SUBMISSION TO THE INQUIRY INTO NAVAL SHIPBUILDING BY THE SENATE FOREIGN AFFAIRS, DEFENCE AND TRADE REFERENCES COMMITTEE

On 10 November 2005 the Senate referred the following matter to the Senate Foreign Affairs, Defence and Trade References committee for inquiry and report by the last sitting day of 2006:

That the Committee inquire into and report upon the scope and opportunity for naval shipbuilding in Australia and in particular:

(a) The capacity of the Australian industrial base to construct large Naval vessels over the long term and on a sustainable basis;

(b) The comparative economic productivity of the Australian shipbuilding industrial base and associated activity with other shipbuilding nations;

(c) The comparative economic costs of maintaining, repairing and refitting large naval vessels throughout their useful lives when constructed in Australia vice overseas;

(d) The broader economic development and associated benefits accrued from undertaking the construction of large naval vessels.

Introduction

When the issue of naval shipbuilding is raised thoughts usually turn to the fabrication of large steel hulls, and possibly the machinery that propels them through the water. This is natural as the hull and superstructure are the obvious physical manifestations of a naval shipbuilding program. However, in terms of value, operational capability, complexity and risk it is the systems onboard the ship, and how they are integrated, that are the key factors in the success, or otherwise, of such a program.

This is reflected in the relative value of the fabrication and consolidation tasks, which vary between 10% - 20% of the cost of a vessel. The majority of the cost of a modern naval ship is in the systems, including weapons and sensors, used to operate it.

International naval shipbuilding programs have repeatedly demonstrated that the areas of highest risk and complexity are the higher level systems that allow the ship to be controlled and fought. Without the capability to successfully design the systems engineering and systems integration solutions for these higher level systems Australia will not have a true naval shipbuilding capability, at least not in a strategic sense.

Aim

Raytheon Australia's submission addresses the systems, systems engineering, and systems integration aspects of naval shipbuilding and the local industry capabilities in these areas during the design, construction, and through life support phases of a ship's useful life.

Raytheon Australia

In order to provide context for the comments that follow, it is desirable for the Committee to appreciate Raytheon Australia's capabilities and role in recent major defence programs.

The company is a wholly owned subsidiary of Raytheon Company, the fourth largest defence company in the United States. Our core business in Australia is Mission Systems Integration, which we are in the process of expanding into Mission Support.

Raytheon has had a presence in Australia since the mid-1950s and has been a major supplier of weapons, sensors, command, control and communications systems to the Australian Defence Force (ADF).

As a result of the Government's *Defence and Industry Strategic Policy Statement* in 1998, Raytheon Company decided to invest further in Australia and establish a local capability. Since then Raytheon Australia has grown to a workforce of over 1,100, with operations in all mainland States and Territories, and annual turnover for indigenous business (not including product sales from the US) of $390 million in 2005.

This is dynamic growth in anyone's language, but particularly so in the Australian defence market. We are involved in a number of major programs in which we are responsible for systems integration, including:

- Air Warfare Destroyers (AWDs),
- replacement combat system on the Collins Class submarines,
- simulators for the upgraded F/A-18 Hornets;
- electronic warfare training aircraft operated out of HMAS Albatross in Nowra, and
- electronic warfare emulator pod, which is to be fitted to the BAE Hawk aircraft.

We also provide avionics support for the Royal Australian Air Force (RAAF) Maritime Patrol Group and the Aircraft Research and Development Unit at RAAF Edinburgh; and the Strike And Reconnaissance Group at RAAF Amberley; in service support for the Royal Australian Navy (RAN) Submarine Group at HMAS Stirling; as well as technical support for the joint facility at Pine Gap and the Tidbinbilla Deep Space Communications Complex outside Canberra.

Finally, we have a geospatial imagery business that takes telemetry data directly from a constellation of orbiting satellites through a dish and terminal equipment in Adelaide to provide imagery and other value-added products much faster than through satellite operators in Europe and the U.S. These satellites have a potential complimentary role in wide area surveillance of our maritime approaches.

We are proud of the fact that the company is staffed entirely by Australians, over three quarters of whom are engineers and technicians. However, a key to Raytheon's success and growth in Australia has been the ability and willingness of our parent company to strengthen the capability of its local subsidiary by transferring technology, knowledge, skills, and processes. We have coined the term *Reach Back* to describe this process, which was first demonstrated on the Collins Class submarines and is now being used to support the AWD program.

