the Commonwealth would devalue this asset by not awarding work to the company. On the other hand, should the evaluation of options indicate that ASC is no longer competitive, the Commonwealth can sell ASC to its preferred tenderer as a condition of undertaking the contract. It is hard to think that agreement could not be reached on the basis of the value of ASC's modern facilities and a project totaling \$35 billion.

In the scheme of a project not intended to begin deliveries until 2025, focusing on ASC's supposed inefficiencies in submarine refit is a short term matter. From the perspective of the long-term success of the project, there are other issues that deserve attention. It is ironic that the current campaign against ASC concerns submarine maintenance, for this task has never been predictable or cheap mostly due to the variability of corrosion damage, and options for achieving economies are always discounted by the absolute need to safeguard lives. Running submarines is an expensive business, with each of the Collins class costing on average almost 80 percent more to maintain than a comparatively simple ANZAC class frigate.⁴⁷ This disparity reflects

⁴⁶ John Kerin, 'Surfacing Row Could Sink Sub Plans', *Australian Financial Review*, 24 April 2009; John Kerin, 'Submarines Boss Safe—For Now', *Australian Financial Review*, 30 April 2009; John Kerin, 'BAE Full Ahead for Sub's Tender', *Australian Financial Review*, 5 May 2009; John Kerin, 'Sub Builder Boss Opts to Cast Off', *Australian Financial Review*, 5 May 2009. The conjunction of such a number of well informed press articles usually indicates the conduct of a premeditated campaign.

⁴⁷ Cumulative spending on maintaining the six Collins submarines over the three years to the end of 2009-2010 is estimated at \$966 million. The comparable figure for the eight frigates is \$720 million. Department of Defence, 'Table 3.8, Top 20 Products, by Expenditure as Forecast in the Portfolio Budget Statements 2007-08', *Annual Report 2007-08*, Volume 2 (Canberra: Defence Materiel Organisation, October 2008), p.51; Department of Defence, 'Table 2.5.3- Top 20 sustainment products by forecast expenditure in 2008-09', *Portfolio Additional Estimates Statements 2008-09*, Part Two, (Canberra: Defence Materiel Organisation, November 2008), p. 167; Department of Defence, 'Table 69: Top 20 Sustainment Products by Forecast Expenditure

both the complexity of the submarines and the challenges of operating in the hostile subsurface environment. Nonetheless, with Sea 1000 intended to provide twelve submarines, cost of ownership for the new class will become a significant issue. Just as the Navy sought higher rates of availability when it initiated the Collins project, so should lowering the cost of ownership, with attention to corrosion control prominent, be a criterion in developing the next class of submarine for the RAN.

Defence is required to provide the government with an off-the-shelf option for the new submarine class. As discussed above, however, the design requirements to meet the RAN's objectives are likely to be such that they can only be met by an extreme extrapolation of a submarine design bureau's experience, as indeed was the process in designing the Collins class. Even were the Collins itself to form the basis of the exercise, Sea 1000 will clearly be a developmental project seeking to incorporate three decades of changes in technology and the military arts. It will clearly need a better process for managing changes in the design than was available to the Collins project.

An adequate contingency fund with agreed procedures for its management will be a basic requirement. This seems obvious but the case for this tool must be made explicitly, for it has been too easily assumed in the past (including with the Collins project) that ministers and the public would balk at such an explicit indicator of risk. The necessity of contingency funding will have to be clearly explained during the formative days of the project. Perhaps one course for emphasising this would be to allow the contingency fund a more active part in the management of the project, rather than holding it in reserve until the test and evaluation stage is reached. One role that the contingency fund could play is to finance research and development of high risk changes that will inevitably arise as the design enters production, especially as it cannot be assumed that responsibility for implementing changes will always fall to contracted commercial parties.

Changes that were not researched at the time were made at various stages during the development of the Collins design. For instance, the design of the generator machinery spaces was changed during the detailed design phase and new isolating blocks (intended to stop the transmission of vibration through the hull structure and into the water as noise) were developed. Changes were unavoidable throughout this stage because of reworked sub-contractor data, refined Service objectives and more detailed awareness of the relationship of components. In many cases there was conjoint responsibility for the development of the design modifications and, although the contract was able to accommodate them as 'no cost' options, there was neither money nor authority in the document to conduct basic research on

2001-10', *Portfolio Budget Statements 2009-10* (Canberra: Defence Materiel Organisation, May 2009), p. 162.

the technologies involved. The isolating blocks did not work as intended and had to be changed after research by DSTO's Ship Noise and Vibration Group identified them as one of the sources of noise that had emerged after HMAS *Collins* began its trials.⁴⁸ Obviously, it would have been of greater assistance had this research begun at the time of redesign.

