REARMING THE ANZACS

Robert Macklin

ASPI
AUSTRALIAN STRATEGIC POLICY INSTITUTE

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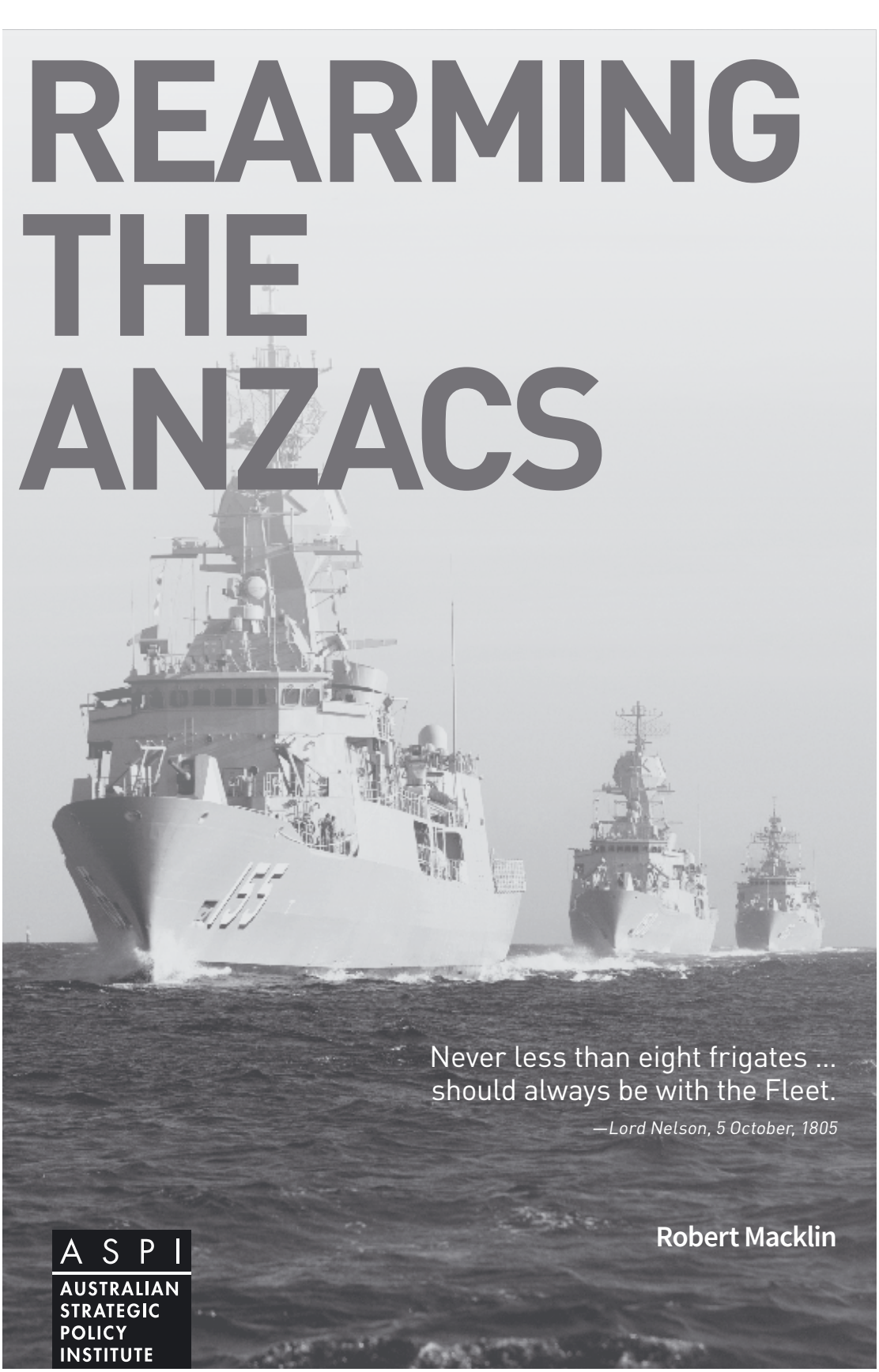

Never less than eight frigates ... should always be with the Fleet.

—Lord Nelson, 5 October, 1805

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Cover image: HMAS *Ballarat* (155), HMAS *Anzac* (150) and HMAS *Stuart* (153) transit through Cockburn Sound, February 2016. Photo courtesy Department of Defence.

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Preface

Rearming the Anzacs tells a remarkable story about how the Royal Australian Navy's Anzac-class frigates—once regarded as a second-tier warship, 'fitted for but not with' key weapon systems—were, in the words of a key participant, upgraded to become pound for pound 'probably the best warship of its size in the world'.

It's a terrific story. Anyone in the Department of Defence, Royal Australian Navy and the many parts of Australian industry that supports the military knows that achieving great results is the product of vision, determination and hard work. There's no shortage of human drama in big defence industry projects, and the quality of decision-making by individuals often determines whether a Defence project becomes a triumph or a disappointment.

In this, the first of a series of *ASPI case studies in defence projects*, historian, novelist and biographer Robert Macklin explains how the Anzac frigates were rearmed with some of the world's best air defence technology. The book is based on extensive personal interviews conducted by Macklin with central figures in the Anzac frigate story. It's a 'warts and all' account that casts a critical but constructive eye over a defence procurement saga that cost the country hundreds of millions of dollars, but ultimately equipped the Navy with ships that have since served around the world.

The purpose of this book, and those that follow it in the series, is to show the lessons learned from the hard school of Defence capability development. I would like to acknowledge the support of Kim Gillis, the Deputy Secretary of Defence's Capability Acquisition and Sustainment Group, who backed ASPI to develop a series of case studies on defence projects to provide insight into the human dynamics of equipping a modern military organisation. Our aim is to develop a number of these studies to help people in Defence and industry to better understand the complexities of the business—all in the interest of improving how Australia equips its defence force. Anyone interested in the challenges of decision-making will enjoy this book.

In the interests of accuracy, ASPI shared drafts of this study with the Department of Defence and other interested parties, but responsibility for the judgements made here, and for any factual errors, rests with the author and the Institute.

Peter Jennings
Executive Director
Australian Strategic Policy Institute

1. A summons to a trial

On a warm, overcast day on 6 August 2013, the Anzac-class frigate, HMAS *Perth*, under the command of Captain Lee Goddard, eased away from her berth at the Queensland port of Mackay. Travelling at 12–15 knots, she made her way south through the channel in the Great Barrier Reef and into deep water before turning to port and setting a course to the east northeast. Her destination was America's Pacific Missile Range Facility (PMRF) off the coast of the tiny Hawaiian island of Kauai.

Established in 1958, the PMRF bills itself as 'the world's biggest instrumented, multi-dimensional testing and training range'—the only one on the globe where submarines, surface ships, aircraft and space vehicles can be tracked simultaneously. It boasts 2,800 square kilometres of instrumented underwater range and more than 100,000 square kilometres of controlled airspace. It's the ultimate unforgiving international naval test site.

Captain Goddard and his crew were primed for the occasion. They had docked at Mackay in the wake of the massive biennial US–Australian Talisman Sabre exercise, on that occasion involving some 21,000 service personnel. Their operations in the exercise had been a useful addition to preparations for the forthcoming trials, and *Perth* had performed well. It was a good confidence builder, and they needed it. Once in Hawaii, they'd be testing their new and radically innovative Australian anti-ship missile defence (ASMD) system against everything the Americans could throw at it. Indeed, most of the crew members had made the journey in this same ship two years previously under Captain Mal Wise. And that had been a very demanding introduction.

Goddard and Wise were among the best ships' masters in the RAN. And they reached their warship commands via quite different career paths. Mal Wise, who by 2017 had become the RAN's Commodore Warfare—was and remains a natural leader of men. A no-nonsense Queenslander, he enlisted in 1985 and after a year at HMAS *Creswell's* Naval College transferred to the Australian Defence Force Academy (ADFA), where he secured his science degree, majoring in oceanography. As a sub-lieutenant he was selected for an exchange posting to Canada and in 1991 joined the patrol boat *Whyalla* as Navigation Officer. After two years in that role, he secured his first command—he was one of the youngest to do so—in the heavy landing craft HMAS *Balikpapan.* He served in the INTERFET force during the 1999–2000 East Timor crisis and in the war in Iraq in 2002–2003, after which he was awarded an Order of Australia Medal. Promoted to Commander in 2005, he captained the new Anzac-class frigate *Ballarat* in operations in the Arabian Gulf and in 2007 attended the US Naval War College followed by a Master's degree in international relations.

He returned to Australia and drove a desk at Navy HQ in Canberra before taking command of the *Perth* in late 2010. As we shall see, he used his own methods to mould the *Perth*'s crew into an extraordinarily cohesive and efficient unit. 'She was just out of dry dock,' he says. 'There was a lot of work to do and I needed a crew who were committed to the job.'[1]

Lee Goddard joined the service from Melbourne in 1987 and quickly carved a name as a high achiever. In his final year at ADFA, where he, too, completed a science degree, he was named Cadet Captain and awarded the Sword of Leadership. The following year at the RAN's Seaman Officer College at Jervis Bay, he was appointed College Captain and won the Queen's Medal. And in 1996 he collected the Sydney–Emden prize and the RAN Sword of Excellence when he topped the Navy's Principal Warfare Officer's course.

He was given international experience in Malaysian, Canadian and US warships and was Warfare Officer on the Anzac-class frigate *Arunta* during its commissioning. He made Executive Officer on her sister ship *Stuart* in 2001 before gaining his own command of another Anzac, HMAS *Parramatta*, in 2005. 'I actually had five postings of Anzacs in a row,' he says, 'so I'm very close to the project.' He later attended the US Naval Command College and on graduation in 2010 collected the college's International Leadership prize.

He took command of the *Perth* from Mal Wise in 2012. At the time, she was again docked at Henderson in Western Australia for refit. 'We undocked the ship in February 2013,' he says, 'and took her out to sea. We tested the platform, making sure the engines were correct. We tested all the auxiliary systems—water, power etc.—very methodically.'

And that was just the beginning. She also performed well in sea trials off both the west and east Australian coasts. He was greatly encouraged by the fact that his 21 officers and 141 crew were at peak efficiency. 'I owe that to Mal Wise,' he says. 'He did a magnificent job.'[2]

But while ship, systems and crew had passed muster, the home-water trials were only curtain-raisers to the main game in Hawaii. As the *Perth* reached cruising speed and headed into a brisk northeaster, Goddard was all too aware that on arrival at PMRF they would put one of the most ambitious projects ever undertaken by the RAN to its final test. They would be defending their ship—and the high-value targets that would form part of the battlegroups and taskforces it was charged to protect—against supersonic missiles approaching at three times the speed of sound. His own interceptors—the Evolved Sea Sparrow Missile—would be travelling slower than the target's speed. By any sensible measure, the odds were against them. Unless the *Perth* and its groundbreaking Australian radar system performed faultlessly, they

would fail the test. Indeed, anything less than 100% success would throw the future disposition of all of his country's eight Anzac frigates into question.

The Anzac-class story began in the 1980s, when a decision to acquire the warships had been taken by the Hawke Labor government. The class was so named because the Defence Minister, Kim Beazley, was determined to bring New Zealand into the project. At the time, the Kiwis had broken with the US over New Zealand's banning of nuclear-powered vessels from its ports; Beazley saw the joint operation as a way of countering the isolationist movement in New Zealand and retaining a de facto commitment to the ANZUS Treaty.

That wasn't an easy sell in New Zealand, where Prime Minister David Lange wouldn't allow his department head even to use the word 'frigate'. The ships would be referred to as 'new surface combatants' or, preferably, 'ocean surveillance vessels'. The NZ Defence Minister, RJ Tizard, told the doubters that they would be used to 'maintain a role in the South Pacific and build cooperation with Australia'. And with a nod to his country's several thousand 'yachties' he declared, 'Obviously, an increased search and rescue response will be a very significant part of our contribution.'