Raytheon assumed responsibility for the troubled Collins Class submarine combat system program in May 2000. The workforce understood the Collins Class, but lacked the expertise and domain knowledge of submarine combat systems to resolve the problems besetting the system. Raytheon provided that expertise and knowledge through a team the company sent to Australia for 12 months. In conjunction with the US Naval Underwater Warfare Centre (NUWC) and the pool of Raytheon engineers at the company's facility in Portsmouth, Rhode Island, this team analysed the problems, derived the solutions, and taught the Australian engineers how to implement them. The specialist team returned to the United States and the local company successfully executed the program within the revised schedule.

Reach Back has strengthened the knowledge and skill base of the Raytheon workforce in Australia and effectively extended the capability available to the Australian defence customer to that of Raytheon Company overall.

It also works in reverse with the parent company benefiting from advances made in Australia. For example, Raytheon Australia is now the company's centre of expertise for integrating combat systems into conventional submarines and has developed an innovative way of interfacing United States-designed combat systems to existing sensors in conventional submarines.

Raytheon's Integrated Defense Systems business has also used the process to leverage Australian skills and knowledge for research and development, investing US$5 million in the following Australian programs:

- open architecture;
- generic combat systems interface/emulator project;
- modelling and simulation for the Maritime Mission Analysis project; and
- geospatial imagery.

Systems Integration

Systems integration involves bringing separate systems and sub-systems together to form a larger or overarching system. Systems integration is complex, there are no books on the subject and the capability is acquired through experience and working with those who have acquired the capability through experience.

In the defence area good systems integration is not just about having complex systems work together successfully, they must do so in a way that ultimately meets the needs of the operators in combat. Unlike in many commercial situations, where the penalty for systems failures or suboptimum performance may be loss of production, in military situations such occurrences could have catastrophic outcomes.

A further objective of good systems integration is to deliver the final capability on schedule and within budget, although this is subject to the selection of a schedule and contracting strategy appropriate to the technical risk profile for the work. For example, if the systems to be integrated employ proven technology, have well defined interfaces and functions, and the overall system design is fully developed there would be a relatively low technical risk in the task. In such cases tighter schedule and cost targets would be appropriate However, if the systems involve immature technologies and/or the overall system design is not yet stable there is likely to be a much higher degree of technical risk and appropriate allowances should be made in both schedule and cost constraints.

The *Defence Electronic Systems Sector Strategic Plan* focused on the integration of military systems at the primary (equipment), secondary (systems and sub-systems) and tertiary (system of systems, or theatre level system) levels. Given the purpose of the Defence Industry Sector Plans this is understandable and probably appropriate.

However, drawing on the experience of our parent company Raytheon Australia takes a broader perspective of the task and uses the term Mission System Integration to describe it. To be successful in meeting the twin objectives described above we believe that it is necessary to address the entire systems life cycle of the project, namely, from conception through development and fielding of the system, as well as the ongoing support and evolution to final decommissioning and disposal.

This is a most important distinction. Many of the problems identified in complex acquisition programs as failures in systems integration are more likely failures of the Mission System Integrator (MSI) role, of which systems integration is a contributing element.

The MSI role is highly relevant to the specification and implementation of any complex system, for example, naval combat systems, network centric systems, command and control systems, as well as systems of similar complexity in the commercial domain.

Mission Systems Integrator Role

Raytheon Australia is a mission system integrator in the maritime and air warfare, and surveillance domains. To perform this role, the MSI must possess the domain knowledge to understand the customer's mission and capabilities as well as having the skills and processes to execute the engineering solution.

As noted above, project failures are often attributed to integration, as it is at this phase of the development that the required emergent behaviour fails to materialise. The root cause however, is generally traced to poorly understood requirements and/or earlier design decisions in the life cycle (the Seasprite helicopter program is a prime example).

Raytheon believes the MSI should perform the following activities:

- architect the system (architecting and integration are co-dependent activities);

- select the appropriate technology and available systems/subsystems through the use of trade studies and make/buy/reuse processes;
- define and manage interfaces;
- integrate the system/subsystems;
- verify the system against the system requirements;
- support the user in the validation of the system; and
- support evolutionary upgrades as appropriate through to disposal of the system.