The problem faced by the Collins project office was that some of the most important research capabilities did not exist when the project commenced. The Ship Noise and Vibration Group was itself established as a separate entity, in an act of foresight, by the direct intervention of the project chief, Admiral Oscar Hughes. The ability of the project team to directly manage technical risk for Sea 1000 is much improved, given the facilities established during the Collins project, access to USN submarine technology and new establishments, such as the underwater test facility opened in November 2008.⁴⁹ Active management of the contingency fund for risk mitigation during the boats' development would allow the Sea 1000 project to influence the development of relevant technological support, either by funding the development of new DSTO capabilities or commissioning R&D from commercial sources. It would thereby provide a degree of proofing to this aspect of project management, as a protection against changes in external priorities that might have unforeseen implications for the management of Sea 1000.

There is another issue which the contingency fund should be used to address. The long timescale of major acquisition projects invariably means that circumstances will have changed by the time equipment is delivered and that the sponsoring Service will now wish to operate in ways different from those initially envisaged. This is a familiar issue but managing it has always proved difficult. For instance, of the \$1.17 billion allocated to rectify the faults of the Collins design following the McIntosh/Prescott report, \$300 million was to meet the costs of changed operational requirements (compared to only \$143 million to rectify performance faults).⁵⁰ It would have been preferable had such alterations been made throughout the course of the project's development, but such changes disrupt the flow of production and have been held to be a major cause of poor acquisition management. Measuring the value of various requests for change against the funding provided by the contingency fund would provide the Navy with a means of quantifying the impact of its expectations against the project's objectives, and provide a tool for prioritising the desires of the sponsoring Service.

⁴⁸ Yule and Woolner, *The Collins Class Submarine Story*, pp. 239-40.

⁴⁹ The Hon. Warren Snowdon MP, Minister for Defence Science and Personnel, 'A Fish Tank for Future Submarines', *Defence Media Release* 181/2008, 21 November 2008.

⁵⁰ Yule and Woolner, *The Collins Class Submarine Story*, p. 324.

Conclusion

Project Sea 1000 will be a difficult and challenging project. The capabilities built for, and the experienced gained during, the Collins submarine project will be of great benefit to those building the new submarine. However, the demands of a new era will impose performance standards on the Sea 1000 team as exacting as those faced in delivering the Collins class. Because of this, it is important that the objectives for the new class of submarine be thoroughly developed and clearly enunciated and that its production be undertaken by companies with a record of performance but, as well, an aptitude in adapting new technology. Ultimately, it will remain crucial that the Commonwealth retains, throughout the life of the project, clear paths to the technology and advice that it may need to overcome problems—for it is the only participant that is guaranteed to retain a compelling interest in the state of the project some two decades hence.

If these circumstances can be maintained, the outcome of Sea 1000 could be truly significant. Improvements in propulsion, components and information technology gave the Collins a performance that was a quantum leap beyond that of its predecessor. Developments during the quarter-century since the initiation of the Collins project have been no less profound and offer strong prospects for the development of a truly outstanding conventional submarine. It is feasible that design advances and the networked systems capabilities of the new design will at last produce a conventional submarine with the tactical flexibility of a nuclear boat. If that proves to be the case, the RAN will undoubtedly revise its project objectives and seek to use the new submarines in unforeseen ways. That will inevitably cause extensive problems in the management of Sea 1000 but that is the way of complex defence acquisition. Maintaining the flexibility in project management to deal with success is as important as the capacity to address problems.

Derek Woolner is a Visiting Fellow at the Strategic and Defence Studies Centre at the Australian National University. He is co-author of The Collins Class Submarine Story: Steel, Spies and Spin, released by Cambridge University Press in April 2008. Derek has written extensively on maritime border control issues, military capability development, acquisition management and defence finance, and drafted the report of the Parliament's Joint Committee on Foreign Affairs, Defence and Trade into Australia's mine countermeasure needs. Derek was Director of the Foreign Affairs, Defence and Trade Group of the Australian Parliament's research and policy advice services until January 2002. Early in his career, Derek was policy adviser to Defence Ministers Lance Barnard and Bill Morrison. During this period he was involved in the acquisition of the FFG-7 frigates, P-3C Orion LRMP aircraft and Leopard tanks. derekwoolner@netspeed.com.au.