Finally, in September 1989 under new Prime Minister Geoffrey Palmer, the Kiwis bit the bullet and announced the agreement to buy two ships at a sail-away price of NZ$299 million each. Moreover, Beazley's desperation to keep the Kiwis in the game meant that New Zealand's project costs would be 20% lower than Australia's. By 1992, Australia's shadow defence minister, Alex Downer, was complaining, 'We offered New Zealand a situation where they could buy one frigate and get the other free at the Australian taxpayer's expense!'

Beazley's equally important concerns were a much-needed reinforcement of Australia's naval strength and a boost to the country's shipbuilding industry. While the Anzacs were based on a German design, they were built by AMECON, an Australian firm incorporating Tenix (soon to be bought by the British company BAE) at Williamstown, Victoria, and Newcastle, New South Wales, with some elements hived off to harbourside Whangarei on New Zealand's North Island. They represented a revival of Australian shipbuilding and were completed to a high standard of workmanship. They weighed 3,600 tonnes, had a top speed of 27 knots and a range of 6,000 nautical miles (11,000 kilometres). But the build was a lengthy process: while HMAS *Anzac* officially entered the service in 1996, the last Australian ship of the class—the *Perth* itself—wouldn't be commissioned until 2006 (Table 1). It was regarded as a highly successful operation. *Anzac* had cost $192.8 million, whereas *Perth* came in at only $144.8 million.

Table 1: Anzac-class frigates launched

Ship	Hull number	Launched
Anzac	FFH 150	18 May 1996
Arunta	FFH 151	12 December 1998
Warramunga	FFH 152	31 March 2001
Stuart	FFH 153	17 August 2002
Parramatta	FFH 154	4 October 2003
Ballarat	FFH 155	26 June 2004
Toowoomba	FFH 156	8 October 2005
Perth	FFH 157	26 August 2006

Their initial armaments were of the 'bare bones' variety, consisting of a single 5-inch gun, a machine-gun and a rudimentary Mark 41 vertical launch missile system, together with a missile-armed helicopter. The radar suite included a Raytheon system for aerial search and long-range surveillance, a Celsius Tech (later SAAB) target indication radar and separate units for missile fire control and navigation (though the *Perth*'s armaments incorporated the Harpoon missile and the MU90 lightweight torpedo launchers introduced during the build program).

The vessels came with a 'fit for but not with' capacity to install a torpedo system, anti-ship missiles and a close-in weapons system; so, as warships, they were a work in progress. Despite their fine lines and an excellent communications system, they were seriously short of fighting capability. In fact, below decks they were dubbed 'the best informed targets in the world'.[3]

Anzac captains respond defensively to such slighting descriptions, but at the time the Hawke government ruled out fitting more powerful armaments on the grounds that it wasn't affordable. Treasurer Paul Keating was certainly running a tight budgetary ship; the mining boom had yet to fill and overflow the Australian Government's coffers. But there were other reasons for the decision, not least the international strategic situation of the time.

Those were halcyon days for Western democracy. In 1989, the Soviet Union began its collapse, leaving the US suddenly the unrivalled superpower on the world stage. The dynamic Chinese economic revival was only then being triggered by Deng Xiaoping, whose international reputation had in any case been disfigured by the violent suppression of students and activists in Tiananmen Square. In other parts of the region, the Pacific was living up to its name.

However, by 1995, when Beazley had become Deputy to Prime Minister Paul Keating, he shared the Navy's concern about its lack of air defence. The Defence Department's 1992 Force Structure Review had contained a plan for an additional six Anzac-class frigates designed specifically for wide-area anti-aircraft warfare. However, on reflection, Defence decided that the ships were too small to carry all the necessary equipment and weaponry. Instead, the RAN began another project to upgrade its Adelaide-class frigates as a stopgap until a purpose-built destroyer class could be acquired. Beneath the waves, its Oberon-class submarines were gradually being decommissioned and replaced by the troubled Collins class. Even with its patrol boats and supply ships, it was a navy in desperate need of firepower. The procurement schedule was crowded with alternative options.

Then, in March 1996, the Coalition under John Howard won the Treasury benches. Soon after, the new Defence Minister, Ian McLachlan, brought a Defence Department submission to cabinet for a major upgrade of the Anzacs' armaments, specifically their anti-ship missile defence system. McLachlan was better known as a South Australian cricketer and grazier. He had come to public notice as President of the National Farmers' Federation before coming to parliament as recently as 1990 and was an unlikely choice for such a demanding portfolio.

But by then the international situation—and Australia's financial position—were undergoing a sea change. China was roaring ahead economically and already there were forecasts of her reaching equality with the US. Defence planners judged that the inevitable rivalry could very easily disrupt the status quo in the region. Moreover, China's steel mills were buying so much Australian iron ore and coal that the Howard government would soon be enjoying an embarrassment of riches. So the Coalition, which had traditionally taken a more proactive approach to defence spending than Labor, found little fault with the ASMD submission; after a relatively congenial cabinet discussion, it was given the green light for an initial spend of some $200 million.

There was no specific completion date in the cabinet decision. The fact that the ships were still coming off the production line made that impracticable. Instead, there was an 'indicative' schedule of 2001 to 2007 for the refit. However, very little progress had been recorded by the time McLachlan retired in 1998. Indeed, no-one at the time could have anticipated the struggle, the fierce conflict, the remarkable serendipity, and the astonishing homegrown inventiveness that would characterise the ASMD project in the years ahead.

However, the warship in which Captain Goddard set out across the Pacific to his date with naval destiny in 2013 was a very different proposition from the one that had first joined the RAN's fighting ships. By now the *Perth* carried a radar and combat system that made the Anzacs a potential force to be reckoned with … but only if the ship passed the forthcoming test against the most sophisticated weaponry in the world. And the outcome was far from certain. Indeed, the Americans and other international observers at the Hawaiian missile range had little doubt that their 'targets' would come through unscathed. According to Lee Goddard, 'They were just sceptical. They said, "You can't do that."'

2. Two mavericks enter the story

Ian McLachlan retired from the field in 1998 and was succeeded by a former Queensland stockbroker, John Moore, who would remain Defence Minister for just over two years. And although his tenure encompassed the INTERFET operation in East Timor and the delivery of the landmark 2000 Defence White Paper, it was disfigured by his extraordinary public falling out with the secretary of the Defence Department, Paul Barratt. Shortly after his ministerial appointment, Moore had commissioned the McIntosh–Prescott report on the notorious Collins-class submarine project. Indeed, during the mid-1990s there had been several recommendations that the project be abandoned and the boats and hulls broken up for scrap. The report concluded that the submarines were 'incapable of performing at the required level for military operations'.[4]

Less than a year later, there were rumours of fierce clashes between Moore and his departmental secretary. They became public when the minister sent Barratt a 'letter of termination', partly over the operations of the Defence Acquisitions Organisation. Barratt publicly defended the organisation on the national broadcaster:

> I don't think there are systemic problems. It measures up very well against the UK and US defence acquisition organisations in terms of both cost overrun and schedule slippage … There is a $40 billion acquisition program and we are always reaching for the edge of technology. So they are high risk programs and inevitably things go wrong.[5]

Moore remained in his post until January 2001, when Howard removed him and appointed Peter Reith to the portfolio. Moore then resigned from parliament and his formerly safe Liberal seat fell to the Labor opposition. In the 2001 election seven months later, Reith became embroiled in the infamous 'children overboard' scandal, which also touched the high echelons of the Navy. He resigned in November 2001, less than a year into the job.

Beneath this long-running contention and dispute at the top, progress on the ASMD was tentative at best. In 1997, a year after the original decision from the cabinet, the Defence Science and Technology Organisation (DSTO) and the Navy had developed what they termed the Anzac Warfighting Improvement Program—better known throughout the service as the WIP. Additional funding was secured, as the WIP made provision for a new suite of armaments, including a second Mark 41 launch system and a very short-range air defence (VSRAD) unit. However, once it entered the department's procurement system there were conflicting views about its efficacy.

According to Commodore Rob Elliott, now Director General Surface Combatants and Aviation within the Capability Division of Navy Strategic Command, 'The VSRAD was what was available at the time and these are very short-range missiles basically connected to existing radar systems.' However, he says, 'when we modelled its capability with our defence scientists, its ability to meet future threat was insufficient. An alternative capability option was necessary.' So, in 1999, they abandoned that idea and began a search for a viable alternative.[6]

Off-the-shelf weapons systems were available from allies and associates around the world, but none really filled the bill. Various other proposals had surfaced, including one to build six more Anzacs designed specifically for air warfare. There was even a plan to lengthen the ships to allow the installation of a heavier radar system. Vice Admiral Chris Ritchie had become Head of Capability Systems in 1997 and was aghast at the plan. 'It was a crazy idea,' he says. 'Cut an Anzac in half and make it a lot longer and fill it up with missiles and all that sort of thing. WIP was still around but it was on its last legs.'[7]

By 2001, no firm progress had yet been made to meet the government's brief. When Commodore Tony Flint was appointed Director General Maritime Development that year, he says he was 'vexed' by the slow pace of ASMD development. 'There was this thing called WIP,' he says. 'They commissioned several companies to do this study and come up with a solution as to how you increase the survivability of Anzac—what would you do, how would you modernise it and all that. In the end it was decided that it wasn't value for money and it was cancelled just as I was taking over.' Some $150 million remained in the ASMD developmental 'kitty'.[8]

After that, Flint says:

> … there wasn't anything for a while. Then I commissioned the DSTO to do some studies and the brief was 'What gives you the best bang for the buck?' The DSTO did all the probability of survivability in a combat situation. It was all earmarked against the current and predicted regional threat. And there were some very fast sea-skimming missiles that were entering the scene and would be in the region. So then we had a kind of order of priority. If you spent a limited amount of money, you prioritise what your [purchases] would be.

The DSTO considered an infrared tracking device to be fitted on the stern of the ships to pick up the 'heat bloom' of incoming missiles. It explored supplementing the ships' radar to counter jamming, and upgrading the Anzacs' long-range radar. 'The upgrades were fairly cheap,' Flint says, 'but what would you do to detect the supersonic sea skimmers which were the hardest threat [to counter]? Would you put in another type of missile? They were fairly cheap, but would you complement the current missile with, say, an infrared missile, which is a totally different way of doing business?'

Flint says that, after collating all the possibilities, 'We got to a point where I think we had a fairly good matrix—if we spend this amount of money, what would give us the greatest degree of survivability, and then the [various elements] were prioritised down.'

It was at this stage that an Australian company—CEA Technologies Pty Ltd, with which the Navy had had several earlier dealings—entered the equation. There was a chance—some said a very good one—that the Australians might be able to contribute. Certainly, the company itself believed so.

CEA was the brainchild of two former naval officers—Ian Croser and David Gaul. When they left the Navy in 1983, Croser had been the Weapons Electrical Engineer on the guided missile frigate HMAS *Canberra* and Gaul the Executive Officer. 'I had a warfare operator background,' Gaul says, 'and Ian had the technical smarts. So we moved out of the Navy together and set up CEA.'[9]

The son of a New South Wales schoolteacher, David Gaul joined the Navy in 1962 at only 15, having just gained his Intermediate Certificate at Canberra Grammar School. He began his training at HMAS *Creswell*, Jervis Bay, and served a year at sea as a midshipman.[10] He was then transferred to the UK for two years—the first at Dartmouth Naval Base, the next travelling to various naval colleges for specialised instruction. At the end of the course, he and his colleagues made their choices of career paths in the Navy. He chose warfare.