Depending on the nature of the contract, the MSI can support high-level, capability and trade studies, as well as the development of key documents, such as, the Concept of Operations, Functional Performance Specification, and Test Concept Document. Additionally, the MSI can assist the transition from capability development to acquisition.

Alternatively, the MSI can be engaged at the acquisition phase and be limited to the translation of user level documents to technical specifications.

The latter model was the predominant approach adopted by Defence in the past and had the distinct disadvantage of a lack of consistency and knowledge in transitioning from capability to acquisition, leading to problems in the acquisition phase. It also limited the flow of industry experience into the planning stages of the project.

However, recent projects, such as Battlefield Communications and the AWD, are involving the MSI contractor in the capability phase, which should help mitigate the disadvantages of the previous model.

The core competencies of the MSI are as follows:

- systems engineering;
    - where supporting disciplines are system analysis, system architecture, software engineering, hardware engineering, structural engineering and configuration management;
- project management;
- integrated logistics support (ILS); and
- contract management.

Each of these core competencies represents a capability that Raytheon Australia has sought to develop.

Distributed and Collaborative Working Environments

Before addressing the issues highlighted in the inquiry's terms of reference there is a final general point to be made that is relevant to the overall subject matter. Unlike the final consolidation phase of a ship, system engineering, and even a large proportion of system integration, can be achieved using distributed working environments.

In the United States Raytheon's Integrated Defense Systems business is the Total Ship Electronic Systems Integrator for the next generation surface combatant for the United States Navy, the DD(X) destroyer. To ensure the best outcome for the customer Raytheon and Northrop Grumman[1] have adopted a “Team America” approach to produce a “best of breed” solution harnessing the skills and technologies of a wide range of companies. To allow participating companies to develop their equipment/systems and prove their integration into the overall DD(X) electronic systems Raytheon has established a distributed test and evaluation network that is depicted in Figure 1 below.

