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Australian Naval Procurement Cycles: Lessons for Other Small Countries

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Abstract

Defence procurement agencies in smaller countries, such as Australia, face a difficult challenge when seeking to acquire new weapons systems that are either intrinsically complex or idiosyncratically tailored to local needs. If they seek to rely on production in-country, they must draw on domestic infrastructure almost certainly too limited in its technological breadth and depth for the task of efficiently producing a wide range of sophisticated military products, which are likely to be internationally uncompetitive, into the bargain. If they "leave it to the market" and award contracts on the basis of a competitive process and set up arms-length relationships to pursue compliance, they may find themselves hostage to suppliers that cannot be replaced once the contract is under way. If, instead, they seek supplies from government-owned arsenals and shipyards, they may find it difficult to resit political pressures to preserve legacy sectors, facilities and products. And, if they look to overseas suppliers to meet their requirements, they usually lack the market power to negotiate favourable terms and sometimes to have their requirements met at all.

These challenges, and the related issue of whether to use defence acquisitions to support domestic industry, are discussed in the context of procurement of naval vessels and support services in Australia. The country has long had domestic warship building and maintenance capabilities, and its shipbuilding sector "is the jewel in the defence industry crown. Naval vessels are the only major platforms built in Australia, and firms that build them are the highest profile and most prestigious element of defence industry" (ASPI, 2002, p. 8). In this paper, we consider Australia's three post-WWII shipbuilding cycles to illustrate how successive federal governments have grappled with these perennial procurement challenges. We draw lessons from the first two cycles to explain why and how the government has been driven to increase its responsibility for managing key shipbuilding projects following a period of seeking to rely more heavily on the forces of competitive industrial supply and after nearly a decade of "smart procurement" rhetoric.

Many lessons apparent in the context of Australian naval shipbuilding and repair are relevant to other defence industry sectors. They illustrate a range of problems typical of many Defence-Industry relationships in small countries: local production vs. imports, political and economic vs. strategic aspects of in-country sourcing of materiel, the role of competition, the management of procurement risks, and business models used to engage suppliers and mitigate the risks of inadequate supplier performance.

Introduction

Naval shipbuilding has consistently captured the attention of the Australian public more than any other area of defence procurement—from the troubled government shipyards of the 1950s and 1960s through to the Collins submarine project of the 1990s (ASPI, 2002). This is partly because naval vessels are the only major platforms built in Australia. And, partly, because the procurement of naval assets and the disposition of industry facilities have long been highly politicised, with the federal government balancing the competing interests of different states, services and industries. As a result, the Australian naval shipbuilding and repair sector has consistently presented governments of the day "with a series of interwoven (procurement) challenges" (p. 1). The response to such challenges has been embedded for 20 years or more in economic and institutional reforms applying to Australian defence industry overall, and the sector has benefited particularly from reforms to the defence supply chain. However, while considerable improvements have been achieved, accounts of project delays and cost overruns still attract media attention and embarrass successive governments.

By the standards of older maritime nations, the industry may not have a long history but it has had its share of both failure and success. Within the former, arguably the most publicised has been the procurement of the Collins Class submarines in the 1980s and 1990s. No other Australian defence acquisition in recent years has had a more profound impact on how the government goes about the acquisition of major strategic capabilities and on the mechanics of the defence acquisition process. As the latest cycle of naval acquisitions has started to unfold, the key question is what lessons have been learned and with what implications for new process.

This would become clear as the Australian government seeks to handle two forms of competition. On the one hand, prime contractors, main systems integrators and some original equipment manufacturers (OEMs) compete *for* a market—the market in new capability elements—by offering alternative specifications of weapons systems sought by Defence (i.e., different platform designs and combat systems). On the other hand, lower-tier contractors compete *in* a market, the market for work subcontracted by primes and higher-tier contractors. In each case, local content requirements and defence procurement policy have a role to play.

This paper is structured as follows. First, we briefly review the history of naval shipbuilding and repair in Australia. We discuss the three post-World War II ship acquisition cycles, which are critical to the understanding of how successive Australian governments have approached naval acquisitions and defence procurement in general. Second, we consider the in-country maritime industry (i.e., shipbuilders and maintainers, facilities and industry disposition, the changing division of labour and the associated supply chains). Finally, we draw some lessons from the Australian naval shipbuilding experience.

Naval Shipbuilding in Australia

Post-war Shipbuilding Cycles

During World War II, Australia became a significant builder and repairer of naval vessels. In total, 113 naval ships were built for the Royal Australian Navy (RAN) at ten Australian dockyards. Also, 4,000 ship repairs were completed for the RAN, 500 for the US Navy (USN) and nearly 400 for the Royal Navy (Parliament of Australia, 2006, p. 41). The scale of activity declined significantly during the post-war period. Since 1945, Australia has experienced two major naval building cycles separated by a 15-year period of low activity and a third was under way by 2008 (ASPI, 2002).

In the 1950s and 1960s, the first cycle saw nine destroyers built at the government-owned dockyards. The cycle also included an afloat support ship, hydro vessels and patrol boats. In the 1970s and early 1980s, no surface combatants were built in Australia; although, four large naval support and hydrographic vessels were completed, as well as eight heavy landing craft (LCH) craft and 14 patrol boats.

The second naval combatant building cycle began in 1984 with an order for two guided missile frigates (FFGs). This was followed by orders for six Collins Class submarines, ten ANZAC Class frigates (involving workshare arrangements with New Zealand), six minehunters and other ships (e.g., patrol boats and two hydrographic ships). The second cycle will end with the commissioning into service of the last Armidale Class patrol boats in the early 2000s.

The third cycle (much smaller by volume) began in the late 2000s, with tenders for the construction of three air warfare destroyers (AWD), two large landing helicopter dock (LHD) ships, afloat support ships and the watercraft element of the amphibious deployment and sustainment (ADAS) project. This cycle of naval shipbuilding is expected to end around 2016-17, with the next cycle expected to start around 2018.

The First Cycle: The Troubled Years

The construction of destroyers in the 1950s and 1960s was notorious for its cost overruns, schedule slippages and industrial disputes. As noted by the Australian Senate inquiry into naval shipbuilding, "Australia's increasing resort over the 1960s and 1970s to purchasing foreign naval vessels for the RAN reflected the poor performance of domestic naval shipbuilding projects" (Parliament of Australia, 2006. p. 41). Apart from two oceanographic ships, the government-owned dockyard at Williamstown in Melbourne did not commission a naval vessel between 1971 and 1991 (p. 42). And, after launching HMAS Torrens in 1968, the other major government-owned dockyard at Cockatoo Island in Sydney did not commission another naval vessel until 1986. Thus, no warships were launched in Australia for over 20 years. This preference for imports left Australian naval shipyards with mostly repair and (limited) refit work (p. 42).

An example of local construction problems in the 1970s was the ill-fated DDL (light) destroyer project approved in 1972. Starting in 1975, three locally designed ships were to be built at the Williamstown dockyard. While it was accepted that cost premia for local build were to be incurred, they were justified on the grounds that local shipyards would later be best positioned to provide logistic through-life support and battle damage repairs. Also, investments needed to pump-prime local shipbuilding capabilities were aimed at enhancing the in-country skill base and technological know-how. The project was cancelled in 1973 as the Navy and the Department of Defence found the initial cost estimates to be grossly over-optimistic and a Joint Parliamentary Committee took the position that risks inherent in a local design were excessive (p. 43). A lesson drawn from this experience was "the need for tighter controls on Navy's design requirements. Part of the problem was that those involved with the specifications for the project were without responsibility for cost and schedule" (p. 43).

Following the cancellation of the DDL project, the government turned to overseas shipyards to initiate the acquisition of guided missile frigates. In 1974, the purchase of two imported FFGs was approved by the government. The vessels were to be built in the USA and acquired under Foreign Military Sales (FMS) arrangements managed by USN. The purchase of a third FFG was approved in 1977 and a fourth in 1980. The ships were delivered between 1980 and 1984, mostly on schedule, but the cost of acquisition ballooned (Parliament of Australia,

2006, pp. 43-44). In part, the cost overrun was due to higher-than-anticipated inflation and exchange rate re-alignment. But the purchase also revealed systemic problems in Australian defence procurement. As new technologies emerged, the first three frigates had to be retrofitted with long-range sonar systems and more capable helicopters. The design of the fourth FFG was altered to incorporate several modifications requested by the RAN. It was argued that some cost overruns might have been avoided "had the RAN seized opportunities to incorporate modifications during the construction phase" (p. 44). The procurement process was thus, apparently, neither sufficiently flexible nor agile to cope with changes in the technical specification of the deliverables.