Back in Australia, Gaul did watch-keeping duties on a range of warships, and promotion followed as he gained both experience and the high regard of his commanding officers. He secured his first command—a patrol boat stationed at Jervis Bay—before returning to the fleet's bigger fighting ships, including the flagship, HMAS *Melbourne.* However, his most defining posting followed when in 1978 he secured a position in the Naval Attache's office in Washington. He would remain there until 1981.

'That was a crucial time for me as far as CEA goes,' he says. 'The Navy was expanding at that stage so we were buying a whole lot of new weapons—new missiles, new Sidewinders for the A-4s and the Air Force. The new FFGs were coming along and by then we had become really US-centric.'[11]

The posting gave Gaul a powerful insight into the American military-industrial complex. 'We were allies, so all the doors were open,' he says. He travelled across the country to various trials and manufacturing systems for the weapons Australia was buying. 'They were big-ticket items in those days,' he says, 'so my reports had to be pretty extensive to get through the [Australian] committee system.' He also had the chance to negotiate Australian industry participation and hold out for better deals from the suppliers. 'It was an invaluable experience,' he says. 'It really opened my eyes to what was possible.'

He returned to become the Executive Officer of HMAS *Canberra*, and Ian Croser joined the ship as Weapons Electrical Engineering Officer (WEEO) soon afterwards. They had met socially, but this was the first time they were thrown together as shipmates. Ironically, given what lay ahead, Croser was coming off a secondment to DSTO. His reputation for startlingly original innovation had reached the organisation's ears, and it wanted him aboard. While he was on a ship in the Far East, radio reception was almost impossible, so he had devised a new antenna system and suddenly reception was as clear as a bell. However, when word reached Navy HQ, a signal arrived: 'Remove that unauthorised modification from that ship forthwith.' David Gaul chuckles, 'So he tossed it overboard. The captain was furious—for the first time in ages he had good comms and now they're back where they started.' However, Croser's time with DSTO was limited, and he found a very congenial companion aboard the *Canberra.* 'We hit it off straight away,' Gaul says.

Ian Croser came from a South Australian family well known for its farming and winemaking, but in his teens he became impatient with rural life and developed an interest in science. He took an electrical engineering degree at Adelaide University, but the South Australian capital in those days, he says, was like a big country town. 'I wanted a little bit of adventure. I was in the Army Reserve but thought that it wasn't a very technical process. I looked at the Navy and the Air Force and decided, quite rightly, that the Navy was the best place to be.' So he joined up in 1971, and in no time he developed an intense interest in radar: 'A lifetime's fascination,' he says.[12]

He's a tall, slim, quietly spoken man with the single-minded intensity of a scientist engaged in the endless quest of discovery. 'The thought of being able to see things a very long distance away electronically was pretty exciting to me,' he says, 'but I never envisaged at that stage that we could have an involvement in radar in Australia because everything was coming from overseas and it was very expensive.' But life at sea, where the curvature of the earth and the natural limitations of the human eye restrict the sailor from knowing what lies in wait over the horizon, provided a special challenge. It fired his determination to explore the electronic possibilities.

Shipmates tell of Croser spending his nights between watches working on new ways to approach the problem. And when he and David Gaul took the bold step of starting their own business in the intensely competitive world of defence procurement they brought with them a unique perspective. Croser reflects:

> We'd both been brought up through the supportive structure the Navy needs to operate. We decided we would try to influence the way the company operated with the same sort of ethics and processes to ensure that our focus wasn't just about money … if you get the right relationships and the right technologies, the funding generally will flow, whereas a lot of other companies tend to focus the other way around. That also helped us, because we were able to put a lot of investment into research and development.

In fact, according to David Gaul, in the early years R&D accounted for 85% of their expenditure. 'We learnt to do R&D for profit as a company,' he says, 'and it's part of our ethos.'[13] Moreover, they took an early decision to establish a protective barrier around the intellectual property their research produced. 'All our IP is ours and we control it very closely,' he says. This would become an increasingly significant factor, particularly when CEA decided to expand its operation with an infusion of funds from overseas sources.

Croser and Gaul established their headquarters in Fyshwick, a Canberra suburb designated for light industry, but with a somewhat raffish reputation at the time.[14] Like all new ventures, CEA had a tough introduction to the commercial world. David Gaul says, 'It took us about four years before we got any traction with Defence at all. They just didn't want to know us. While we were in our embryonic stages they felt there were huge risks … we could disappear. But eventually they came to us.'

Their first contract with the Defence Department was for a surveillance communications system for the Oberon-class submarines that were now working mainly with Australia's special forces. It was a resounding success and established them as a reliable supplier. 'We haven't been without a Defence contract since,' Gaul says. 'It's just a step up each time—bigger, more difficult, a more stretching project—and as long as we deliver we get the next one. You keep moving up the chain, as it were.'[15]

By 1997, they had begun to work with the Navy on aspects of continuous wave illumination, which sends out a beam from the ship to the target. The reflection is then picked up by the ship's missile in flight, which homes in on the reflection. 'We were given an opportunity in the Anzac program,' Croser says, 'to transition the illuminator that was being procured from the US—a vacuum tube based illuminator—to a solid-state version. We had to build a transmitter that had a very large number of transmit elements, which we combined to produce a very high power output.'

And Ian Croser was at last able to give free rein to the obsession that had engaged him for years: phased array radar (see box).

Ian Croser on phased array radar

If you think about a searchlight, it has typically a parabolic mirror and a light source, and it focuses the beam in a given direction. And if the searchlight beam hits an object you get a reflection back. Mechanical radar—by far and away still the most prolific of radar forms—is just that, except instead of light they're emitting electromagnetic waves from, typically, a parabolic-like reflector. The beam goes out where it's mechanically pointed, hits something, comes back in and gets back to the point of origin in the antenna. The only way you can steer that is mechanically.

With surveillance radars, which are just scanning the volume, they typically rotate. For tracking radars, they typically have a full parabolic reflector on a mechanical platform that has three degrees of freedom; and they will fire a beam at a specific object and get the returns back and adjust the position of the antenna as the object moves. So they're fixed to that object.

If you're firing a gun or a missile against a target, the entire time that you've got the missile in flight or you're firing the gun, the dish has to be on the target. So you've got one dish on the ship; you can only fire at one target at a time. The question has always been: how do you break that mechanical constraint and get flexibility, because a rotating system will always take 4 or 5 seconds to do a rotation and a supersonic target might travel 5 kilometres in that time.

The problem has got very significant. In fact, the first radar systems were phased array. The Chain Home radar [the coastal radar system used by Britain in World War II] was phased array and it was very big. What it's doing is not acting as a mirror. It's a series of antenna regions that receive the signal from the target. And typically, if the target isn't on the axis of the antenna there will be a different time that the signal is received at different parts of the antenna. And you can measure that by looking at the phase of the signal; the frequency's the same but it's just the sine waves that are received in the different parts of the antenna are lined up differently. By measuring that phase difference you can calculate the angle at which it's coming in. So that works really well.

> There are a lot of phased arrays, which are called passive phased arrays, that use mechanical antennas with lots of receive and transmit elements and generally address the target area. They can put one beam out at a time but because they can electronically steer the beam very quickly they can move it around the space to hit multiple targets more often. So that's really good technology. For example, the Aegis system—the Spy-1 radar—is a passive array like that. It's got a big transmitter down below, lots of power into the array and it points the beam dynamically to where it wants it to go and receives it back in the same way.

In this first operation, CEA was restricted to the technology of the day. 'When we started phased array,' Croser says, 'we made what's called an analogue array. But instead of having a big transmitter down at the bottom, we put a little transmitter and receiver at all the antenna elements across the face, and then formed a beam out of that. It worked really well.' As it happened, this project did not only confirm CEA as a highly professional operator in breakthrough technology: the unique innovation would eventually form a vital element of the digital phased array system that CEA would develop for the Anzac class.

However, according to Tony Flint, 'They were not mature enough at that stage. They didn't have something that we could actually put into that model that the DSTO were doing.' And that's when the ASMD project began to take on many of the characteristics of a maritime battle royal. In time, the opening shots across the bows would become broadsides amidships.

3. ‘There’s always room for sceptics’

On 11 September 2001, Islamist terrorists under the banner of Osama bin Laden’s al-Qaeda flew two airliners into New York’s twin towers and crashed two others, one in Pennsylvania, the other into the Pentagon in Washington DC. By chance, Prime Minister John Howard was in Washington at the time. Indeed, the black plume from the Pentagon was easily visible from his hotel. The previous day, he had met with President George W Bush at the White House, where they had begun a political and personal friendship.

Bush would order an immediate response: an attack on Afghanistan, where the ruling Taliban had provided bin Laden with a safe haven and training facilities in the mountains for his fighters, who had been garnered from radical communities in Afghanistan and abroad. On 7 October, Bush launched the offensive. Australia, with our special forces in the vanguard, joined the US, the UK and other nations in Operation Enduring Freedom. This coalition coordinated with the homegrown Northern Alliance, which had been fighting the Taliban since 1996. By 2002, the extremists had been banished from government and defeated on the battlefield.

However, their leaders escaped capture and would later return to the fight. Indeed, Bush himself would provide the opportunity for their revival. Under the influence of his Vice President, Dick Cheney—and in response to some questionable intelligence—he turned his attention from Afghanistan to Iraq. At America’s initiative, the UN imposed sanctions on the regime of the autocratic Saddam Hussein, who was suspected of developing weapons of mass destruction. And, as the US developed plans to invade Iraq, Prime Minister Howard was preparing Australia to join the so-called ‘coalition of the willing’. The demands on the Navy would continually increase and the pressure would be felt at all levels, not least on the ASMD.

The new Defence Minister after Peter Reith’s abrupt departure was Senator Robert Hill, who took up the post in late 2001. He would retain the portfolio until 2006, providing a much-needed sense of continuity at the top.

A South Australian with a reputation as a small ‘l’ Liberal, he was an unlikely candidate for the Defence portfolio. But in the event—and with the able assistance of a very experienced and congenial departmental head in Ric Smith, a former Acting Secretary of the Department of Foreign Affairs and Trade and Ambassador to China and Indonesia—his would be one of the more successful tenures in office.

At the time Hill was sworn in, the Anzac-class frigate HMAS *Arunta,* commanded by Captain (now Vice Admiral) Ray Griggs was deployed to the Persian Gulf to enforce the UN sanctions against Iraq. The ship and crew were exposed to a potential combat engagement with only the original Anzac-class armaments. 'The only modification for that trip was the Nulka decoy system,' Griggs says. The Nulka was a product of the defence scientists in DSTO; it was a missile with the unique capacity to hover in controlled flight. It's designed to entice sea-skimming offensive missiles away from the ship. Moreover, it has an electronic payload developed by the American company Sippican. It has become one of Australia's biggest defence exports.

'We were there in the six months leading up to the invasion of Iraq,' Griggs says, 'and my big concern during the period was that Saddam might do something silly to make a point. That was a constant fear. It represented a real threat.'

'Because the Anzac had a shallow draft, we were able to get further up to Iraqi waters than the FFGs, for example. We were right up close to the al-Faw peninsula and on a number of occasions there were missile site activations on the peninsula—most of them Silkworm sites—and they were taken care of; the coalition took them out.'[16] But others remained, and at any time one of the Chinese-made Silkworms could be heading for his vessel.

Like most captains, Griggs is loyal to his ship and insists that he felt 'comfortable' that his armaments—as controlled by his crew—had the capacity to defeat the threat. 'They were big, relatively slow missiles,' he says, 'so it wasn't like 10 years on [when missiles could travel at three times the speed of sound]. But we had only eight missiles ourselves, so I was thinking of Nulka not so much as a decoy but as part of my overall response. It was a constant worry. That exercised my mind a lot … a lot.'