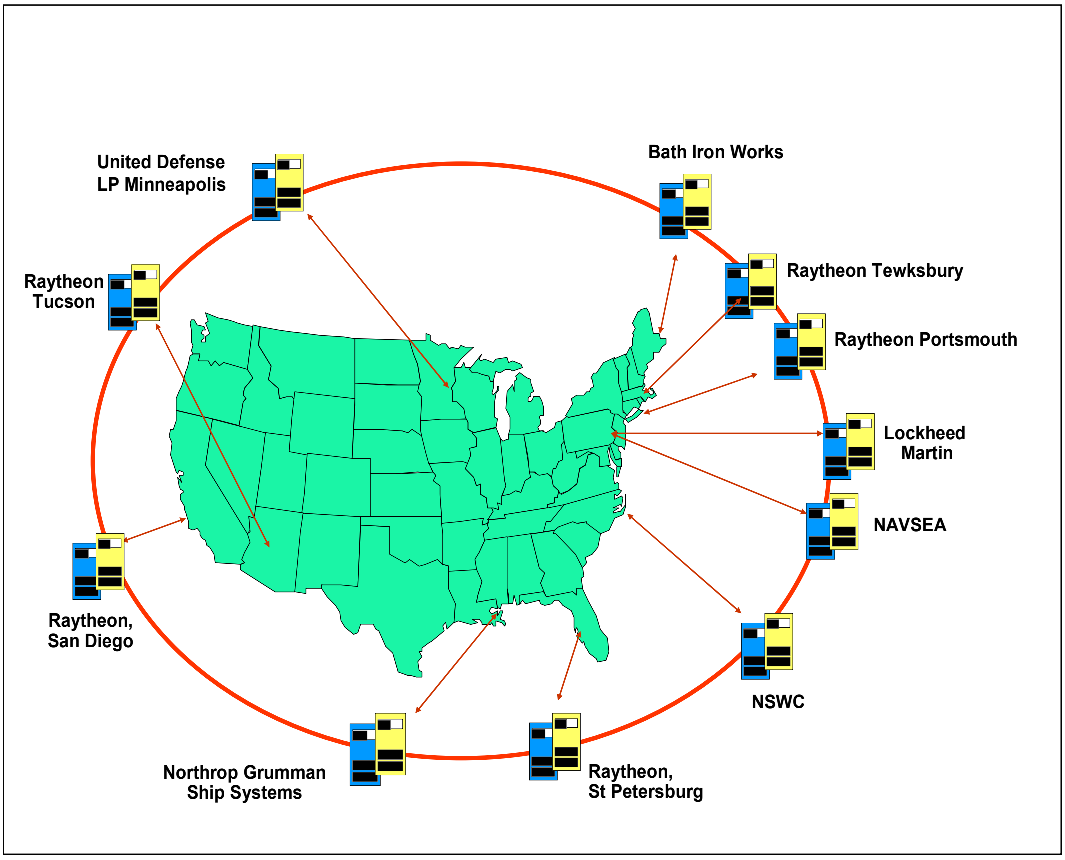

Figure 1 - DD(X) Distributed Test and Evaluation Network

This concept allows companies to conduct work in their own premises, which has a number of important advantages

- Workforces are available to conduct the work in their existing locations rather than having to transfer or recruit staff in another area.
- Rather than having an isolated team working on a project in a new location companies can draw on their full engineering capabilities to contribute to the effort, especially in problem solving.
- Required specialist technical and engineering infrastructure exists, including specialist test and evaluation equipment.

[1] Northrop Grumman is the shipbuilder and prime contractor for the DD(X) program with Raytheon the major sub-contractor as Total Ship Electronic Systems Integrator (TSESI).

- Companies are able to protect valuable intellectual property (IP) and do not have to worry about exposure to competitors in a joint facility.

Raytheon believes such an approach would not only assist in the execution of local programs, but could be used to facilitate the participation of Australian companies in United States programs if the distributed environments were to be created and connected, as illustrated in Figure 2 below.

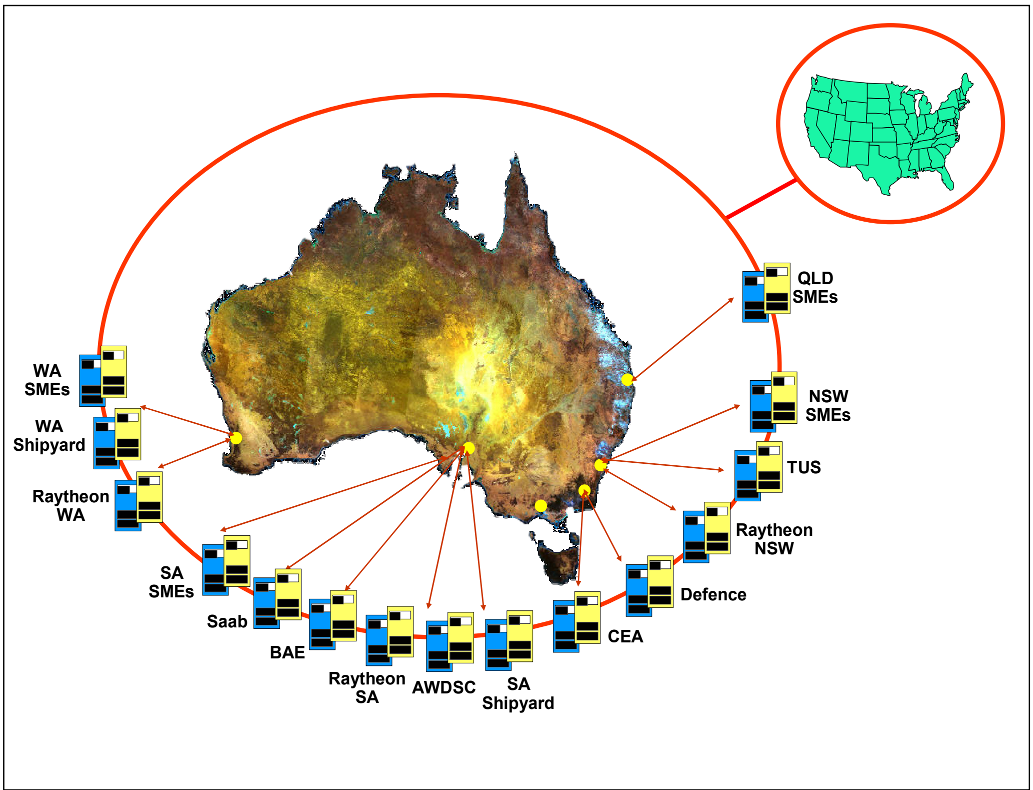

Figure 2 - Illustrative Australian Distributed Test and Evaluation Network

Such a distributed environment would be of particular advantage to small and medium sized enterprises (SMEs) in Australia and go a long way in facilitating their participation in larger programs.