There were also problems with the use of FMS arrangements. A 1974 Memorandum of Agreement with the US allowed Australia to withdraw from the project if the ships failed to meet the RAN's requirements or turned out to be "unacceptably costly." However, the USN and the US Department of Defense resisted changes requested by Australia (p. 44). The Agreement also included a limited "offset-type" provision to make Australian industry manufacture and supply components for the RAN and the USN FFGs. The actual FMS arrangement, as opposed to what was initially envisaged, frustrated all such local content initiatives and restricted the scope for Australian industry participation. A lesson drawn from this experience was that "in future, it was necessary to sign deeds of agreement with the prime contractors before negotiating a Letter of Offer and Acceptance with the US government" (p. 44). Another lesson drawn was that Australian industry was not competitive enough to win work on its own merit and that earlier participation of potential suppliers was needed at the project planning stages if any in-project import substitution was to be achieved (p. 45).

By the end of the 1970s, it was apparent that the naval shipbuilding sector in Australia was suffering from deeply ingrained systemic problems. Industrial relations were particularly bad as naval shipyards were seen by both the unions and the shipyard management as Defence-funded sheltered workshops (Parliament of Australia, 2006). The Department of Defence lacked the ability to specify its needs precisely enough to prevent endemic requirements creep. It also lacked effective contracting skills. This was an important limitation as changing technologies, especially the growing use of electronics and information technology, made naval vessels increasingly complex and knowledge-intensive. Project management skills were also lacking in defence and there were shortages of critical shipbuilding skills at naval yards.

Fresh Start

The *1976 Defence White Paper* foreshadowed aspirations to develop local defence industry capabilities to enhance Australia's defence self-reliance. In line with this aim, the Australian Frigate Project (AFP) was initiated in 1978. The FFG-7 Class frigate would be constructed locally to an imported design that was seen as flexible enough to accommodate high local content requirements. In 1980, the government decided to build two FFG-7 frigates at the Williamstown dockyard, providing that the shipyard "demonstrated its capacity to build the ships to the RAN's requirements" (pp. 46-47).

The arrival of a new Labor government in 1983 brought with it the re-affirmation of the self-reliance objectives, accompanied by a commitment to microeconomic reform aimed at increasing the competitiveness of Australian manufacturing industry. The government was keen to build warships in-country providing that significant improvements in shipyard productivity could be negotiated and delivered. Preferably, this was to be achieved through transferring ownership to the private sector. Privatisation of government factories and shipyards, including naval shipbuilding facilities, was seen by the government as an essential part of its broader

package of “microeconomic” reform. The new government was also ready to confront unions by resisting their demands to build a tanker at Cockatoo Island “ultimately condemning the yard to extinction” (p. 47).

The two FFGs were to be built at the Williamstown dockyard providing that its productivity could be lifted, cost and schedule discipline imposed, and a series of enforceable agreements concluded to tighten work practices and restrict the drift of product specifications. A contract between the Department of Defence (customer) and the Department of Defence Support (contractor) was signed in 1983 for the two ships to be delivered between 1992 and 1994. The contract was to facilitate extensive local industry involvement to enhance national defence self-reliance and navy preparedness. As revealed by the 1986 review of the project by the Joint Committee of Public Accounts, the project budget included a cost premium for the local build of about 30% (p. 48). In 1987, the government sold the Williamstown naval dockyard, with the FFG arrangement, to the Australian Marine Engineering Corporation (AMEC). The privatisation of the yard turned out to be a very successful initiative. Both ships were launched by AMEC ahead of their initially agreed schedule and within the original cost estimates (in real terms). The only real cost increase was attributed to the privatisation process *per se*. Further, local industry content accounted for 90% of the AMEC-borne cost and 75% of the total project cost (Parliament of Australia, 2006).

The Second Cycle: Back on Track

While the beginning of the second shipbuilding cycle may be associated with the FFG project, it really unfolded in the late-1980s. The *1987 Defence White Paper* reaffirmed the Labor government’s commitment to the development of competitive local defence industry capabilities, particularly in the shipbuilding sector, and to the policy of defence self-reliance. The second cycle got under way following the government’s decision to build six Collins Class submarines, awarding the contract to the Australian Submarine Corporation in 1987; and ten ANZAC (Meko 200 Class) frigates, the contract going to the AMEC-Blohm+Voss consortium in 1989. In 1994, another major contract was awarded to the then Australian Defence Industries (ADI)—now Thales—this time to build, to an Italian design, six Huon Class coastal minehunters. The final contract in the second cycle was signed in 2003 with Defence Maritime Services Pty (DMS), a joint venture between P&O Maritime Services and Serco Australia for the delivery of 14 Armidale Class patrol boats. The fleet was built by Austal Ships Ltd., Australia’s largest commercial shipbuilder, and is to be fully supported by DMS throughout its service life (Kerr, 2008a). The second cycle also included some minor naval construction (e.g., Freedom Class patrol boats and hydrographic ships). In contrast to previous periods, nearly all ships required by the RAN during the second cycle were built in-country. The main projects of the second cycle are discussed below.

Collins Class submarine project

To facilitate building submarines in Australia, the Australian Submarine Corporation (ASC) was established in 1985 as a joint venture between Sweden’s Kockums (as shipbuilder and designer holding 49% of the company’s shares), the Australian government-owned Australian Industry Development Corporation (49%) and Wormalds International and Chicago Bridge and Iron (holding the 2% balance of shares). In 1987, ASC was chosen as the prime contractor for the fixed cost Aus$3.9 billion (1986 prices) project to deliver six submarines. With over 73% local content for the six platforms, at least 3,500 suppliers, and 1,600 individual contracts (Parliament of Australia,2006, p. 56), the project was “Australia’s most ambitious and technically advanced defence project ever” (McIntosh & Prescott, 1999, p. 5).

The submarines experienced much publicised teething problems but were eventually acclaimed as "world class" (Parliament of Australia, op. cit.). The main early problem was attributed to a decision to acquire a sophisticated combat data system (CDS) independently of the platform design when the most straightforward approach would have been to select a design with the CDS fitted as standard (Woolner, 2006, p. 72). This was compounded by Navy's preference for the CDS to be developed in order to meet its unique requirements rather than purchased as a military-off-the-shelf (MOTS) system (Woolner, 2001, p. 9). "By including the combat system with the platform in the single prime contract, with a unique military specification, Defence left itself widen open to […] technological problems" (McIntosh & Prescott, 1999). By 1993, it had become apparent that Rockwell, the CDS sub-contractor and designer, was not able to meet Navy's specifications. Nevertheless, Defence did not authorise a replacement MOTS system. The first submarine was provisionally accepted into service in 1996 with the combat system incomplete and, by the late 1990s, the Collins Class project had become a major embarrassment for Defence and the government.

In 1999, the government terminated the failed CDS sub-contract and sought another CDS contractor through open competition. In 2001, however, the government decided to scrap the tender process and awarded the contract to the US firm Raytheon. Later that year, the RAN and the USN signed an agreement to cooperate in equipment-sourcing and logistic support and to enhance Collins Class interoperability with US ships. The German STN Atlas was also awarded a contract for sonar and navigation equipment (Parliament of Australia, 2006, pp. 59-60).

The sequence in which the six hulls were constructed allowed for little learning by doing. As a former high-ranking naval officer argued during a 2006 parliamentary inquiry, "there is a need to have an increased gap between the lead ship of a class and its successor. The lead ship needs to be evaluated and give the all clear before the successor is completed" (Parliament of Australia, 2006, footnote 31, p 59). Instead, the ships were largely batch-manufactured and batch-constructed. While economies of scale and scope are unavoidably lost through fragmenting the sequence of ship construction, there is more opportunity to alter the specifications of successor ships by learning from the in-service performance of their predecessors. This principle of "spiral" or incremental new capability formation was well understood and practiced in Sweden where the Collins Class design originated.[1]

Criticism has also been directed towards how the project was commissioned and managed by Defence. A fixed-price contract was used to avoid cost overruns associated with traditional cost-plus contracts, and to shift most product- and (construction) process-related risks from the Commonwealth to the contractor. However, the use of a fixed-price contract for that reason was flawed on three accounts:

- for a country lacking experience as the builder of modern, sophisticated weapons systems, the magnitude of the technological challenge inherent in this project was grossly underestimated by both by the ASC as a contractor and by Defence as a customer. There was too much reliance on Kockums' expertise as a builder of submarine platforms and a rather poor understanding of technological challenges posed by the development of the bespoke CDS. In such circumstances, the Commonwealth

[1] Sweden has traditionally ordered its submarines in very small batches to allow for benefits of learning-by-doing and technological change to be continuously absorbed into subsequent designs—even though it has been well understood that cost premia would be incurred as a result of fragmented production.