Griggs says that the biggest issue he confronted was the long stay in such close proximity to the threat:

> We were only 13 to 14 miles from the peninsula, but if you're in a patch of water for six months there's a danger that the situation will become 'normalised'. That makes complacency among the crew the number one issue, particularly if you've got only 45 seconds from flash to bang—that's no time. So there was that constant worry, especially when at the same time we were putting boarding parties out to enforce the blockade.
>
> Some nights we had 20 to 30 dhows come out at once, loaded with oil and occasionally dates. We'd often have all four inflatable boats out, with the helicopter up, using the ship as well, trying to manage the breakout in very constrained international waters only 14 miles from a potential missile threat. You had to continually remind people that, while they were good at it, this wasn't normal.

The invasion of Iraq began with a 'shock and awe' aerial bombardment on 20 March 2003. While *Arunta* had just departed for Australia, the two other Anzacs on station, HMAS *Darwin* and HMAS *Anzac*, became part of the Australian contingent. They too had been on sanctions enforcement duties. They were soon joined by the transport HMAS *Kanimbla* carrying Army air defence and landing craft detachments. But such were the Navy's concerns about the Anzacs' lack of air defence that Vice Admiral Ritchie says the ships wouldn't have been deployed there if Australia hadn't been confident that the Iraqi Air Force had been eliminated from the battlespace: 'We had no air defence capability,' he says. 'If the Iraqis did have any aircraft to get airborne they would have been shot down by the Americans straight away.'

In the event, the naval deployment added a new sense of urgency to the ASMD operation. Tenix Defence (later BAE), as the builders, and SAAB, as the supplier of the combat management system, had negotiated a formal alliance with the Australian Government via the Defence Materiel Organisation (DMO). The alliance was an unusual *modus operandi* in naval procurement. According to Merv Davis, who was SAAB's managing director from 2003 to 2008, 'It was previously used in the building game for large military and commercial projects, but it's common sense if you're all aligned on the project outcome. You share the pain and the gain.'

However, it had its critics. He says that the Australian Government 'ultimately became uncomfortable with it because it was in the alliance but also a customer of the alliance. I can understand that. But set that aside for the moment, and you've got three parties whose interest is in what's best for the program, and ultimately that's in the Commonwealth's interest. There's always room for sceptics,' he says, 'and it's hard to defend against every criticism, but philosophically I'm something of a fan of the alliance process. And I believe it worked in this case.'

There's some disagreement among the parties as to whether CEA was invited to join. In a written answer, BAE's Support Services General Manager Darren Kirkby says, 'It was not only a decision for CEA.' But, in any case, Ian Croser says, 'We didn't feel it would be advantageous. We felt that we would be better placed contracting to the Commonwealth (through the Defence Department) but having a strong working relationship with the alliance.' Indeed, Kirkby says, 'The final agreement reached was for [the Australian Government] to manage CEA as their subcontractor, and hence CEA were represented into the ASMD project alliance through the [government] from a commercial perspective.'[17]

At the same time, the Defence Department was dealing with the recommendations of the 2000 Defence White Paper. The Prime Minister had called it 'the most comprehensive reappraisal of Australia's defence capability for decades'. Written by Defence's Deputy Secretary, Hugh White, who in the interim had become the newly appointed inaugural director of ASPI, it was a very detailed appraisal of Australia's materiel requirements.

Vice Admiral Ritchie says:

> It gave three priorities for the maritime forces. One was long-range air defence, and it talked about acquiring three air defence ships which later became the Hobart-class guided missile destroyers under the Air Warfare Destroyer (AWD) program. The FFG upgrade was in progress, so it was thought that was okay. But it was the Anzac class that needed something done. At that time, Anzac was still only equipped with the NATO Sea Sparrow, not the NATO Evolved Sea Sparrow Missiles. So really the capability was pretty poor.
>
> The National Security Committee of the Cabinet took charge of the expenditure on capability. Prior to that, Defence used to shift money around [and] did all sorts of things to balance the books. But after that it had much less say in where the money went; everything had to go to the security committee to be approved, which is probably right and proper, but it isn't what happened beforehand. [One effect was that] money flowed more easily to large projects … but something like ASMD isn't quite as sexy for the government to talk about.[18]

However, the Defence Department was required to reprioritise its 'shopping list' through the Defence Capability and Investment Committee, chaired by Secretary Ric Smith. Chris Ritchie was a member and is full of praise for the chairman's work. 'We thrashed it out around the table about what we could afford and what we were going to give up,' he says. 'That was a really great example of how we could all work together. We came out of it with a plan which really has lasted up until now.'

In the meantime, following his Middle East engagement—which earned the *Arunta* the Duke of Gloucester's Cup as the RAN's most efficient ship of 2002—Captain Griggs had been posted to Rockingham in Western Australia, where the ships were undergoing various elements of their refit, as the Anzac-class Capability Element Manager. 'We focused on all the fundamental elements relating to capability of the Anzac class.' he says. 'We'd have some decision rights around configuration changes that needed to be made. And we were looking at the performance of sensors and weapons.'

At the time, CEA and SAAB were starting to work on adapting the radar and the weapons system to each other. 'They seemed to work well together,' Griggs says. Merv Davis says that this cooperation was one of the keys to the operation. The SAAB representative was Peter Evans, a retired Navy Captain and weapons engineer. 'He was a great systems engineer,' Davis says. 'He absolutely understood the importance of supporting the Navy, and the Commonwealth more broadly. The relationship between Peter and Ian [Croser] was absolutely fundamental to the success of the project. Peter understood the technology of the radar and how it fitted together with the combat system. The other great benefit in the relationship was that the engineering always drove the solution.'

Griggs says, 'I think SAAB saw the potential of the radar but from my perspective I was concerned with what became the rest of the ASMD.' This included the Operations Room, which had to be totally redesigned. 'We drove that redesign pretty heavily,' he says.

For Griggs it was clearly a labour of love. 'There was a lot of resistance to it because it was going to add about $30 million to the program,' he says. 'But those several months in *Arunta* off Iraq were very useful to me. I knew when things were not in the right place ergonomically and from a work perspective. When I'm looking around for key information [during combat], I don't want to go hunting for it.'

In the event, Griggs and his team travelled to South Australia's Edinburgh Defence Precinct, which housed the DSTO—among others—and spent two or three days in a unique design process. 'Using basically cardboard mock-ups and flat-screen simulations,' he says, 'we ran through a range of air warfare and surface scenarios and it was basically about where we put stuff. If I'm sitting here as the captain, who do I need there? I'm going to look for that particular person—where should they be? It was really fascinating to see what you could achieve with minimal investment—just cardboard cut-outs, really.'

It was a thoroughly successful exercise. 'We effectively designed the Ops Room the way it is now, so every time I go on the water in an upgraded Anzac, I think, "Yeah …"' he laughs. His pleasure in the achievement is understandable. A recent visit by the author to HMAS *Anzac* revealed an Ops Room that brought to mind the bridge of the Star Ship *Enterprise* in the early *Star Trek* television series. Indeed, with its big commander's chair overlooking the screens and workstations of the operators, it has taken the place of the bridge for many of the Anzac frigate skippers. The bridge itself is a smaller and more spare area a flight of steep steps above.

By now, all the stars were aligned for a major step forward. Well, almost all. The warlike atmosphere of the day would extend down the line to the participants who would decide its fate—CEA on one side, DSTO on the other.

One of CEA's strongest supporters was Paul Greenfield, who joined the RAN in 1973. Another Queenslander, he had taken his engineering degree at UQ and after some years in engineering posts on surface ships he transferred to submarines. He then moved to ship management systems and found himself doing detailed work on the Collins class. He was first Chief Staff Officer to the Maritime Commander and in 1999 was appointed Commanding Officer of HMAS *Cerberus*, the Navy's premier training establishment on Victoria's Mornington Peninsula. Soon afterward he was posted to assist the McIntosh–Prescott review of the Collins program and followed that with the task of coordinating remedial action to bring the submarines to full operational condition. In 2000, he was appointed Director General Undersea Warfare systems,

which delivered two completed Collins subs, (*Dechaineaux* and *Sheean*) within 12 months. And in 2002 he was promoted to Commodore and became the Navy's Director General Maritime Development. His first priority was ASMD.

'By then,' Greenfield says, 'we were still investigating which options were available to develop for government [decision] for the project. It had come to a halt due to a lack of technical understanding and lack of confidence because of past failures to find a reasonable and practical option.'

He was no stranger to CEA and its leading personnel. He had joined the Navy with Ian Croser's younger brother, Peter. 'I had met their parents at their Adelaide Hills property in 1975,' he says. And as an engineer he was able to grasp the technical aspects of Croser's work. 'In 1999–2000 I had asked Ian to design and build me a couple of wide-band UHF antennas to fit on the Collins' masts,' he says. 'And of course he delivered.'[19]

Greenfield reviewed the earlier ASMD work. 'They'd investigated the "baby" Aegis [radar] and that was too heavy. They'd investigated something else and that didn't work. Their only option left was a second radar director and that would be on the very edge of the design margins of the ship. By then I'd realised what Ian had, and I thought there was so much potential that it really warranted very, very serious attention.'

He was not alone. Rob Elliott had met Croser when he was a Lieutenant WEEO on the Navy's Charles F Adams guided missile destroyer, HMAS *Brisbane.* Since then they had often touched bases. Elliott says, 'I had been working on different levels of technology with them.' This included the continuous wave illumination project, which by 2000 had been expanded to include the development of an integrated radar component, called CEAFAR.

CEA had also taken the initiative to promote its work at government level. Senator Robert Hill had come to the ministerial post believing that Australian industry should be encouraged to involve itself in the defence industries. 'I was keen to see those who were investing in Australia getting a fair chance,' he says. And as a South Australian he had met the Croser family, though not Ian himself. He had more to do with SAAB because they were based in Adelaide. However, he took the opportunity, he says, to 'invite myself' to CEA's Fyshwick factory. 'In fact, over a period I went there several times,' he says.[20]

Tony Flint says, 'We were having very good discussions with them, but at the same time they had a way to go. I started getting "ministerials" [from Senator Hill] saying, "Why aren't you supporting Australian industry?" CEA had very good relationships with the minister's office; and there's this great capability out in Fyshwick. But there was obviously an air gap between the appreciation of the minister and what was actually in existence.'

However, he says, he discussed the minister’s concerns with Vice Admiral Chris Ritchie as the Head of Capability Systems (HCS). ‘I suggested to him that we had some “study money” left over from the WIP program—about $5 million—which was there to be used but not allocated,’ he says. ‘And I got HCS to agree that we use it to start a developmental program called “CEAFAR to Sea”. So Ian came in and we agreed that we would work jointly together to get the radar offshore—the Navy would provide the ship—to prove the capability at sea rather than it just being something that’s out at Fyshwick.’

Flint says, ‘It took some time for CEA to get their act together.’ And CEA’s initial estimate of the cost was less than $5 million. ‘I thought, “This is a great solution because, one, we’re supporting Australian industry; two, the minister’s going to be happy; and three, it could be a great capability for the Navy”.’ He arranged for the Navy to designate HMAS *Arunta* for the task, but before then the CEA team operated out of Jervis Bay, first on land and then on a small support vessel. But there were choppy waters ahead. DSTO wasn’t convinced that CEAFAR at that stage was the best option.

Paul Greenfield says, ‘I remember the huge battle, the fight with DSTO right to the top. They love to be at the forefront of technology. When they’re not, they get very jealous. I sat in meetings between Ian and DSTO. I felt the DSTO guys who were sitting opposite were out to stop the whole thing.’

While Greenfield was Director General Maritime Development (DGMD), the big decisions would be taken further up the chain of command, where General David Hurley—later Chief of the Defence Force and still later Governor of New South Wales—occupied the key post of Chief of Capability Development Group.