DISCUSSION

In addressing the more specific issues contained within the terms of reference for this inquiry Raytheon Australia has focussed upon the areas of our core expertise. We leave it to the companies with experience in constructing and consolidating modules to comment upon those elements of the shipbuilding task. Although it is worth noting that the growth in Common User Facilities, funded by State governments, in South Australia, Western Australia and Queensland suggests that the need to sustain proprietary infrastructure could be lessened.

The capacity of the Australian industrial base to construct large naval vessels over the long term and on a sustainable basis.

The successful execution of three major naval shipbuilding programs over the last two decades, the Collins Class submarines, Anzac Class frigates, and Huon Class Coastal Minehunters, demonstrate that Australian industry is capable of constructing large and complex naval vessels.

Australian defence industry also has shown itself to be flexible and innovative. The two leading builders of fast catamarans, Austal and Incat, are prime examples of Australian companies leading the world in their field. While the size of our defence market will limit the amount of sophisticated electronic military equipment that Australian companies produce, with the right policy framework, they will adapt to whatever future war fighting technologies the ADF may wish to adopt.

The emphasis in this item on “large naval vessels” could be misplaced as a long-term consideration. With our limited ability to predict significant changes in the global strategic environment, together with the rapid advances in technology, the committee might bear in mind the potential for future RAN vessels to be substantially different to those being built today.

Notwithstanding the recent decisions to build several large steel-hulled ships, who can say what the next generation of naval vessels might look like. There are a number of factors that will need to be considered, including very importantly the availability of appropriately skilled people to man them. However, for reasons of both increasing combat effectiveness and the need to constrain crew sizes future naval vessels are likely to be increasingly complex with greater use of automation and systems.

Due to the size and nature of the Australian defence market the majority of these systems will come from overseas. Although there are some sensors and control systems developed and made in Australia it is most unlikely that a world class naval combat management system would be developed here in the future. There is simply not the expertise within the local defence industry to produce a system that could equal those produced in the United States or Europe.

The last time a combat management system was developed to indigenous specifications was the original system for the Collins Class submarines[2]. This experience demonstrated that there is insufficient knowledge or experience in either industry or Defence to understand the risks and the methodologies, what works and what does not, in such complex real-time systems.

The Collins Class experience also demonstrated the additional costs and burdens of being the parent navy for such a system. This entails not only the full design, development, test and evaluation effort, including possibly weapons certification, for the construction phase of the vessel, but for all of the vessel’s operational life, some 25-30 years.

[2] The combat management system for the FFG Upgrade program is an evolution of the originally fitted Naval Combat Data System (NCDS).

Selecting fully developed overseas combat management systems can obviate these problems, but only as long as the system itself is not substantially altered from the baseline in service with the system's parent navy. If a system is adopted off the shelf, as has been done for the replacement combat system for the Collins Class and for the AWDs[3], the RAN can leverage the investment and future developments made to the system by the parent navy, in the latter cases the United States Navy (USN). This does not come without cost, but that cost is straightforward and relatively easily provided; it is cash. Whereas the parent navy responsibility assumed for the Collins Class requires skilled and experienced engineers and other specialists, scarce commodities for both the RAN and defence industry, in addition to the direct cash costs.

While the central function of the combat management system is common in western navies the choice of sensors and, in some cases, even weapons needs to take into account the environmental conditions of the planned operational areas and the modus operandi of the navy. For example, a sonar designed for the colder, deeper waters of the North Atlantic is unlikely to be well suited to the warmer, shallower waters to Australia's north. Similar considerations can apply to radars and electro-optical devices.

These considerations have been recognised in the approach to the design of the sensor suite for the AWDs, with the Alliance team examining options for some of the sensors and weapons to be integrated with the core Aegis system and its associated SPY-1D(V) surveillance and target indication radar.

Due to these considerations the skills and capabilities required of industry in Australia are not to design and develop naval combat management systems, rather they are to conduct the system engineering, including overall system architecture and design, for the selected sensors and weapons and integrate them with the chosen combat management system. This is what was done in the Anzac Class, is now being done on the Collins Class, and is to be done with the AWDs.