(Defence) might have realised the limitations of risk-shifting between the parties and, instead, relied on risk-sharing mechanisms such as those provided by incentive contracts and risk mitigation through more collaborative management of the project;

- given the developmental nature of the project, the use of a fixed price contract provides little effective protection for the buyer (Defence) since contract variations are inevitable. An *ex-ante* fixed-price contract may in reality, become an *ex-post,* cost-plus arrangement. If contract variations are regularly approved, there is no incentive for the contractor to seek cost efficiencies. It would have been preferable to use a flexible form of contract to allow for learning, to provide incentives to improve and share risks rather than to end up with the *de facto* cost-plus arrangement dressed up as a fixed-price contract; and
- a belief that project risk could be shifted to the contractor to reduce the Commonwealth's exposure was naïve, given the ASC equity structure. With its 49% share of equity, the Commonwealth was both the sole buyer of the ships and a key shareholder on the supply side. In 2000, when Kockums was acquired by the German submarine builder HDW, the Australian government stepped in to buy the Kockums' share of ASC equity.

This contractual debacle was summarised by an Australian parliamentary researcher thus:

> 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, the point where it was decided to develop a unique design for the new submarines was the time to change the procurement strategy. (Woolner, 2001, p. 47)

The nationalisation of ASC was an embarrassment for a government overtly committed to the privatisation process: "There was more than a touch of irony in the fact that after decades of effort to transfer all defence production capability to commercial industry, the Government finds itself the owner of ASC" (ASPI, 2002, p. 24). But, the nationalisation of ASC also exposed a more serious flaw in the procurement philosophy that was inherent in the Collins Class acquisition. Under the original contract, Kockums retained much IP in the vessel's design. The ASC shareholding arrangement made it difficult to determine the ownership of various IP changes to the original design, new IP elements and the associated body of design data that were critical to access if ASC was to carry on as the ship's maintainer and modifier. The resultant legal dispute took until 2004 to resolve. Under the new arrangement, Kockums owns the legacy IP but ASC has full access to it (Parliament of Australia, 2006, p. 55).

The introduction of sensitive US technology into the vessels and the involvement of the US firm Electric Boat as a capability partner with ASC added another degree of complexity to the IP dispute. The inadequacies of the Collins Class technology management highlight the critical importance of access to proprietary technological know-how and IP in all knowledge-intensive projects. This is often poorly understood in large, technologically complex, developmental projects in which a detailed design does not exist at the time a contract to proceed with the project is signed. Thus, a classic "hold-up" relationship may emerge between the parties as the buyer belatedly realises that its ownership of an asset is incomplete without the transfer of all IP. The incompleteness of ownership rights imposes severe limitations on who is allowed to maintain the asset and who has the right to modify it. By the time the buyer becomes aware of such problems, the cost of contract re-negotiation may be prohibitive and opportunities for switching suppliers limited. This problem is compounded when the product design incorporates "black boxes," which can only be accessed by the original supplier or its

agent and which are subject to technology restrictions imposed by the supplier's home government.

In sum, the Collins Class project "exposed serious flaws in defence's procurement processes" (Parliament of Australia, 2006, p. 57). Its well-publicised difficulties were not only embarrassing for the government but also made the government determined to change the nature of its principal-agent relationship with Defence. Following yet another review of new capability formation and procurement management by Defence (*Kinnaird Report*), the government decided to restructure the Defence Materiel Organisation (DMO—its procurement agency) into a "prescribed agency" (partially detached from Defence and reporting directly to the government) to handle defence procurement and through-life capability support. In particular, DMO was to foster the kind of professional project management expertise required to bring rigour and experience into the procurement process and to end the long tradition of well-intended and energetic but sometimes amateurish project management.

ANZAC frigate project

At Aus$7 billion (2006 prices), the ANZAC Frigate project, was the largest *single* Defence design and construction contract awarded in Australia in the closing decades of the 20th century. It was also the only European-style naval "workshare" contract. There were two customers, the navies of Australia (eight ships) and New Zealand (two ships) and the industry workload was shared between the two countries. It was expected that neither navy would cross-subsidise the shipbuilding costs of the other; sub-contractors were to be selected competitively; and the achieved workshare between the two countries was to reflect the overall cost shares. The frigates were assembled at the recently privatised AMEC shipyard at Williamstown with modules built at this and other shipyards in Australia and New Zealand. During the contract life, the shipbuilder changed its name twice to finally become Tenix Marine Division of Tenix Defence Pty Ltd. (Parliament of Australia, 2006). By the early 2000s, Tenix Defence—incorporating the marine division—had become one of Australia's largest defence contractors.

Despite its initially limited experience as a shipbuilder, Tenix completed the project on schedule and on budget. This outcome was helped by the modular ship construction and by a collaborative and highly synergistic arrangement with SAAB, the combat system supplier, to test the combat system prior to installation (Tasman Asia Pacific, 2000, p 9). A requirement for the project was to achieve high levels of local content (the then government policy of *Australian Industry Involvement*, AII). This was in part accomplished through effective sub-contracting with the help of the Industrial Supplies Office (ISO), an agency set up to assist small and medium sized enterprises (SME) in broadening their customer base. The search for subcontractors to meet the AII target sometimes involved what a Tenix manager described[2] as "reverse garage sales," i.e., components were put on display and SMEs were invited to decide which of these products could be made locally. This approach to sub-contracting has been acclaimed as a factor contributing to the project's cost and schedule discipline and copied by other projects (Tasman Asia Pacific, 2000).

In 2001, Tenix, SAAB and the DMO (Defence) signed a tripartite long-term alliance agreement (the first of its kind) to provide in-service support for the ANZACs and to collaborate in future modifications and capability enhancements of the class (Parliament of Australia, 2006).

[2] During one of the authors' visit to the Williamstown shipyard in the mid-1990s.

This agreement concluded Tenix' involvement in the second shipbuilding cycle and positioned the company favourably as a bidder for construction work in the third cycle (see below).

Minehunter coastal project

In 1989, Australian Defence Industries (ADI) was formed as a corporatised, government-owned entity set up to consolidate major defence industry facilities still in government ownership. This included naval engineering at the Garden Island dockyard in Sydney. ADI was awarded the prime contract for the Huon Class minehunters, based on an Italian design but with ADI as the designated design authority to modify and Australianise the design. The Aus$ 917 million (1994 prices) project was the first Australian-sourced naval project in which the local prime contractor was given design authority (p. 67). The six ships were built on schedule at a greenfield site facility employing new, 'greenfield' labour force (Parliament of Australia, 2006). The first composite hull was made in Italy and the remaining five in Australia. The key to tight schedule success was an onshore facility that integrated and tested the combat system prior to installation (Tasman Economics, 2002, p. 9). As with ANZAC frigates, the Huon Class also complied with a high local content target of nearly 70%.

In 1999, the French Thales and Australian company Transfield bought ADI from the Federal Government as a 50-50 venture (Parliament of Australia, 2006. p. 71). In 2006, Thales Australia was granted government permission to acquire the Transfield's share and consolidate it with its other Australian assets. This acquisition has turned Thales into one of Australia's largest defence contractors and a key naval repair, maintenance and upgrade contractor.

FFG upgrade project

In contrast with the very successful minehunter project, ADI's Aus$1 billion upgrade of four FFGs has been plagued with problems. This project, commissioned in 1999, involves the upgrade of ships' combat systems. Initially, it was to cover six ships but as the first ship was delivered three years late (in 2006) and over budget, the project scope was reduced to four vessels. The upgrade is very extensive and has required advanced design and engineering work, including the ADI-designed and developed Australian Distributed Architecture Combat System (Parliament of Australia, 2006, p. 69). However, "the Department of Defence noted that while ADI is viable in the ship repair and upgrade activity, it is having problems in meeting schedule and performance specifications" (p. 69). Comments such as this cast doubt on Thales' chances of success in the next shipbuilding cycle, even though in 2007, it was Australia's largest defence contractor (Hinz, 2007-2008).

Armidale patrol boats and multihulls

In Australia, there are two relatively small but internationally competitive commercial builders of aluminium multi-hulls: Austal Ships Ltd (Austal) and Incat. While they have no experience building large steel vessels, both companies have established market niches in wave piercing multi-hulls, fast multi-hull ferries and luxury motor yachts. Both companies have also been successful exporters and are well regarded internationally for their innovative designs.

In 2003, Austal won an Aus$553 million project to build 14 *Armidale* Class patrol boats—the last major contract of the second shipbuilding cycle. This contract was innovative in that Defence's requirements were framed in terms of operational performance specifications (e.g., operational availability) rather than set as detailed technical guidelines for ship designers.