And at ground level, the fight got personal. Greenfield says that when he supported some of CEA’s proposals, ‘There was even a complaint made at the lower levels of DSTO about me which went all the way to the Chief Scientist and across to General Hurley.’

Fortunately, nothing came of it, but Greenfield realised that, without the compliance of DSTO, CEA’s involvement was in danger of being permanently blocked. ‘They were so against what we were proposing I was never going to get anywhere,’ he says. The only solution, he felt, was to bring in contacts from outside the confines of the Defence bureaucracy. He decided to call in ‘the US cavalry’.

Soon after he had become DGMD, he formed an air warfare working group with a US Navy admiral and was invited to visit Lockheed Martin in Philadelphia. He used the occasion to promote Australian industry and asked how best to develop the connection with the US. 'Two guys got up,' he says. 'One was Orlando Carvalho, who now heads the Joint Strike Fighter project in Lockheed; the other was Ian Croser! I was astounded. Ian's telling me what could be done with his radar. He's *their* expert. That showed me how much respect Ian was held in by the US Navy.'

It was now time, he felt, to engage again with the Americans to give him the expert ammunition he needed. 'I said to my US admiral, "Can we get a study done?" and so they did,' he says, 'And when completed they said, "Yes, it should work". I went back to DSTO and said, "Okay, right. Can you see anything wrong with this [analysis]?" And they couldn't, so finally they went along with it.' However, while he might have won a battle, the war of words was far from over.

His next target was the newly appointed Chief of Navy, Vice Admiral Ritchie. Greenfield recounts:

> I took him to CEA to talk to Ian and have a tour of the factory. On the way back, I said to him, 'You know, we don't have enough budget to do all our ships with this arrangement. However, we probably have the budget to do a couple, maybe three, because there's got to be changes to the ship's superstructure and so on. So maybe the rest of the ships will have to have a simple second director or maybe nothing.' And he said, 'No, I don't want that. They've all got to be the same,' I thought, 'Okay, I love it.' I said, 'You realise we'll need a real cost increase to the project for that?' and he said, 'Yep. Let's do it.'

It was a big hurdle jumped. But there were more to come, and they just kept getting higher.

4. '… if Ian went under a bus we were in trouble'

Before the sea trials of the CEAFAR radar, there was extensive testing at the Fyshwick headquarters, and according to Tony Flint the results were 'positive'. Indeed, they had already sold three of their active phased radar units to the US for land-based facilities. But the water-based operations presented new challenges. And CEA was developing other markets.

Vice Admiral Ritchie says, 'We used to go out there and they were doing other things. They were selling shipping control systems. They had all sorts of things going on. It takes you the next five or six years to get through that period. After a couple of years, people toss it around, [wondering] "Is it worthwhile proceeding with this?" Clearly they had something [in CEAFAR] but it was taking a hell of a long time to get to fruition.'

Part of the reason was undoubtedly the resistance that continued to come from DSTO and other elements of the Defence Department. According to Vice Admiral Griggs. 'It's fair to say there was a very vigorous debate about the risks involved in pursuing CEA.' And much of it came from 'internal sources'.

'It was not so much in the Navy,' he says. 'I think DSTO felt the technical risk was too high. We all knew that if Ian went under a bus we were in trouble. We passed that, but there was a period when if Ian did go under that bus we would probably have failed. There was a degree of concern about that.'[21]

Another senior officer says, 'There's no doubt that the "not designed or thought of here" attitude may have been prevalent at DSTO at the time. This led some personalities in the scientific community in Defence making it clear that this was an extreme risk and [they] did not support it. However, you must remember that at the time the integration of DSTO with industry wasn't like it is today—very much more integrated. But it's always up to the Chief of Navy to make the recommendation to proceed.'

Ian Croser has some sympathy with the Navy's concerns. 'The program, in the early days, was high risk,' he says. 'The technology was very new and Defence had some difficulty in coming to grips with the solution.' David Gaul is less forgiving. 'They are still saying that sort of thing today,' he says. 'It's unbelievable.'

While there were serious delays in the ASMD project, the department's procurement problems were by no means confined to the Anzacs. The combination of the war in Iraq, the demands of the White Paper and the earlier difficulties in the upper political echelons meant that a range of projects were experiencing delays and cost overruns. Minster Hill had commissioned a review of the procurement system in December 2002, and he released the Kinnaird Report in August 2003.

The review had been conducted by a major South Australian engineering figure, Malcolm Kinnaird, and two well-respected fellow commissioners: Len Early, a former deputy head of the Defence Signals Directorate, and Dr Bill Schofield, a distinguished scientist in his own right and director of the Aeronautical and Marine Research Laboratories at DSTO. It was scathing in its appraisal of the department's procurement systems and outcomes. And its criticism might well have been aimed directly at the ASMD project:

> The mission of the Defence Materiel Organisation is to procure and support the equipment … that comprises the protection of the nation's interests and the safety of its frontline personnel, but the outcomes have not always been as positive as the Australian people, or government, have a right to expect. Major capital equipment has been delivered to the Services many years after its planned introduction. Budgets have been balanced by reducing capability …
>
> The DMO needs to become more business-like and outcome driven. But reform must extend beyond the DMO. It is clear that change is needed at each cycle of acquisition and whole-of-life management of the equipment that comprises the core of defence capability …
>
> It would be unfair to suggest that Defence has ignored these issues. On the contrary, problems have been recognised, their causes identified and important reforms have been implemented. However, the evidence gathered by this review leaves little doubt that there needs to be more change, that it needs to be more rapid and more fundamental in reshaping systems, structures and organisational culture. To do otherwise will add more risk to what is already a difficult and high risk international environment for the nation, and to the safety of the men and women of the Australian Defence Force who are tasked with its protection.

The report made ten far-reaching recommendations (see box).

Recommendations of the Kinnaird Report, August 2003

1. Defence should present to government the following information in a succinct form on an annual basis: an assessment of the types of contingencies Australia might face in carrying out the strategic tasks endorsed by government in Defence White Papers; advice on the military force required in each contingency and the capacity of the ADF to apply this force now and in the future; and advice on capability to be sustained, acquired or retired to ensure this can be achieved at acceptable cost.
2. A three star officer, military or civilian, should be responsible and accountable for managing capability definition and assessment. This appointment should be on a full-time basis, with a defined tenure (minimum five years) to ensure a coherent, cohesive, holistic and disciplined approach.
3. Government should mandate, and enforce via revised Cabinet rules, a rigorous two-pass system for new acquisitions with government considerations dependent on comprehensive analyses of technology, cost (prime and whole-of-life) and schedule risks subjected to external verification.
4. Following second pass approval, the capability managers should have the authority and responsibility to report, and be accountable for reporting, on the development of defence capability. To undertake this role they should have access to all information necessary to enable them to fully inform government on all aspects of capability.
5. An Advisory Board should be appointed with immediate effect, to provide advice and support to the head of the DMO and report to the National Security Committee of Cabinet on the implementation of all Defence Procurement Review recommendations.
6. The DMO should become an executive agency.

7. Project managers should be selected on merit by the head of the DMO particularly for their project management skills. Managers could be drawn from the military, industry or the public service and they should be accountable to the head of the DMO and have minimum tenures, usually of five years. Remuneration levels should be set at the relevant level to attract and retain project management specialists.
8. The head of the DMO should be consulted on military postings to the DMO and should have the authority to accept only those ADF personnel who possess the requisite skills and experience.
9. Capability managers should have the option to locate their representatives in the DMO to monitor the acquisition and logistics management of approved capabilities.
10. The role of the project governance boards should be extended to include through-life-support of ADF equipment and report to the head of the DMO on potential difficulties.

The department's response was similar to its responses to earlier reports on its activities and shortcomings. Whether the Kinnaird Report had a salutary effect on the progress of ASMD is debatable. However, in November 2003, the project received its first-pass approval from the cabinet; and, in the report's wake, a new CEO of DMO entered the scene in 2004—Dr Stephen Gumley.

5. ‘Some of the boffins in DSTO had become implacably opposed’

A native Tasmanian, Stephen Gumley was well qualified for the highly demanding role of leading DMO. He had taken an engineering degree at the University of Tasmania, won a Rhodes Scholarship to Oxford, where he earned a PhD in engineering, and followed it with an MBA. His first CEO job was with a Hobart technology company. He worked for a time in California’s Silicon Valley and was subsequently a vice-president of Boeing’s Commercial Airplane Group in Seattle. Prior to his DMO appointment, he had headed the Australian Submarine Corporation in Adelaide. He would remain with DMO through most of ASMD’s most active period until 2011. And in the telling of the ASMD story, he said, he expected to receive ‘a few bruises’.[22]

Gumley oversaw some 200 separate procurement projects at a time for the department. ‘Some were in the planning stage, some in the research stage, some build, commissioning, some in the rollout,’ he says, ‘but across the entire life cycle there’d be a couple of hundred at any one time.’

‘I would get a fortnightly report from all of the managers in DMO and it would typically run 240 to 250 pages. Every project and every sustainment fleet wrote a paragraph. Put it all together and you ended up with probably a thousand different pieces of information. I used to take that home every second week and spend the weekend poring through it.’

The job of the CEO, he says, was to stay on top of the projects and work out how to resource them to ensure that as many as possible were successful. ‘But that doesn’t mean I devoted only one two-hundredth of my time to ASMD,’ he says. ‘It was taking a lot more—unquestionably one of the top ten.’

The first pass approval in the previous year meant that a number of capability enhancements were now officially in train. The ships would be equipped with the Evolved Sea Sparrow Missile (ESSM). Indeed, the development of the ESSM had been a genuine achievement over the previous five years. The original NATO Sea Sparrow had been an expedient design intended to provide quickly deployed short-range defensive fire. The ESSM emerged as a completely new weapon with a bigger, more powerful rocket motor and upgraded aerodynamics, and four ESSMs could fit in a single Vertical Launch System cell. Most importantly, the latest missile guidance technology made it compatible with phased array radar.

As well, the Anzac-class ships were to be fitted with the Harpoon Block II anti-ship missile. The main gun was a United Defense 127 mm Mk 45 Mod 2 able to fire at a rate of 20 rounds per minute to a range of over 20 kilometres. Two triple 324 mm Mk 32 torpedo tubes for Mk 46 anti-submarine torpedoes were fitted. The Mk 46 was being replaced with the Eurotorp MU90 Advanced Lightweight Torpedo.

The introduction of Super Seasprite helicopters towards the end of 2004 would extend the ships' surveillance and anti-surface warfare capability. Other enhancements included the Centaur electronic support measures system and improved access to both satellite and modern high-frequency communications.

According to the editor and writers of the authoritative *Australian Defence Magazine*, in ASPI's 2004–05 *Defence budget brief*, 'The estimated eight-ship Australian project life to date expenditure to 30 June 2004 is $487.8 million. The involvement of industry in Australia and New Zealand has been critically important to the success of this defence project. A core industrial capability for product through life support has been established and the target of some 70 per cent local content has been achieved.'

However, the 'capability upgrades', they said, were subsequently 'assessed by DSTO in more stressing environments' using its modelling and simulation techniques. Based on those studies, the Anzac Alliance would decide whether they could be 'procured, integrated and introduced to service and supported within the program's budget'. The ships' combat management system 'will also be upgraded to match the functionality of the new equipment and increase its data processing capability.'

CEA's phased array radar would face a 'study and related trials to consider the feasibility of including [it] as part of an ASMD solution in the Anzac class. The outcome of these trials will determine whether the proposed second channel of fire—to enable multiple launch of ESSM missiles and illumination of their incoming targets—is based on installing a second conventional fire control director or a phased array radar. The acquisition of a second channel of fire will be made under a subsequent phase of the ASMD upgrade program.'