The sector of the defence industry engaged in systems engineering and the integration of complex systems is healthy with three companies currently engaged in active naval programs Raytheon Australia (AWD and Collins Class replacement combat system), Saab Systems (Anzac Class), and ADI (FFG Upgrade) and other companies engaged in different defence industry sectors. Indeed, demand is such that the availability of sufficient skilled workers in a tight national workplace has become an issue.

Systems engineering and systems integration are areas where local subsidiaries of large international companies make a substantial contribution to raising the level of knowledge and improving the techniques, processes and tools utilised through the transfer of best practice from their parent companies. The benefits of this in strengthening Raytheon Australia's capabilities were outlined above. On the other hand simply contracting the

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3 The United States' Aegis system has been selected as the core of the combat system for the AWDs.

work to an overseas company, or hiring overseas workers without ensuring the transfer of knowledge to local people, results in little or no increase in Australian industrial capability.

In Raytheon Australia's opinion there is no question as to the capability of Australian industry to construct large naval vessels. With an ambitious program of naval shipbuilding the issue is one of industrial capacity, the most crucial element of which is the availability of appropriately skilled people. The latter challenge has four dimensions to it: the size and makeup of the existing workforce; the capacity to train new workers; carrying out the required work in a more efficient and effective manner (thereby reducing the number of workers required); and programming the work in such a way as to reduce the overlap between competing programs.

Raytheon Australia is recruiting as many engineers as possible at present, and has programs with universities that aim to encourage under graduates to join us once they have their degrees. We also run internal courses, send people to the United States to undertake courses our parent company runs, and encourage our people to learn from external training providers here in Australia. For example, having identified the need for systems architects we have set up a training program that leverages the parent company's Certified Architect Program, which extends over two years, to address this capability gap. We also run a five-day course on the Principles of Systems Engineering, which we offer not only to our own people, but also to staff of the DMO and SMEs with whom we have strategic relationships. We are making ground, but it takes time to expand a workforce in these highly skilled areas.

The comparative economic productivity of the Australian shipbuilding industrial base and associated activity with other shipbuilding nations.

Three years ago Raytheon Australia conducted a benchmarking test against our parent company in the United States. The study showed that we could conduct many of the functions associated with systems engineering and systems integration at less than two thirds the cost of doing them in the United States. However, Raytheon Australia did not have the capability to carry out the full range of tasks that our parent company was capable of doing.

This hardly constituted a rigorous test, but it did provide a useful indication that the transfer of knowledge, process and tools by Raytheon Company had improved our performance and that we could be competitive in the global market, albeit in selected areas.

The drive for continuous improvement by most, if not all, defence companies in Australia is what will make us globally competitive and allow us to undertake major programs on a cost competitive basis. There are many aspects to seeking best practice. For example, Raytheon Australia has invested heavily in tools and processes in key skill areas and was the first organisation in defence industry to reach the sought after level 3 rating in risk management and in quality management under the world's best practice model, "CMMI". The company was also the first in defence industry to sign a strategic agreement with the Australian Institute of Project Management to professionalise and certify all our program managers to recognised Australian and international standards, a process that was largely completed last year. The company fully supports the DMO's efforts to lift standards across the industry.

The processes described do represent best practice. In the United States they are being proved on the DD(X) destroyer program, the LPD-17 amphibious ship program, and the CVN-78 new generation aircraft carrier program. We have drawn upon these processes from our parent and, while we still have a way to go in reaching the level of maturity in them that our parent company has achieved, we are well advanced and have made huge improvements in our performance. For example, we have recently delivered the first elements of the new combat systems for the Collins Class submarines within both schedule and budget.

The comparative economic costs of maintaining, repairing and refitting large naval vessels throughout their useful lives when constructed in Australia vice overseas.

Due to the fact that a large proportion of the electronic equipment fitted in future naval vessels will be of overseas origin, irrespective of the country in which the ship is constructed, the cost of maintaining or repairing that equipment will be the same. What would be different is the cost of changing equipment if the overall systems in the ship are designed, engineered and integrated in Australia rather than overseas.