In 2001, Austal also opened a US shipbuilding facility in Mobile, Alabama. From this foothold in the US shipbuilding market Austal operates as part of the General Dynamics team building prototype littoral combat ships (LCS) for the US Navy. Austal's role is to design and build the LCS platform for USN.[3] Austal is the only Australian naval shipbuilder to be involved in foreign direct investment in offshore construction facility while retaining its core design team in Australia.

In the early 2000s, Incat sold and leased out high-speed catamarans to naval users, including the Australian Defence and the US Department of Defense. However, while the adaptability of these civil ship designs to military uses provides an example of dual-technology opportunities inherent in civilian designs, the company has no intention to expand its operations into naval shipbuilding (Parliament of Australia, 2006, p. 74). Other small shipbuilders and repairers include Forgacs with its facilities in Newcastle and Brisbane, and NQEA based in Cairns.

Third Post-war Cycle

Based on the 2006 *Defence Capability Plan* (DCP) and anticipated upgrades and maintenance, Defence intends to spend about Aus$30.5 billion (2006 prices) on naval construction and sustainment programs between 2006 and 2025 (ADO, 2006b, para. 3.4). While the proportion of local content differs from project to project, about Aus$19 billion (63%) could be spent in Australia.

At the start of the third construction cycle in 2007, much Defence demand for naval construction and through-life support work over the subsequent period was committed under supply arrangements already in place or soon to be finalised. These included:

- the sustainment contracts for ANZAC frigates (Tenix Marine with SAAB as the combat systems integrator), Collins Class submarines (ASC with Raytheon as the combat systems integrator), and Armidale Class patrol boats (Defence Maritime Services);
- a construction contract for three air warfare destroyers (AWD) awarded to ASC, based on the Spanish Navantia design (see below), and a contract with Raytheon for the AWD combat system, which is likely to be followed by a future contract for through-life support with the two companies; and
- a contract for two landing helicopter dock (LHD) ships awarded to Tenix Marine, again based on Navantia design, which is also well positioned to win a future contract for the LHD sustainment support.

The early commitment of such a large proportion of the 2006-2018 spend limits the scope available to Defence to attract new competition into the domestically located market before the onset of the fourth shipbuilding cycle around 2018. Although the support arrangements for the AWDs and LHDs are yet to be decided when their construction phase draws to a close (the first ships are expected to be delivered in 2012-2013), the logic of Defence sustainment requirements favours the existing supplier consortia.

Also, with the resource export boom in the late 2000s and, thus, tight labour markets, Defence has an incentive to build non-combatant vessels overseas. At an international level,

[3] If the LCS program proceeds, the US LCS trimaran project may involve the building of 60 vessels at a cost of US$15 billion (Parliament of Australia, 2006, p. 72).

competition is already strong and the competitiveness of the market could be reinforced by the availability of second-hand civil ships that could be adapted locally or overseas for Australian use.

Defence continues to source overseas designs for its major platforms (e.g., AWDs and LHDs). However, past schedule slippages and cost overruns have reduced its appetite for extensive Australianisation. As the success of the Spanish Navantia in winning the AWD and LHD contracts has demonstrated, overseas shipbuilders with successful designs adopted by a foreign parent navy will be able to compete for work in Australia by teaming with Australian prime contractors. Over the past 20 years, this preference for imported designs has produced competition between design-based consortia of shipbuilders, integrators and OEMs, fronted by domestic prime contractors but also including overseas designers and suppliers. This form of competition, and the increased market contestability resulting from the threat of foreign entry, has benefited Defence in that it has produced greater market rivalry and increased scope for benchmarking alternative delivery arrangements.

Naval Maritime Industry

Shipbuilders and Ship Repairers

The traditional concept of "naval maritime industry" focuses essentially on shipyard-based shipbuilding and ship repair/maintenance activities. In this narrowly focused approach to defining the industry, ship assembly and module manufacturing are included as long as module building and component manufacture are undertaken by specialised shipbuilders. Second-tier suppliers of major maritime equipment such as power plants or navionics, normally OEMs, and maritime service providers such as naval architects and surveyors are also included. However, jobbing firms supplying components made-to-order are likely to be excluded as are most third-tier subcontractors.

Another distinction has traditionally been drawn between *shipbuilding*, including capability upgrades and *ship sustainment* (maintenance and repair, including battle damage rectification). These two sub-sectors are essentially shipyard-based, using specialised infrastructure such as dry docks and sea lifts. In Australia, these two sectors have tended to operate in parallel, with the yards involved in ship repair and maintenance separated from those used in shipbuilding (e.g., the Garden Island dockyard specialising in ship repair while the Williamstown dockyard is used to integrate new vessels). This division of labour has evolved to allow platforms, once constructed by specialised and often overseas-based shipbuilders, to be maintained and repaired by "jobbing" repair yards with on-board equipment supported by OEMs and jobbing contractors. This division of labour often required long supply chains linking OEMs to maintenance shipyards and led to delays in the availability of parts and long repair turnaround times.

Changes to the traditional division of labour between shipbuilding and ship repair/maintenance were driven by the growing complexity of platforms: ships were becoming increasingly automated, requiring the integration of on-board equipment into larger, network-based and knowledge-intensive systems. Sophisticated ships such as modern submarines and AWDs are increasingly maintained by their builders, companies that retain the IP they have created in platform design and/or work closely with the design authority to protect and support the integrity of ship design. The retention of or access to design IP, the use of dedicated facilities and the tacitness of ship-specific knowledge gained during the construction phase underpin the shipbuilders' competitive advantage in through-life upgrade and maintenance

work. Thus, strong synergies (economies of scope) have come to exist between the construction and sustainment phases of naval capability. Also, when ships are built in small batches with long gaps between shipbuilding cycles, resources used in construction (e.g., specialised labour, docking facilities) may subsequently be redeployed in fleet sustainment.

In Australia, this synergistic relationship between ship construction and sustainment phases was first exploited in the Collins Class submarine project: the Osborne construction facility in South Australia is dedicated to the production and deep maintenance (full docking) cycles of the class. However, routine maintenance work is undertaken in Western Australia, where the ships are home-ported. This model of "construction-enabled" ship maintenance has now been adopted in the sustainment of other vessels (e.g., the ANZACs) and is also likely to be used in support of future additions to the fleet (e.g., AWDs and LHDs).[4]

Australia's naval shipbuilding activity is largely confined to four main shipbuilders: ASC, Tenix Marine, Thales (ADI) and Austal. Of these, ASC and Austal are currently Australian-owned while Thales is a fully owned subsidiary of the French parent company and, in 2008, BAE Systems was finalising the acquisition of Tenix Marine.[5] As the third post-war building cycle began to unfold, three of these companies were involved in the construction of the AWDs, LHDs, and afloat support ships; the progressive upgrades of ANZAC and FFG frigates, the Collins Class submarines, minehunters and other minor war vessels; and maintenance of the fleet-in-being. Defence Maritime Services (DMS) are responsible for the maintenance of Armidale Class patrol boats built by Austal. (Some module building and consolidation work and maintenance activity has been undertaken by smaller maritime suppliers such as Forgacs, with facilities in Newcastle and Brisbane, and NQEA in Cairns.) The three shipbuilders and DMS are also the main providers of naval sustainment support the submarine deep and intermediate maintenance cycles, ANZAC and FFG frigate sustainment, support for minehunters, patrol boats, and other minor war vessels.

Facility Disposition and Ownership

In the 2000s, Defence's preferred industry disposition reflects the RAN's fleet basing strategy, which envisages the maintenance and home-porting of major surface ships on the east coast of Australia (Sydney) at Fleet Base East (FBE) and on the west coast (near Perth) at Fleet Base West (FBW). The submarines are home ported and maintained at FBW but all full-cycle dockings (deep maintenance) are carried out in South Australia. Minor war vessels are mostly home-ported and supported in Darwin and Cairns.

The home-porting of naval vessels at FBW has spawned the development of navy-preparedness-related industries in close proximity to the ships they support. Thus, in addition to major shipbuilders and repairers (e.g., Tenix Marine, ASC, Austal), other designers and builders of aluminium boats and ships and engineering firms supporting resource projects have clustered

[4] Under this model of construction-enabled ship maintenance, two major contracts were let. In 2001, Defence signed a long-term alliance agreement, underpinned by a through-life support contract, with Tenix Marine (shipbuilder) and SAAB (system integrator) covering the development of all future capability change packages for the ANZAC ships. In 2003, it signed another long-term contract with ASC for the 25-year, through-life support for the *Collins* Class submarines.