Finally, the *Australian Defence Magazine* writers noted that the ASMD project had been deferred pending the findings of the 2003 Defence Capability Review, and that its revised $520 million budget was not approved until the end of 2003, when the government announced funding approval for the project:

> Despite this delay, Anzac Alliance members are confident that the scheduled in-service date of 2007 will be met and might even be exceeded.
>
> If as a result of current trials phased array technology is adopted as part of the ASMD solution it is likely that locally developed and manufactured phased array radars and illuminators will be used, providing an additional boost to the level of [Australian industry involvement] in this project. The current sea trials of a representative subset of the CEAFAR phased array are expected to conclude in June.[23]

Finally, in 2004, they mounted the phased array radar faces on the *Arunta* and set out into the Tasman Sea. And to everyone's delight, it worked! It was a 'Eureka! moment' for those most closely involved, not least the naval radar operators on board who were suddenly confronted by a clarity of view never before experienced. However, this was only the initial version of CEAFAR, and the faces were of a different technical basis from those developed later. And not everyone was quite so enthusiastic. On the contrary, some of the boffins in DSTO had become implacably opposed.

What was then DSTO has since been renamed the Defence Science and Technology Group. The unit embraces most of Australia's finest defence scientists and is unquestionably a major asset to the country's defence and security. And by all reports it's now much more open to innovation from private Australian companies than in past decades. But its current website gives a good indicator of the pride it takes in its unique role as the source of scientific innovation for Australia's defence forces: 'THE BRAINS TRUST OF DEFENCE,' it declares. 'We provide the Technology Edge for Safekeeping Australia; PROTECTING AUSTRALIA WITH SCIENCE—We keep Australia safe, the smart way; ADDING VALUE THROUGH INNOVATION—Smart solutions for Defence and National Security.'[24]

David Gaul says, 'They damned (us) with faint praise. They'd say, "They're a very good *boutique* developer but they haven't produced anything in quantity." You'd beat that hurdle down and they'd say, "But they haven't done it for an overseas order" or "They haven't done it to international standards; they haven't competed in an open market", anything to belittle our achievements.'

In fact, while the CEAFAR radar was progressing well, the company had been forced to diversify its operations to maintain its cash flow and expand its customer base. It had not only won a very big contract for the communication systems of RAN patrol boats, but was ramping up its American market. 'The patrol boat contract was huge,' David Gaul says, 'and it really kept us going through that crucial phase while CEAFAR was being developed.'

'We also had American developments,' he says. They included basic 'off the books' research that would lead to future projects, a series of radar installations for the protection of facilities and working with the Marine Corps on a system of above- and below-water sensors. 'We developed $60 million worth of exports in one of those programs alone,' he says.

Vice Admiral Ritchie recalled the attitude of CEA's detractors at the time. 'The impediment for them was the fact that they were "these two blokes who've left the Navy and started a company,"' he says. 'Can we really believe they could [do] something as big and as good as this?" Their problem was convincing DSTO, BAE and everybody else that "Yes, they can."'

Not all CEA's R&D projects bore fruit immediately. Vice Admiral Ritchie says, 'They had CEAFAR, the short-range missile defence one; they had CEAMOUNT, which was the illuminator.' Both of these would repay CEA's intense research effort. 'But they were developing this other thing which was called AUSPAR, which was a higher-powered version of CEAFAR. Defence supported that one as well, but I don't see it around anywhere now, certainly not on the Anzacs.'

In fact, Ian Croser says, AUSPAR (Australia US Phased Array Radar) was a technology development program with the US Navy. 'It has been fundamental to development and testing of many new technologies such as the Gallium Nitride used by the CEAFAR2 high power systems now in production,' he says. The contract was signed in August 2005. 'It used the Anzac CEAFAR1 digital array technology and software and was supplemented by a high power element level transmit technology. It only completed formally last year.'[25]

Meantime, another complication arose for CEA from a decision to seek an overseas investor. It was a move urged upon them by Stephen Gumley. 'The company needed more capital for development,' he says, 'because Ian Croser and his shareholders, I suspect, only had a certain amount. Ian came to see me several times to discuss the concepts behind some of this.'

According to Gumley, the preferred CEA investor was the giant American defence contractor Northrup Grumman. In 2006, David Gaul told a Senate Estimates Committee hearing, 'It was a very deliberate process that we went through to get Northrup Grumman on board. We first of all got two big brothers—the US Government and the Australian Government—and we got IP agreements.' This was a vindication of CEA's early decision to put a formidable barrier around its intellectual property. 'So they were standing next to us,' Gaul says. 'Then we went out and selected our gorilla, basically, and we went through a very rigorous process to do so. SAAB was also considered but obviously the American market is much more in our foci than is the European market. SAAB are very comfortable with the outcome.'[26]

In 2017, he was less enthusiastic about the move. ‘Northrup Grumman came in and it gave credibility to the company,’ he says. ‘But in reality they handled us poorly and hardly any of the projects they were aiming to put our equipment into got up. And often they weren’t even bid by Northrup because they couldn’t digest us and use our systems in their bidding because of the internal squabbles they have between groups.’ Their marketing was minimal. ‘And really,’ he said, ‘they just bought shares from our shareholders. They didn’t contribute any capital to the company itself.’

However, in 2005 the ASMD project seemed at least to be gathering momentum. In September, the government had approved the second pass, which made provision for all eight ships to be upgraded as soon as practicable. Three months later, CEA signed a contract with DMO to deliver system architecture and risk studies, pre-production items (an engineering development model, test jigs, production tooling); long lead items (printed circuit boards, power supply units); high-end engineering effort (system performance specification); and a qualification and validation system—basically a land-based test site capability for phased array radar (PAR)—plus one shipset PAR.

Croser describes the task:

> The challenge we had was manifold. It was to create a whole new technology capability, both for the radar system but also for the missile control. And we had to create it in a form that could fit within an Anzac and achieve its performance within the limitations of power, weight and ship movement. So the challenges were pretty big.
>
> The trades that we had to come to achieve the range and performance were, we needed to get height for the sensors to gain sufficient time to be able to engage some of the newer target threats. And of course the higher you go the more impact it has on the ship.
>
> It became a space, weight and power trade that interacted with the mast height. And surprisingly, we all agreed fairly early in the program what that height would be.

However, BAE had some serious reservations concerning the positioning of the mast—preferring it to be on the forward part of the ship—and other related ‘trades’. Its attitude, according to a senior Navy officer, was, ‘We built the ship; so we say where the mast should go.’ Ian Croser says, ‘That would have been a very unsatisfactory outcome.’

However, according to BAE's official spokesperson:

> There were three key issues in the first phase of the mast integration trade off analysis—first, the [Australian Government] decision to retain the extant SPS49 long-range air search radar; second, the required height above the waterline for the phased array; and third, the available ship stability margin.
>
> It is correct that CEA were the first to suggest the option of putting the SPS49 radar on top of the phased array on a new aft mast, but this was never a bone of contention with BAE (or Tenix at the time) … All stakeholders had an opportunity to input into this process … the issue which did arise after this decision was that early cost estimates for the project had been based on changing only the forward mast of the ship to accommodate the phased array radar, whereas the option selected by the working group required changes to both masts, and in particular an entirely new aluminium aft mast to house both the phased array and SPS49, which in turn drove up the total project implementation costs.[27]

Anzac Alliance program manager Sheryl Lutz says that several designs were considered. 'You've got to look at the different options,' she says. 'CEAFAR had to be mounted at a certain height; we obviously had concerns about the funnels—whether they would be an issue when the mast was mounted—but we went through several options, the pro and cons of that.'

Ian Croser's principal concern was to achieve maximum operating efficiency for the radar-cum-missile-control system he and his team had created. 'The ship installation issues became quite significant,' he says. 'The radar for the Anzac had to be multi-functional. So while the missile control is one part of its scope, it's going to spend much more of its time, hopefully, doing general surveillance and defence support of other activities—navigation radar capability, for example—but the main functionality is situational awareness and also things like helicopter control, and controlling maritime surveillance aircraft etc.—a whole range of different activities.'

At the same time, the alliance was under contract to deliver systems engineering, preliminary and detailed design and specialist project management for all eight ships. But despite this success and the urgency of the project, DMO's grudging attitude remained a serious impediment. And BAE dug its heels in. It wanted its concerns dealt with.

6. One plus seven: concerns arise

By now the international strategic situation was very different from the triumphalist days of the apparent American 'victory' over the Taliban in Afghanistan, to say nothing of President Bush's premature declaration of 'Mission accomplished' in Iraq. By 2006, the pressures on our armed forces were unrelenting, as were the demands on the Defence Department's procurement system. There was movement on the domestic political front when Defence Minister Hill resigned from the ministry in January. He was replaced by Dr Brendan Nelson, a former President of the Australian Medical Association and a 'coming man' in the Liberal Party. The ministerial transition was relatively smooth but, as with all new ministers, Nelson would take time to get across his portfolio.

Now Director of the Australian War Memorial, Nelson says, 'The ASMD did not require ministerial involvement. Things get to the minister if they require a decision at that level, or if Defence has cocked it up and they want to make sure the minister is responsible for it.' But when he had been Parliamentary Secretary to the Minister for Defence in 2001 he toured the CEA building in Fyshwick. 'They had developed this technology and they couldn't get Defence interested in it, even though the Americans were. I was certainly aware of that,' he says, 'and there was constant resistance in Defence. At that time it was a problem. It's much better now but it was a real battle to get Defence—such a large organisation—to have the capacity to take innovative technology that's being developed domestically, and take the risk; in fact, we're too risk averse as a country generally.'

Aside from the mast problem, the ASMD project was making progress, at least on paper. According to Vice Admiral Ritchie, CEAFAR 'bubbled away in the background. The trials were happening and Evolved Sea Sparrow came along,' he says. 'So the ships had a bit more defence capability. It was tied up with fitting Harpoon [surface-to-surface missile systems] to the ships; it was all part of the same package.'

Indeed, the combined efforts of CEA and the alliance passed a system functional review in August 2006 and a preliminary design review in August 2007. Their next hurdle was a critical design review scheduled for 2008. But when CEA returned to the bargaining table, at least for the moment, the project stalled. Paul Greenfield was a sympathetic observer. 'Ian was taking all the strain on his shoulders,' he says. 'He was trying to keep a company of 250 people going, knowing that if it folded not only would his company go but also its really important contribution to the defence of Australia.'

Stephen Gumley says, 'There were a couple of absolutely crucial meetings in my office where we brought together the Navy and others. As project deliverer, the centre of the action was the DMO rather than the Navy. The commercial decisions and the programmatics and what we'd actually do was centred at DMO.'

In June 2007, there was what Gumley terms a 'deep dive' into the project:

> It's like a non-advocate review where you get a lot of experts in the room and you spend hours going deeply into the project and find out what's truly happening; and you expose the assumptions being made or the assumptions still valid or the assumptions that need to be changed. And that deep dive was the first time I can remember the concept of doing one ship and then doing the other seven ships later came up as a way of mitigating risk. We were getting some uncertain project outcomes, and to lower the risk it made a lot of sense to get a prototype correct before embarking on the full production run.

Paul Greenfield remembers the outcome in rather more dramatic terms:

> At a committee meeting in Defence they had the usual three solutions.
>
> There was the cheapest, then a really expensive one, and then the one they wanted in the middle—and Dr Gumley just saw risk all the way through and he said, 'You're not having any of that' and he virtually swept the table clean and said, 'This is what I want.'

What he wanted was a completely new *modus operandi*. Instead of upgrading the new systems on all the Anzac ships, he decided they would concentrate on getting one completed and tested to prove its capability. Only then would the program proceed to refit the other ships in the class. It became known as the 'one plus seven' solution, and the companies involved had little choice but to agree.