If an overseas ship were to be acquired with the systems supplied as an off the shelf package the cost of making changes to that system through the company that did the original systems integration could be very expensive indeed. The reason for this is straightforward, the supplier is in a monopoly position and there is no leverage the RAN or DMO could apply to ensure that the price is constrained by the supplier; the latter would have them over the proverbial barrel.

This situation could be avoided by negotiating a licensing agreement at the time of purchase to allow other companies to access the IP involved, but this would add substantially to the cost of the original purchase. It also would require a tightly written contract to ensure that the full rights to the IP are guaranteed.

In the case of the replacement combat system for the Collins Class submarines the RAN is able to acquire biennial, or any ad hoc, upgrades to the system software developed by the USN through the Foreign Military Sales (FMS) system. However, should the RAN decide to upgrade one of the sensors in these submarines it could have the new sensor integrated by Raytheon Australia, as the local contractor for the systems integration.

The RAN could be assured that the price for this work would be competitive as, aside from the normal processes of cost investigation that the DMO applies to work carried out by local companies, there would be pressure on

Raytheon Australia to do the work at a competitive price as its contract could be terminated and the work given to another company if it did not.

It is the presence or otherwise of this competitive dynamic that ensures the cost-effectiveness of work carried out by local companies, as compared to monopoly supplier situations that could exist for foreign, off the shelf proprietary solutions.

The broader economic development and associated benefits accrued from undertaking the construction of large naval vessels.

Raytheon Australia has not undertaken specific research that could contribute directly to this issue. However, two studies conducted by Tasman Asia Pacific and Tasman Economics into the impacts of the Anzac[4] and Minehunter Coastal[5] projects respectively are acknowledged to have provided robust examinations and sound findings on the economic benefits of undertaking construction programs in Australia.

The report into the Anzac Ship Project included the following conclusions:

- The project involved over 1,300 companies in Australia and New Zealand.
- Over 60% of the subcontractor companies were based in Australia; 75% of these were from the manufacturing sector and about 90% were SMEs.
- 72% ($4 billion) of the contract's value was provided by companies from Australia and New Zealand.
- The project generated between $200 million and $500 million in additional annual GDP, or a total of $3 billion in GDP over the 15 year construction phase of the project.
- The project generated around 7,850 full-time equivalent jobs.
- The project generated between $147 million and $300 million in additional annual consumption, or a total of $2.2 billion additional consumption over the construction phase of the project.
- Each additional $100 million spent by the government on the project generated $195 million in national output and 1022 jobs in the Australian economy.
- Benefits to the economy would continue over the 25 to 30 year life of the ships, as the high levels of local industry participation secured during ship construction should result in a correspondingly high level of participation during their through-life support.
- The growth in economic activity resulting from the Anzac Ship Project arose from a range of factors which increased the productivity and competitiveness of the businesses involved in the project through:

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4 *Impact Of Major Defence Projects: A Case Study Of The Anzac Ship Project*, February 2000, Tasman Asia Pacific

5 *Impact Of Major Defence Projects: A Case Study Of The Minehunter Coastal Project*, January 2002, Tasman Economics

    - becoming more innovative through their own research and development, and access to foreign technology;
    - improving their business practices, leading to a culture of continuous improvement;
    - increasing their export opportunities; and
    - acquiring new defence capabilities enabling them to play a greater role in Australia's national security.

- One in five Australian businesses involved with the project obtained new technology. This technology enabled those companies to increase their commercial and defence-related sales by extending their product range, opening up new markets. and improving the quality of their products and the flexibility of their business. Many of these firms obtained their new technology through original research and development. Notably, the study found that a higher proportion of manufacturers involved in the project conducted original research and development than companies in the broader manufacturing sector.
- The high quality standards required by Defence from its prime contractors also affects subcontractors, as these requirements flow down the supply chain. The study showed that involvement with defence work, including the Anzac Ship Project, was a major factor in a company's decisions to implement best practice programs and techniques. As a result, both manufacturing and services companies involved with the project were two to three times more likely to implement such programs and techniques than their counterparts in the wider business population.

One of the report's final conclusions was that "this study demonstrates that the benefits that accrue to Australia from high levels of local industry participation in major projects are not just economic. Participation in the Anzac Ship Project has improved the capability of Australian companies to contribute to the defence of Australia."[6]

[6] *Impact Of Major Defence Projects: A Case Study Of The Anzac Ship Project*, February 2000, Tasman Asia Pacific, p xi