[5] However, in 2007, Tenix Defence, including its Tenix Marine Division, was offered for sale and BAE Systems Australia was rumored to be the most probable buyer. Also, as ASC is likely to be offered for sale in the late 2000s, Australian subsidiaries of major foreign companies may be invited to bid for it.

in Western Australia, in particular at the Australian Marine Complex (AMC) in Henderson. There appear to be strong *agglomeration economies* that naval firms can gain by locating at AMC. There is also more scope for forging direct business links between firms that operate in close proximity.

In the previous naval shipbuilding cycle, ownership of capital-intensive facilities (e.g., shiplifts and dry docks) was a key characteristic of naval shipbuilders. This is still largely the case; however, the high cost of establishing and maintaining such facilities constitutes a formidable barrier to entry into the Australian market for naval shipbuilding and repair. The provision of these facilities involves high-fixed costs, which can only be recouped over the long term and which even the largest marine companies have difficulty absorbing in the relatively small Australian market. An example of such a facility is the shiplift/transfer system operated by Tenix Marine's facility also located at Henderson, WA. This facility was initially funded by Defence and the WA State Government but subsequently sold to Tenix Marine (Tenix, 2001). Apparently dissatisfied with this arrangement, the West Australian (state) government developed, adjacent to the Tenix facility, a protected deepwater harbour—a 15,000 tonne service and heavy lift wharf, and several other facilities, including offices, workshops and other amenities. This investment, completed in mid-2003, is owned by the State Government and operated by AMC Management (WA) Pty Ltd as a common user facility (CUF). While Tenix' Henderson facility is maintained by the company for its own use, the CUF is deliberately designed for multiple users, including the oil and gas, resources, marine and defence industries and is sufficiently large to accommodate several projects simultaneously. Parties using the facility provide their own management and workforce and accept normal project accountabilities. They use the CUF only when their projects require it and are charged only for the specific facilities they use for a particular period. This arrangement greatly reduces project set-up costs and company overheads, thereby enhancing CUF-users' potential ability to win contracts.

Initial infrastructural investments in the Henderson CUF attracted complementary private investment on land adjacent to the marine complex (e.g., ASC is establishing its submarine maintenance facility there). In response to these developments, the West Australian government invested an additional Aus$81.5 million in a floating dock to launch and dock large ships and a rail transfer system to allow construction and repair within the CUF's undercover facilities; an extension and upgrade of the existing wharves to accommodate all types of naval and commercial vessels; and the installation of marine services such as power, seawater fire main, wharf communications and sewerage off-take.

The South Australian government followed suit with plans to invest Aus$300 million in Techport Australia, including a CUF adjacent to ASC in Osborne (Kerr, 2008b, p. 2). The SA CUF is scheduled for completion in 2010 and, like its WA counterpart, is intended to support multiple projects concurrently. The nearest equivalents to such infrastructure on the east coast are the Captain Cook Dock (leased by the Commonwealth to Thales at Garden Island, Sydney).

The introduction of CUFs funded by state governments and, subject to leasing arrangements, on-going Commonwealth ownership of the Captain Cook Dock combine to reduce the significance of facilities ownership as a barrier to entry, particularly in the market for naval ship repair. As an indicator of policy trends, they also suggest a reappraisal of the value of public ownership of assets which governments were so determined to privatise in the late 1980s and 1990s.

Changing Division of Labour

The impact of defence procurement on industry was traditionally viewed in terms of the relationship between an agency responsible for defence procurement and the prime contractors with which it negotiated. These days, however, it is recognised that effective procurement depends on the activities and performance of a much wider range of industry players, domestically and overseas.

Defence considers the naval maritime industry in broad terms that embrace not only shipbuilders and maintainers but also a myriad of second- and third-tier SME suppliers (ADO, 2006a, paras. 1.18-1.20). The latter reportedly account for some 70% of the total cost of a shipbuilding project.[6] As noted in the Defence submission to the 2006 Senate Inquiry, a typical frigate comprises some 170,000 parts and components provided by 600 suppliers and sub-contractors and takes 1.2 million person-hours, spread over 22 months, to construct. A large conventional submarine may consist of some 500,000 parts provided by 1,600 suppliers and takes 2.5 million person-hours and 60 months to construct (ADO, 2006a, Figure 1).

Table 1 shows the stylized breakdown of typical warship production costs that includes all on-board combat systems but excludes capability elements that are shore, rather than ship-based. In the table, the platform element of capability accounts for 33% of the total production cost for a more technologically complex naval combatant: a 3,500 tonne frigate costs about Aus$600 million to build, while on-board combat systems account for 42% of the cost. The other two cost items are largely platform-related and represent the cost of logistic support acquired during the construction phase and the cost of project (delivery process) management. By way of comparison, for a large naval support ship constructed closer to commercial standards, on-board combat systems account for only 15% of all costs and the platform for 47% of the total. For a naval combatant capability, therefore, the combat systems component of the overall system is the most important element, both in cost and functional terms. This is reversed in the case of the naval support capability. For a typical combatant ship, imported combat systems and other major equipment account for 50% of the construction cost (para. 2.5). For technologically complex vessels, such as the submarines and the AWDs, the proportion is likely to be much higher.

[6] These suppliers are said to contribute “70% by value of a project” (ADO, 2006a, para. 1.18). However, the third-tier contractors, as well as other tiers of suppliers, should not be seen as a reflection of a hierarchical industry structure. These relationships are project-specific. Thus, a large firm that is engaged as a prime contractor in one project may be a third-tier, sub-contractor in another.

Table 1. Percentage Cost Breakdown in Warship Production
(Based on ADP, 2006a, Table 1, para. 2.2)

Production cost element	Surface combatant ship %	Support ship %
Platform design, hull, machinery and equipment	3	47
Combat systems	41	15
Logistics support and training (mostly platform-related)	17	25
Project management	9	13
Total	**100**	**100**

In Australia, combat systems integrators (e.g., Raytheon, Thales, BAE Systems) and OEMs (e.g., STN Atlas) are either subsidiaries or agents of major overseas companies (with the notable exception of CEA Technologies). In the early 2000s, the Australian industrial footprint of these multinational companies varied from significant (Raytheon, Thales) to small (Lockheed Martin). The footprint could, in most cases, be flexibly expanded or shrunk, depending on the quantity of in-country work in hand. Much has been claimed by these subsidiaries for their direct access to the parent company's global network and technology. However, Defence has at times observed, "experience indicates that they have difficulty obtaining suitable licensing and intellectual property rights which in turn may have time and cost implications particularly in providing sustainment" (ADO, 2006a, para. 2.9). For this reason, the Commonwealth sometimes facilitates technology transfers using government-to-government arrangements (e.g., the US FMS framework) to secure access to sensitive foreign equipment, military technologies and IP (e.g., the direct purchase of the US Aegis combat system for the AWDs by Defence from the US Navy under the FMS arrangement). Such Commonwealth action has direct implications for the role of prime contractors, an issue we address below.

Critical to the provision of through-life support is access to the IP behind the *ship design*. At the smaller-vessel end of the naval market, Austal is, arguably, the only Australian shipbuilder offering world competitive naval design expertise for multi-hull aluminium vessels.[7] For larger and/or more complex ships, Australia has been an importer of ship design, usually from parent navy ship designers such as the German Blohm+Voss for Meko 200 Class frigates (ANZAC ships) and the Swedish Kockums for the Collins Class submarines. However, design adaptation to meet the Australian Navy's unique requirements and political pressures to increase local content have resulted in considerable Australianisation of original designs. In the Collins Class case, this was further complicated by the transfer of ASC ownership to the Commonwealth. It was only when the Commonwealth negotiated full access to the Kockums-owned IP that ASC became the *de facto* design authority for the class of which the RAN is the parent navy. Similarly, Tenix Defence is the *de facto* design authority for ANZAC ships. The Huon Class minehunter was "the first Australian-sourced naval defence project in which the prime contractor (ADI now Thales) *was given* design authority" (para. 4.39, our italics). This is in

[7] This is reflected in its aforementioned involvement as a ship designer and potential builder in the General Dynamics-led bid for the US Navy Littoral Combat Ship.

marked contrast to the ANZAC ship and Collins Class projects, in which Tenix and ASC effectively became design authorities by default.

Defence appears to be determined to avoid excessive Australianisation in ship design in the next generation of vessels to be constructed in Australia: the AWDs, LHDs and afloat support ships. For example, in the case of AWDs, the government overruled Navy's reported preference for the unproven Gibbs & Cox adaptation of the Arleigh Burke destroyer in favour of the already-operational Spanish design based on the Navantia-built F100 destroyer (Walters, 2007, 1 March, p. 8).