Gumley says:

> It would be wrong to think there wasn't some tension and conflict during the program—there was frustration from both the department and the company at each other's position on certain things. I think the company would have liked to rush into production for all the ships but we were wanting the trial. So I think there would be quite a few areas, but there was never any ill will. You can have differences about different ways of doing things but there was no ill will or personality conflict. There was argument and, looking back on it, productive argument about the best ways to proceed.

But while the companies could see some virtue in the idea, it had an obvious financial downside for all three. Indeed, within the DMO, Warren King, at the time the General Manager Projects, says, 'I had to moderate it a bit.' One problem was the sudden reversal of economies of scale. This struck home to CEA, in particular. As mentioned above, the phased array radar uses a large number of identical modules, and the unit price fell according to the numbers manufactured. Ian Croser says, 'When it got split into one plus seven it became a sequential program and the economies of scale were very hard to achieve.' Warren King says, 'CEA was a very small company with a very small funding stream. We got approval to authorise certain expenditures within a limit—placing orders for spares with a long lead time, for example.'

SAAB and BAE had different concerns. They had engaged a workforce designed to upgrade all eight ships at Williamstown and the Henderson yards in Western Australia as well as SAAB's Adelaide facility. According to BAE's Darren Kirkby, the company was able to handle the disruption, but the new program 'drove a significant gap in production workload between the first of class [HMAS *Perth*] and the next seven ships,' he says. 'This resulted in the majority of the labour workforce at the Henderson shipyard being laid off at the back end of 2010 and then having to be built up again from January 2012 when the follow-on contract was signed for the remaining seven ships.'

Anzac Alliance project manager Sheryl Lutz says, 'Obviously, it was not the ideal situation because it gives you issues in your procurement. However, we did get the agreement [to continue] and we accepted the decision; and if we delivered on the first one we'd get the remaining seven. So it was a matter of delivering the capability requirements for the first of the class.'

The project then entered what the engineers termed 'a major derisking phase' in which CEA in particular was required to test every advance before taking the next developmental step. And it was even required to submit a business case before undertaking the next step. Ian Croser says:

> This inevitably changed the whole program schedule but also created a series of 'confidence demonstrations' to provide routine visibility of tangible progress, not just paper outcomes.
>
> A major source of struggle in the early days of the program was to overcome the prejudice and risk aversion built up over previous decades of less than successful development programs. Logical engineering processes and techniques had been supplanted by almost irrational risk aversion and a desire for process-driven paper products, adding little except extra work to the delivery of real capability.

Stephen Gumley defends the process. 'You can't dole out taxpayers' funds without proper process,' he says. 'We all have to be accountable and CEA was treated exactly the same as everyone else. We used the "Ausdefcon" template which made it as simple as possible for the companies to fill out. Of the 280 paragraphs in the [form] only 20 would be different each time it was submitted.'

But this was the worst possible atmosphere in which to confront such a complex endeavour. Croser says this attitude produced an uncertain and low-confidence atmosphere. 'It quickly descended into a paralysis phase where the uncertainties and lack of confidence in the team's ability to achieve such a complex outcome threatened to derail it totally,' he says.

Not surprisingly, perhaps, in May 2008, the critical design review revealed 'a number of challenges, including the mast problem'. Indeed, it was clear to Stephen Gumley that delays were causing cost overruns from the original budget that were running out of control. Gumley was preparing to take a drastic step.

Earlier that year, DMO had introduced a new element into its procurement system to deal with projects that were suffering from the kind of problems that had bedevilled the ASMD. It was designed 'to intensively manage projects experiencing significant technical, schedule and commercial difficulties'.[28]

Many of these, the DMO said, were 'legacy projects' put in place before the Kinnaird reforms. According to the department:

> [S]trategies for recovery of these projects are managed at the highest levels in the DMO in consultation with Defence stakeholders, industry and the Minister for Defence Personnel, Materiel and Science. Recovery is monitored and regularly reported at these levels.
>
> DMO has also put in place a Gate Review process whereby a group of DMO and Defence experts, including independent external advisers, examine highly complex projects at critical stages of their lifecycle. The DMO has also established a Defence Systems Integration Technical Advisory (DSI-TA) unit headed by a senior DSTO scientist aimed at addressing complex integration issues.

Such projects fell under the 'Projects of Concern' designation and they could be cancelled outright, or continued with different participants. The third option was 'remediation', which allowed the companies involved to make adjustments and take the project forward to an acceptable conclusion.

By then, the political situation had itself undergone a sea change. In the 2007 election, the Howard government had been overwhelmed by a resurgent Labor Party led by 50-year-old former diplomat and Chinese linguist Kevin Rudd. Indeed, Howard had become only the second sitting prime minister to lose his seat in an election. Rudd and his deputy, Julia Gillard, had promised a generational change, and the Liberal Party countered with the election of Brendan Nelson, also 50, as Leader of the Opposition.

The new Defence Minister, Joel Fitzgibbon, was a former automotive electrician turned small businessman. He had been shadow defence minister in the Rudd opposition but would resign from the cabinet after a series of controversies within 18 months and be replaced by Senator John Faulkner. However, the Minister for Defence Personnel, Industry and Science was Greg Combet, a former Secretary of the ACTU. He was regarded not only as a hardworking minister but as a 'safe pair of hands' in the portfolio. It was he who had the prime responsibility to deal with the recommendation from the Chief of the Defence Force, Air Chief Marshal Angus Houston, and the department secretary, Ian Watt. And after due consideration Combet made the fateful declaration: ASMD was now officially a project of concern.

It was a blow to all the participants. After 12 long years of stops and starts, of scientific and technological breakthroughs, of fierce argument, round-the-clock endeavour, progress and regress—to say nothing of the funding struggles—at last it had come to this.

Failure stared them in the face.

Digital Dual Faced Demonstrator fitted to HMAS *Perth*, November 2008. Photo courtesy CEA Technologies.

The first ASMD mast structures under construction at BAE Henderson, September 2009. Photo courtesy CEA Technologies.

Evolved Sea Sparrow Missile launch from HMAS *Perth* at Jervis Bay after ASMD upgrade, May 2011. Photo courtesy Department of Defence.

Newly upgraded operations room on the HMAS *Perth*, May 2011. Photo courtesy Department of Defence.

Celebration after successful ESSM firing. Capt. Mal Wise and Mr Ian Croser pictured, May 2011. Photo courtesy Department of Defence.

ESSM firing from HMAS *Perth* at test range off Hawaii, August 2013. Photo courtesy Department of Defence.

Capt. Lee Goddard on HMAS *Perth*, leaving Sydney for deployment to the Middle East, March 2014. Photo courtesy Department of Defence.

HMAS *Warramunga* at Henderson shipyard awaiting undocking after ASMD upgrade, August 2015. Photo courtesy Department of Defence.

7. A new determination sets in

The shock reverberated through BAE, SAAB and CEA. But in its wake, Ian Croser discovered a lifeline. 'Fortunately, someone, perhaps Warren King, had the courage and insight to put in place a confident and competent naval engineer, Captain [now Commodore] Rob Elliott as the Project Director,' he says. 'Rob's confidence gave others confidence as we headed down the path with a new attitude of not letting the naysayers win or get in the way of progress. Rob was ably assisted by a handpicked team including Sheryl Lutz and Rob Jackson from the Anzac Alliance and John Runge [from the Australian Government].'

Rob Elliott had joined the Navy in 1988 after completing his engineering degree at Adelaide University. 'I was lucky that when I joined the Navy,' he says, 'there was a lack of engineers, so I was able to stay at sea for 14 years.'[29] He began his work upgrading naval units with the modernisation of the old Charles F Adams-class DDGs. 'I started in that program and then I got posted to the ships continuously for eight years,' he says. 'As a 28-year-old Lieutenant Commander I had a department of 104 and that was pretty cool.'

Following his posting to HMAS *Brisbane*, he was promoted to Commander in 1999 and transferred to HMAS *Anzac*, the lead ship in the Anzac frigates. 'And that was the start of my love affair with that class,' he says.

He met Ian Croser again in 1997 when Elliott was WEEO and head of the engineering department on HMAS *Brisbane* and CEA was gaining increasingly important contracts from the Navy. 'At that time we [the Navy] were primarily working with them on continuous wave illumination for the Anzacs,' he says. But 11 years later—on the day after Elliott came on board as the new Project Director—the ASMD had been declared a project of concern.

'I went up to see Stephen Gumley and the first word he said to me was, "What did you do [wrong] to get put on this project?!" Actually, I'd previously been Project Manager for the Collins-class combat system replacement so I was quite familiar with projects of concern. They're a good thing to be in because things can only get better!'[30]

However, it was the first time he had worked so closely with industry, and he found BAE, SAAB and CEA in entrenched positions on the argument over the radar mast. 'It took a while for them to realise that if we don't do this together we're going to fail to deliver this great radar capability to our navy,' he says. 'We're doing this for the benefit of the Navy and providing the technology to our war-fighters to defeat the ever-increasing threat faced by our warships.'

Project Manager for the Anzac Alliance, Sheryl Lutz, was another South Australian who had secured a Bachelor of Applied Science at Adelaide University, majoring in mathematics and information systems. She had joined SAAB as Business Improvement Manager in 2003 and after managing the ASMD project for the Alliance she would be promoted to General Manager before returning to SAAB as General Manager Maritime, responsible for all maritime defence operations. She says the teamwork 'operated extremely well' under Elliott's direction. [31]

Rob Jackson was a Commonwealth public servant who had been working on ASMD at Rockingham since 2005, initially as a systems engineer, before becoming the Alliance's point of contact after CEA's phased array entered the equation in 2006. The BAE representative was Darren Kirkby, who had graduated from ADFA with first-class honours in electrical engineering in 1989. After postings in the Oberon-class submarine fleet he transferred to the Anzac ships in 1998. He left the Navy two years later and in 2004 joined Tenix (BAE) as the Anzac Engineering Manager before moving to the ASMD project as the Alliance Engineering Manager.

John Runge worked under Elliott as project manager. A former Navy Chief Petty Officer, he had risen through a series of onshore managerial roles, notably in the revival of the Collins-class submarine project.

Elliott quickly identified the nub of problem. 'It wasn't about the radar technology; it was a system integration problem of where we were placing the radar on the ship. Mutual interference from other radar systems meant the design had to change.' And when the contractors remained obdurate, there was an industrial-sized magician's wand at his command. 'It took a very short period of time when we said, "We're going to cancel your contracts." You motivate a lot of people when you say, "We're going to cancel unless you do this."'

Once he had their attention, Elliott at Stephen Gumley's suggestion organised a series of workshops in Canberra's conference venues to break down barriers between the parties. 'We went through a lot of therapy,' Elliott says. 'How do we work together? How do we sort this out? Because up to that time it had been divisive between industries. I was fascinated because these companies—BAE, SAAB and CEA—knew that if they got this right there'd be a future for them in the Navy in providing this capability, not only in this ship but in other classes.'

The workshop concept, Elliott says, was to become standard for people working in the field. 'Steve Gumley is a great man,' he says. 'He always had time to talk to you; he was just passionate about getting the outcome for the customer.'

Gumley says, 'It doesn't matter what industry you're in, when about halfway through projects they reset their time and their budget. It's remarkable how common the success or failure of projects are between industries. People have a go at Defence as having its own special problems but you find the same in other industries—infrastructure, agriculture, manufacturing, software—they're very similar.' However, he was determined that ASMD would be in the 'success' column.

He and Elliott reorganised the companies into 'working groups' focused on different elements of the project. The companies responded well. 'It was basically reputation management for them so they came to the party eventually,' he says.