Marine Industry Supply Chains

Defence's broader approach to what constitutes the naval marine industry has also shifted the emphasis from functionally based naval industry sectors, such as shipbuilders, OEMs and ship repairers, to capability-centered supply chains that include combat systems integrators and the plethora of second- and third-tier suppliers, many straddling sectoral divisions and serving different customers in different industries. While the functional representation is helpful in identifying firms largely dedicated to shipbuilding and fleet sustainment, the supply chain framework sheds more light on the competitive dynamics of defence capability supply.

Two types of prime contractor arrangements and, thus, supply chain structures, have dominated the interface between Defence and Australian naval shipbuilders:

- a *traditional single channel model,* under which a single prime contractor is engaged by Defence to lead and manage the supply chain and to orchestrate all the back-to-back contracts with upstream suppliers of systems, equipment, components and services; and
- a *complex multi-channel model*, in which two or more prime contractors are engaged by Defence to lead and manage parallel supply channels that jointly produce the required capability element.
- These two models are used both in shipbuilding and through-life fleet sustainment.

To illustrate, consider Figure 1, in which two stylized traditional supply chain management (SCM) models are shown: one for the construction of a support ship and another for a major weapons upgrade.[8] In the shipbuilding case, the shipbuilder is also a prime contractor who engages a system integrator and OEMs as well as a large number of small second- and third-tier subcontractors to produce the end product: a platform with all systems and equipment integrated into it or on it. Although the ship design is likely to be imported and Australianised, it is a relatively simple design. Given its role in the process, the prime contractor, as the project's manager, accounts for about 13% of the total project cost. In the weapons upgrade case, much greater weight (and cost share) is assigned to combat system integration

[8] The figure has been stylized using total project cost breakdown by project elements shown in ADO (2006a, Table 1, p. 8). Thus, the cost of "platform design" is imputed to Platform Designer; the cost of "combat systems" is imputed to Combat System Integrator; and the cost of "project management" to Prime Contractor. The cost of "hull, machinery, equipment" and "logistics support, including training" is attributed to Shipyard (operator) and OEMs. Other second- and third-tier suppliers are included in OEM, Shipyard and Combat Integration cost elements.

but project management by the prime contractor still accounts for about 12% of the total project cost.

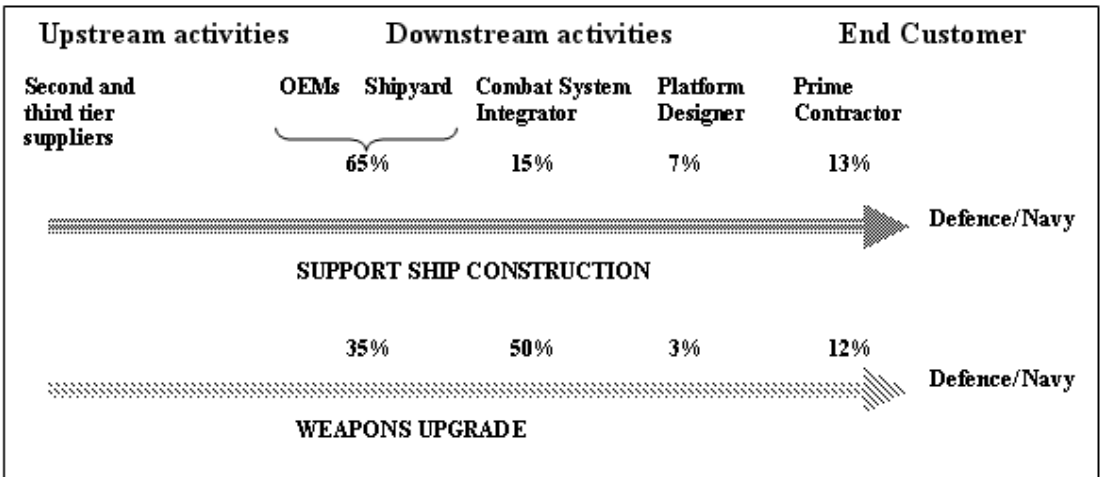

Figure 1. Conventional Value Chains for Support Ship and Weapons Upgrade: Total Project Cost Breakdown by Supplier Category
(Based on ADO, 2006a, Table 1, p. 8)

The conventional prime contracting model has traditionally been used by Defence as a risk management arrangement under which the prime contractor is expected to manage and mitigate risks associated with the operation of the supply chain. This model was used by Defence during the second building cycle in all major shipbuilding projects, initially including the Collins Class submarines. But the conventional model failed the test when the Collins Class project ran into problems with combat system integration. By 1993, Rockwell, the combat systems integrator, was not able to comply with Navy's specifications and "ASC effectively lost control of the Rockwell sub-contract" (Parliament of Australia, 2006, para. 4.18). As noted earlier, the solution involved replacing the original combat system integrator and Defence awarding the contract to Raytheon in 2001 (Parliament of Australia, 2006). Under this arrangement, Raytheon became a parallel prime contractor for system integration. To complicate the model further, "*Defence itself has essentially primed*" the subsequent Aus$500 million combat data system replacement program by purchasing the FMS-mediated software and working *with* ASC, Raytheon, Atlas Electronics and Thales Underwater Systems to integrate all combat systems (para. 4.20, our italics).

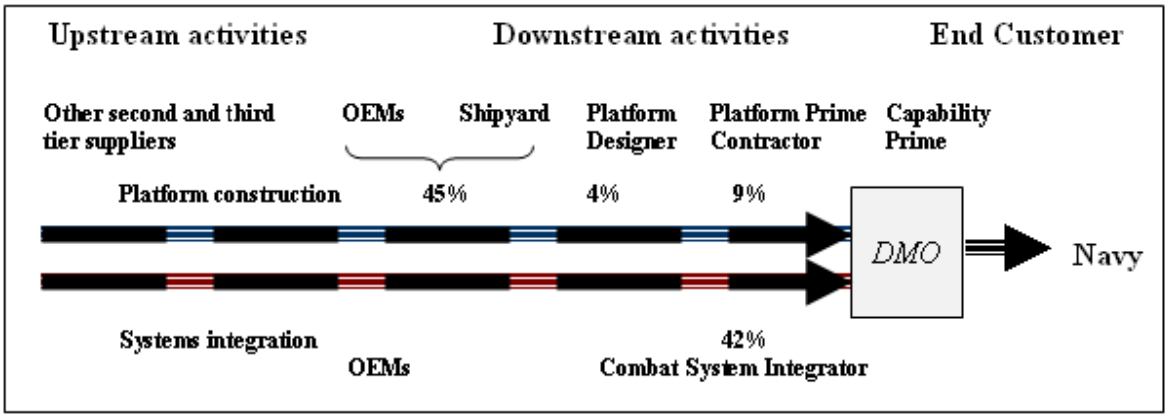

Figure 2. Complex Supply Chain for a Naval Combatant: Total Project Cost Breakdown by Supplier Category
(Based on ADO, 2006a, Table 1, p. 8)

The resulting structure is represented in Figure 2, which shows a complex, multi-channel supply chain (say, for a frigate-type naval combatant). In the figure, the stylized supply chain involves two *parallel channels* of progressive value-adding activity: platform construction and systems integration. The figure highlights downstream activities (close to the end customer) such as project management, design, and platform integration along the platform construction supply channel and combat system integration along the systems integration channel. Further upstream are OEMs that provide equipment and subsystems for downstream platform and systems integrators and other second- and third-tier subcontractors who provide inputs for OEMs and downstream integration activities. Some of these smaller second- and third-tier contractors are specialised naval suppliers but most tend to be broadly based manufacturers and service providers. Also, some apparently small subcontractors (in terms of quantities and dollar value of supplies) are subsidiaries or agents of large producers of generic products. As we move from right to left along each supply channel, from downstream to upstream activities, suppliers are less likely to be dedicated to the production of naval systems. The reduced role of the prime contractor for the platform is indicated by the smaller proportion of the total project cost (9%).

This representation of the naval construction supply chain for complex projects emphasises the changing concept of the prime contractor. In this case, there are two prime contractors operating *in parallel*, the shipbuilder (prime contractor for the platforms) and the systems integrator (prime contractor for the combat system). Shipbuilding activity accounts for nearly 60% of the total project cost and systems acquisition and integration for over 40%. The figure highlights an important aspect of complex naval ship construction: the *management of the multi-channel supply chain is distributed between two or more prime contractors*, each responsible for the orchestration/management of construction/integration activities along its particular supply channel. This at once raises a higher-level coordination problem: Defence, through its procurement agency DMO (shown in Figure 2 as a “capability prime”), is now responsible for coordinating the activities of the two (channel-specific) prime contractors. This necessarily implies that Defence cannot (as it has often sought to) adopt and maintain an arms-length relationship with its suppliers. The new model has already been applied in the acquisition of the AWDs via an alliance-based contracting strategy (Australian DoD, 2008). This strategy is given practical effect through an *Alliance-based Target Incentive Agreement* signed in October 2007 by the Defence Materiel Organisation, ASC as the designated builder and prime contractor for the Navantia-designed AWD platform and Raytheon Australia as the combat system

integrator.[9] Defence is also directly involved in the supply chain management as it purchased directly from the US Navy the Aus$1 billion US Lockheed Martin Aegis combat system, which Raytheon is to integrate with the platform and other on-board systems.

Competition for Large, Complex Projects

During the second shipbuilding cycle, the competitive conduct of defence naval suppliers was assigned a pivotal role in achieving "value for money" for the Commonwealth and became a mantra of Defence procurement. Competition to take on the role of prime contractor for larger, complex naval projects took the form of rivalry among consortia formed between Australian shipbuilders, overseas designers, and Australian subsidiaries of overseas systems houses. The competitive process led to the award of contracts to successful consortia (e.g., AMEC-Blohm+Voss for the ANZAC Ships) using the conventional model of engagement between the prime contractor and Defence. This mode of engagement had worked reasonably well for projects involving less complex deliverables (e.g., the ANZAC ships). However, as the experience of the Collins project demonstrated, the conventional model based on the arm's-length relationship between Defence and prime was not suitable for procuring complex capabilities such as submarines or technologically challenging systems upgrades (re: the troubled FFG upgrade). A key reason for the difficulty lies in elements of hold-up present in the relationship between the incumbent prime contractor and Defence.

While competition is normally used to engage prime contractors fronting competing overseas designs, competitive pressure on prime contractors, combat systems integrators and often key OEMs tends to fall away once the prime contract is signed. If the prime contractor fails to deliver contracted performance, slips behind schedule, or runs over the budget, Defence is heavily constrained in its option for remedial action. Switching prime contractors and/or main sub-contractors is often technologically infeasible, financially prohibitive or politically embarrassing. Even for a medium size naval project, such as the FFG upgrade, the prime contractor was allowed to continue with the project, despite public expressions of dissatisfaction from the client and an adverse national audit report. Despite tough rhetoric in public, Defence has only limited scope to bring a contractor into line. A financial penalty for contractual default, for example, may be no more than a slap with the business equivalent of a feather. And, when the worst comes to the worst—as in the case of Rockwell's failure to deliver the CDS system for the Collins Class submarines—Defence decided against re-competing the requirement and, instead, *appointed* a substitute, Raytheon, to take over as system integrator.

In the third naval procurement cycle, much of the competitive process for major naval projects was completed early on, with winning consortia announced for AWDs and LHDs and large, long-term support contracts for ANZACs and Collins submarines given to Tenix and ASC.

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[9] The arrangement takes the form of Alliance-based Target Incentive Agreement (ABTIA) between the Commonwealth, represented by the Defence Materiel Organisation, ASC, as the shipbuilder and Raytheon Australia as the mission systems integrator. "The broad AWD procurement principles articulated by the Alliance comprise value for money, efficient and effective process, ethics and probity, accountability and transparency, good faith and fair dealing and *competition*" (Kerr, 2008b, pp. 2-3; our italics). Under this arrangement, major equipment is already specified by Navantia SA—the Spanish designer—and the Alliance will utilise Navantia's established supply chain. Navantia will perform all the required design modifications and will maintain design configuration control. Raytheon will undertake the Australianisation of the combat system around the fully imported Aegis core sourced by the Commonwealth via the US FMS (2008b, pp. 2-3).

It seemed unlikely that any prime contractor would subsequently be dumped and replaced by another contractor. However, there was a key difference between the second and the third shipbuilding cycles. Defence had become aware that lack of effective competitive pressure, following contract award had deprived it of effective market power vis-a-vis its larger prime contractors. The complex, multi-channel procurement model described above can be viewed as an evolutionary adaptation responding to Defence's recognition that, to maximise the likelihood of success for its projects, it would have to embrace fully its ultimate responsibility as "prime contractor of the last resort." It had been obliged to accept that the prospects for shifting project risk to primes in large, strategically important projects were at best limited and, realistically, often unachievable. For successful outcomes, Defence would have to manage projects more proactively and build close, synergistic relationships with primes rather than relying on contract specifications, impracticable penalties for non-performance and arm's-length dealings with contractors.

Lessons Learnt

In a microcosm of naval shipbuilding activity, this case study shows in detail how various defence industry policies and procurement initiatives have worked in Australia over the past 30 years. By focusing on naval shipbuilding and repair, we have not only selected a sector that is seen in Australia as the jewel in the defence industry crown but also one that comprises a wide variety of business entities—from diversified large contractors to highly specialised small firms, including new forms of government shipyards such as CUFs and technologies such as mechanical (platforms), IT (combat systems, specialised equipment). We conclude this paper by highlighting what are, in our view, key lessons to be drawn from Australian naval shipbuilding experience. These concluding comments focus, respectively, on the demand and supply sides of the market and the demand-supply interface.

Demand

Lumpiness of demand

For reasons associated with durability, cost and changes in military technology, most defence systems, including those embedded in naval capabilities, tend to be replaced at relatively widely spaced intervals rather than continuously. This applies to simple weapons systems, such as small arms, but particularly to large and chunky elements of capability such as naval ships that tend to be replaced as fleets. This batching of demands can be smoothed by Defence to the extent that fleet replacements can be staggered, but some lumpiness of demand seems unavoidable. Long-term forward plans, such as the Australian DCP, make it easier for industry to anticipate forthcoming demand and ramp up for future tenders. But the scope for demand smoothing is limited as Defence has to be flexible enough in its forward commitments to respond to changing strategic and economic circumstances, sometimes at very short notice.

Asset ownership

The complete control of "use rights" is necessary for key combat assets such as naval combatants. This can be achieved through the conventional full ownership of ships, or through leasing arrangements, particularly the leasing of vessels from foreign governments. However, more flexible arrangements can be used to procure the services of secondary assets such as patrol boats, which tend to operate in peacetime in more stable roles and predictable circumstances. As demonstrated by the Armidale patrol boat arrangement, the procurement of ship services from a private consortium of maritime service providers rather than the full

ownership of vessels is feasible and attractive. And, in the event of war, the nature of the relationship can be changed by placing the vessels under complete naval control.

Local content requirements

The history of Australian naval shipbuilding and repair highlights often-encountered trade-offs between local and overseas sources of supply and naval preparedness. In Australia, as in other small countries, it is increasingly accepted that building ships in country is politically as much as strategically driven. In modern warfare, there is no time to replace combat assets, such as ships, and nations are unlikely to engage in wars of equipment attrition. It is thus perceived as more important to have domestic industry capability on hand to undertake ship repair and modification, including battle damage rectification. The LHDs project, incorporating hull construction at Navantia's Ferrol shipyard in Spain and superstructure by Tenix in Australia, departs from the recent tradition of building ships in-country to an imported design. However, the procurement of the AWDs follows the conventional path, with expectations that substantial premia will be paid for the political decision to construct them in South Australia (Dodd, 2008).

Australia continues to import naval ship designs and the recent tendency is to minimise design Australianisation (Kerr, 2008a; 2008b). To reduce risks of "design parentage," the approach is to incorporate MOTS components in imported systems and make considerable use of the design authority's established supply chain (e.g., the AWD and LHD arrangements with Navantia). Political pressures are likely to support ongoing high levels of local content in platform construction, but strategic issues may be more important in influencing levels of local content in combat systems maintenance and modification. Defence may be worried about the risk of relying on local supply for developmental components. For example, the locally developed CEAFAR active phased array radar for the AWDs has not been included in the baseline specification as it is still under development by its maker—a small but high profile Australian firm CEA. But, the new technology is likely to be incorporated as it matures (Kerr, 2008b).

Business models

A range of new business models has evolved in Defence to engage suppliers in the most effective way. These models tend to be tailored to the nature of the product and the characteristics of the supplier. When mature products are supplied by established contractors, the inherent risks of performance degradation and schedule slippages are low and traditional fixed/firm price models can be used. An evolved model of this kind has been used to acquire the services of the Armidale Class patrol boats. When the developmental content of the product increases and if the supplier's track record also inspires less confidence, various forms of incentive and incremental contracting are more likely to be used (e.g., the acquisition of the electronic warfare system for the AWDs—Kerr, 2008b, p. 6). And, for technologically sophisticated, complex and politically high-profile acquisitions, such as the AWDs, it is now accepted that the Commonwealth cannot divest itself of its ultimate responsibility for strategic capability formation. In the emergence of the multi-prime contractor model (in which DMO has entered a "prime alliance" with shipbuilder and systems supplier), it has been recognised that the buyer's procurement agency must engage in *relationship management* and that even a very detailed contract cannot shift all risks away from the Commonwealth to commercial prime contractors.

Supply

Facility ownership

It was widely claimed in the 1980s and 1990s that privatising government shipyards and factories, and related 'private finance initiatives', was a necessary precondition for their improved productivity and dependability. In 2000s, however, it became increasingly apparent that the private sector would not invest in capital intensive assets such as shipyards unless it could reasonably expect an adequate return on its investment. Commercial owners would only invest in new shipbuilding facilities if their order books justified the heavy capital commitment. This in turn depended on owners' confidence in a continuing flow of potentially profitable orders - hard to create in the face of a history of long intermissions in demand and the competitive processes for allocating work. It has, thus, been recognised that competitive sourcing might have to be abandoned in favour of sole or dual sourcing if local platform builders and maintainers are to be encouraged to invest in capital-intensive facilities. But, it also seems increasingly accepted that *lack of competition and not the public ownership per se* was the main cause of poor performance of government shipyards and factories. The designation of a private contractor as sole source provider to Defence is likely to lead to many problems previously experienced with government-owned enterprise.

As the third post-war building cycle unfolded, the competition between the States for defence orders has resulted in renewed public investment in capital infrastructure in shipbuilding and repair (re: the CUF model was pioneered by Western Australia and adopted by South Australia). And, the Commonwealth of Australia (federal government) has retained its ownership of the Garden Island dock leased to Thales. Under CUF arrangements, governments attract and sustain private naval investment by investing in complementary infrastructure and engaging in a form of quasi-vertical integration under which the publicly owned asset is then leased to a private contractor for the period it requires to supply goods and services to Defence.

The 1990s and 2000s have also witnessed increased penetration of the Australian shipbuilding sector by overseas capital. Of the three largest naval shipbuilders, two (ADI and Tenix) have become subsidiaries of foreign companies (Thales and, subject to satisfactory negotiations, BAE Systems, respectively). The third, ASC, is to be sold in the late 2000s, and may yet end up in overseas ownership. All systems integrators and nearly all major OEMs (except CEA) are subsidiaries of overseas companies. And P&O Maritime Services and Serco Australia have pioneered the provision of fully supported services for minor naval vessels (the Armidales). This trend is very much in keeping with global developments in defence industry. Few small countries can support indigenous systems integrators and OEMs while exporting of defence-related products from small countries poses well-known difficulties.

Structure

The 1990s and 2000s have also seen the increased consolidation of ship assembly in fewer hands and, in a clear break with the past, a growing integration between shipbuilding and repair. In part, the latter trend reflects the changing global division of labour as systems houses and OEMs become increasingly involved in the provision of through-life support for their products. In part, it also reflects the shift of emphasis in Australian industry policy from a focus on platform construction to through-life capability support. The three large projects of the second shipbuilding cycle have also had implications for the size distribution of firms in the sector. The building of the ANZACs, Collins submarines and Huon minehunters attracted a large number of firms to third-tier naval subcontracting. As a result, the size distribution takes a Pareto form with a small number of large naval firms operating in the first and second tiers, downstream in the

supply chain; a large number of third-tier sub-contractors are engaged in the upstream segments of the chain.

Conduct

In the 1990s and 2000s, firms have increasingly made efforts to collaborate along the supply chain rather than to do business with each other at arm's length. On the other hand, firms also appear to have been competing with increasing frequency and intensity for markets opening up for all segments of the naval supply chain. Firms' awareness of their mutual dependence in the network of supply arrangements appears to be driving a tendency to greater collaboration once the principal contract has been awarded.

Performance

The second shipbuilding cycle saw a marked increase in shipyard productivity and less severe budget overruns and schedule slippages. The Collins Class project was the most troublesome acquisition of the period but by no means because of problems restricted to the supply side. The FFG upgrade project appears to have suffered from the classic syndrome of supplier overconfidence: ADI seems to have lacked awareness of its capability limitations and underestimated the importance of technical challenges that were likely to arise in a project of such complexity. As the third shipbuilding cycle unfolded, Defence (and indirectly the government) appeared reluctant to risk quality-budget-schedule outcomes by trying to over-Australianise designs and aiming at high, local-content targets. "Buying MOTS" and minimising the local developmental content characterised its strategy to head off poor performance.

Demand-supply Interface: Competition for and in the Market

Arguably the most striking development since the end of the second shipbuilding cycle, particularly in the aftermath of the Collins project, has been much better understanding by Defence of competitive processes, especially the difference between *for*- and *in*-the market competition. This reflects the growing maturity of Defence as an investor in new capability elements and buyer of military materiel. It is increasingly accepted that different competitive processes operate for different segments of the naval supply chain. Creating a competitive environment in downstream segments of the chain in a small country calls for opening the market to overseas participants. When this is done, the range of competing designs and combat systems is broadened as overseas consortia of platform builders, system integrators and OEMs (sometimes combining with local firms) come to contest the market. Once a preferred package has been selected, competition in the market follows, and sub-contractors vying for various elements of the package emerge. Domestic subcontractors can be assured a major role in this part of the process if local content requirements are in force.

Finally, it appears that Defence has become more aware of the difference between the pre- and post-contract opportunities open to it in sourcing supplies. That is, it is better understood that, once the contract is signed, switching suppliers and supplies may be impossible for technological, budgetary or political reasons. As a project progresses through the tendering process, the scope for product and supplier substitution decreases and, for major projects, there may be no realistic way of returning to *status quo ante*. Post contract, competition in the market is largely restricted to upstream segments of the supply chain in which third-tier suppliers are easier to replace if their contractual performance is inadequate.

Also, applying a one-size-fits-all business model can often be a recipe for failure in defence procurement. But, to tailor different models to different acquisitions, it is necessary to

acquire good understanding of supply conditions and commercial business processes. Following its designation as a prescribed agency, the DMO has become increasingly professionalised as a procurement agency and as a hands-on equity partner in major acquisition projects.

Conclusion

Faced with the challenge of efficiently procuring naval vessels of increasing technological sophistication, the Australian government has learned over recent decades that contract arrangements alone are often insufficient to allow it to address and remedy problems, especially when developmental issues are at stake. While fixed-cost contracts, for example, apparently offer the Defence customer the prospect of shifting all risk to its industry suppliers, the experience of the Collins Class submarine clearly showed that when the success of the project was seriously threatened, the government felt it had little option but to intervene directly to re-organise supply-side production arrangements. As the nature of the naval warship has changed with technological innovation, it has also become clear that government must take on an overarching prime responsibility if the production tasks involved are to be effectively coordinated. A warship is a sea-borne platform carrying weapons. But the business of designing and building sea-worthy and battle-ready vessels is altogether different from the enterprise of designing and producing the highly sophisticated, often network-integrated weapons systems that the warship must support. We have shown that the Australian government has recognised the force of this reality by creating different industry primes for platform-building and weapons production and adopting the coordinating role for itself. Despite past rhetoric to the contrary, innovation and complexity in design and production appear to create conditions in which governments find themselves obliged to form close and durable relationships with suppliers if they wish to maximise the likelihood of project success. It may neither be realistic, given the industry structure, nor wise, given the alternatives available to suppliers, for governments to threaten competitive recontracting as their sole, or even principal, means of discipline and performance control.

For political reasons familiar in most countries (smaller ones being no exception), governments routinely find themselves under pressure to favour domestically located supply. If the depth and breadth of expertise and capabilities in local defence industry is limited, there is the potential of conflict with the goals of successfully procuring increasingly sophisticated systems, especially if tailored idiosyncratically to national requirements. As this paper has shown, Australia has at times focused heavily on local content requirements in naval shipbuilding and, whatever the benefits, has sometimes paid a high cost premium for doing so. The issues around such requirements are not likely to disappear in Australia or in other countries in the foreseeable future.

In relation to naval ships, it may appear eminently sensible and potentially efficient to provide sustainment, repair and maintenance for warships domestically but more problematic to justify actually building the vessels in-country. On the other hand, it can be argued that such a large fraction of through-life costs relate to post-delivery support that any cost premium on domestic construction can be discounted as relatively unimportant. If local through-life support is more efficient when ships are also built locally in the first place, the argument is reinforced. Analogous arguments may also be applied to other sorts of platform and weapons system. No simple generic solution indicates when *make* domestically should be preferred to *buy* overseas in such cases. But the historic experience of substantial cost premia on local content in small country environments suggests that a critical eye should always be applied

to *ex ante* predictions of large expected *net* benefits from locally producing the more innovative and idiosyncratic weapons systems.

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