Merv Davis says, 'On the mast, I don't recall from the SAAB perspective that there was a big debate. I would assume Peter Evans supported the preferred engineering solution. I can't recall a debate between ourselves and CEA. I am aware of there being cost overruns and delays around the mast and I gather it was about the positioning of the mast. The notion was all about ensuring the critical criteria of height and uninterrupted field of view.'

Ian Croser says, 'The mast and the cupola structure is really just a shell. The faces sit on the outside of that and the whole of the centre of the mast structure is a big hole. It's not a heavy structure, which was the other part of the problem—we needed to get it up high. When the design group sat down and looked at the [mast] problem, it became clear that the aft solution would be the only one that would achieve the operational capability. BAE came up with a design that achieved the outcome … and in fact achieved a really good position in terms of weight and ship movement with some other modifications that were done in parallel.'

This was a real breakthrough. And there were more to come. Croser says, 'The SAAB team upgrading the 9LV combat management system to integrate with the capabilities of the PAR system of phased array radar and missile control had struggled at first to understand the differences between phased array technology and the traditional radar and fire control sensors. However, they quickly adapted and provided an excellent outcome, with functionality shared across a new form of interface—a task managed interface where the sensor system is given complex tasks to conduct rather than simple single function commands.'

Rob Elliott saw the changed attitude among the senior managers:

> The close, trusting relationship enabled a much greater flexibility. This meant solutions to contentious issues were secured. They knew that only when the upgraded system had been successfully fielded at sea would the project be allowed to return to the government for the green light to install the ASMD into the rest of the Anzac ships.

> They reduced costs. They went back to the bare bones just to get this on this ship, to prove that Australian industry can do this high tech—no-one else in the world has got it—and to demonstrate that we might have got it wrong initially but we recovered pretty quickly.

And recover they did. Rear Admiral Boyd Chapman Robinson, the Head of Maritime Systems at the time, gave a decidedly upbeat report to a Senate Estimates Committee. 'ASMD is an exciting project,' he said. 'It is going to deliver an unprecedented capability—that is, one that isn't anywhere else in the world—into a frigate size ship. It is going to use an Australian designed and built phased array radar, a CEA system from here in Canberra. Essentially, it is going to allow the ship to employ multiple channels of fire for its air defence weapons.'

Rear Admiral Robinson told the hearing that this was a 'fourth generation' system. He said the real issue was taking the development through all its steps, with DSTO support, and then fitting it to the ship. 'That is going to involve constructing a new mast cupola fairly high in the ship to get the right level above the waterline for this radar,' he said. 'Various gates we have put in place for design reviews have passed.'

'The next test will be here in Canberra,' he said. It would ensure that the radar could pass a target from one of its six faces to the next. 'We will then take that to sea and test it in that environment. Both of these are strong confidence demonstrations.' The ship chosen for the sea test was the *Perth*, since it was the latest Anzac to be commissioned. 'Subject to successful completion in that ship we will go back to government and say, "We have proven it at sea. We'd now like to go ahead with the other seven."'

West Australian Senator David Johnston interposed, 'But it is a high-risk developmental project?'

Rear Admiral Robinson replied, 'It is high risk because we have not done it, but it is a risk that we are managing and that we are aware of. But it is a great success story for Australia.'

Senator Johnston: 'Good. I am rather more worried about the ones that are not going quite so well.' Senator Johnston would become Defence Minister himself in 2013 and would embarrass the Abbott government when he declared that he 'wouldn't trust ASC [the government shipbuilder] to build a canoe'. He was replaced shortly afterward and left the parliament in 2016.

Elliott's project manager, John Runge, would remain throughout the life of the ASMD project and later become the Defence Department's in-house liaison with CEA in developing its exports while protecting the sovereign assets of their research. 'We'd never actually developed something from scratch on such a large scale as this,' he says, 'so the approach was, to me, a bit risk averse. We were a bit like mercenaries dealing with CEA saying, "You need to do this before we give you more money." It wasn't until we finished the risk reduction that I [could] write a business case that went to Dr Gumley. He would say, "Okay, you've met the milestone; here's some more money." And that allowed us to do the first ship.'

Gumley says:

> I suspect things were getting tight there for a while but they muscled through all right. The project was releasing funds to them but against certain milestones. The money was flowing. It wasn't as though you only get paid when everything works perfectly and the whole system is finished. There were little progress payments being made, like when you build a house.
>
> These [milestones] were particularly important since the project team had to go back to the government for additional funds to meet a real cost increase. That is always a hard thing to do, and if you're going to do it you'd better be sure you've got the answer that's going to work. You can't go to a government and then six months later say, 'Oh that didn't work; we'll do it again'; you really only get one proper shot if you have to reset a project.

In fact, it took until July 2009 for the government to formally approve the 'one plus seven' strategy. Some critical laboratory testing of CEAFAR was also done that month. Gumley says, 'It was a full test of the system and it all worked. We were working at that time to have the mast structure for the first ship finished by the end of 2010,' he says. 'Despite the difficulties of 2006–2007, it was all starting to come together by mid-2009.'

While the *Perth* completed its commissioning in 2006, it would return to the massive Australian Marine Complex in Henderson in Western Australia in 2008 for a major refit in preparation for a gruelling series of tests. By now the Anzac Alliance had moved its senior coordinators to Henderson, 23 kilometres south of the city after which the ship was named. It's the centre of a huge industrial development servicing the marine, defence and resource industries and involves more than 150 businesses located in four main precincts. The Alliance team reassembled there, and the refit was accomplished in good time.

In 2009, the DMO General Manager Projects, Warren King, told a Senate Estimates committee that the ASMD was 'definitely progressing along the revised remediation path and achieving its milestones.' This was a big step forward for Australia. 'The phased array radar is world-breaking in its performance for its cost and it had challenges early in the program,' he said. However, since the revised 'one plus seven' strategy was agreed, 'industry has responded very well, particularly CEA.'

He then told the committee:

> I had an email a little while ago to say we are at sea with the radar and the initial tests are very encouraging. We will have about an eight-week to ten-week technical testing program, to refine the radar's software to ensure it can track all necessary targets. The important thing about this radar is that it has to also control missiles in flight and a missile engagement. The project is one that looked like it would fail when it became a project of concern and it now looks like a project that will succeed. I am very pleased with the results.

Senator Gary Humphries asked, 'You may be removing this project from the projects of concern list in the future?'

Warren King: 'We have a little way to go. It is a very challenging program. We are doing things in this country that are world leading edge on this technology. There is a pessimist in me that says we may encounter problems that we have not anticipated, so it may take a little longer. However, if it succeeds in all those trials—and I know the Chief of Navy [Vice Admiral Russ Crane at the time] is very keen to take it to the Pacific Missile Facility off Hawaii to operate it there.'

In fact, it would be two long years of testing—and some unanticipated problems—before it was ready for that first journey across the Pacific.

8. ‘I’ve got a job for you’

While the technicians at Henderson were working at full pace to refit the *Perth* for its date with destiny in the blue waters off Hawaii, the man most responsible for ship’s performance was in Canberra working on capability development. Captain Mal Wise had secured his master’s degree in international relations at the Pell Centre of the Salve Regina University on Rhode Island and was now driving his desk at Navy HQ. Towards the end of 2010, the Deputy Chief of Navy, Rear Admiral Trevor Jones, knocked on his door one afternoon and said, ‘I’ve got a job for you.’ The *Perth* was his to command.

Mal Wise jumped at it. ‘I was lucky to get it,’ he says. One of his colleagues, Michael Noonan, had been in line for it ‘but at the last minute he’s been promoted to Commodore and lost the command,’ Mal Wise says. ‘He was the least happy promoted commodore ever in the history of the RAN. I was just in the right place at the right time.’[32]

And as it turned out, Wise was exactly the right man. He could hardly wait to look his new command over. ‘She was towards the end of the ASMD upgrades,’ he says. And when he flew to Henderson to look her over she wasn’t a pretty sight. ‘The first time I visited her she still had the sheds on her,’ he says. ‘They put these sort of tin sheds on the mast to keep the water out and allow them to work. And she was a fairly insalubrious looking ship when I joined her the first time.’

He was also conscious of a larger issue of morale within the Navy. Everyone was keen for some good news for a change. They had suffered through the Collins-class submarine problems. ‘We’d had the Seasprite, for example,’ he says. ‘That was the helicopter that got cancelled [in 2008]. It was another project that was a disaster for us. The early days of the FFG upgrade had been quite problematic, even though it’s a good product now …’

In fact, when he celebrated the fact that he ‘got the drive of another ship and I’m going to Hawaii’, others said, “You won’t go to sea anyway, Mal. You’ll be stuck in WA for the first two years trying to fix it.” And at the time,’ he says, ‘I don’t think that was a cynical view; to some extent it was a realistic view.’

By now, the key members of the team had also assembled at Henderson, led by Rob Elliott and including Sheryl Lutz, the Alliance Project Manager, Darren Kirkby of BAE and John Hind, who headed the SAAB team. He, too, had attended Adelaide University, where he took a science degree in computing before specialising in systems engineering. And of course, Ian Croser was on call day and night.

Darren Kirkby says the implementation of the refit 'was very much as "one team" with a clear and common objective and measure of success'.

The Anzac Alliance contract mechanism was a key to the team's smooth operation. 'When problems arose, it became normal for the first step to be getting the right brains around the table to solve them, rather than trying to allocate responsibility or blame to one company,' he says. 'One effective technique was to establish Alliance project team roles on the basis of function performed rather than their company; and use individual position titles or names rather than company names.'

Another was to distinguish elements developed by the Alliance versus those from individual companies—for example, SAAB led the software development, while BAE led the platform integration design and development of the new mast. 'The Alliance contract system worked very well,' he says.

Sheryl Lutz says, 'There were certain discussions that were animated at the time, but part of my role was to make sure we got the solution we needed and met all the [contract] requirements; and that also met the requirements of BAE on one side and CEA on the CEAFAR side.'

By now, Stephen Gumley was working with Auditor-General Ian McPhee to institute an annual audit of the top 30 DMO projects, with special attention to the ASMD as a project of concern. 'This allowed us to create a running narrative on the progress of the project against time, schedule and capability,' he says, 'and every year the [Australian National Audit Office] was putting out this report to explain what had changed since the previous year.' It not only kept a close watch on expenditure, he says, 'It gave us data at known points in time. It was one of the best things we ever did.'

He later told a Senate Estimates Committee, 'We are working our way through doing a full financial health assessment. The seven or eight main primes that we deal with are all healthy and, as far as we can work out, don't have excessive debt-to-equity ratios and seem to be making reasonable money.'

Mal Wise had returned to Canberra to prepare for the relocation of his family and the challenge ahead. At the Russell Hill Defence complex he found there were plenty of doubters:

> There were a lot of people in Canberra who wondered whether the ASMD upgrade was actually going to work. Just look at it in simple terms—we've taken an existing ship, put a whole new radar on it; it's a bit heavy so we've put some ballast down the bottom. What are the odds? Well, the radar is Australian and we've built how many of those? None. We are going to marry it up to a SAAB Swedish combat system and it's all going to work and it's going to be great! People just didn't believe it and I'm not saying I did either. Given our history of projects, disaster and other things, there was plenty of reason to be concerned.

However, when he arrived back to Henderson and saw the way the ASMD was operating he was greatly encouraged. Wise says:

> In my mind there were three strengths that it might be successful. [Firstly,] Ian Croser's motivation to deliver something that worked; he was personally as well as corporately motivated; and he is a perfectionist, so by the time we had actually built the thing, it had a good chance of working.
>
> Secondly, Rob Elliott was just single-mindedly motivated to get this to work and brought some incredibly talented engineering intellect to the problem.
>
> And lastly, I would have to give credit to SAAB as well. SAAB could have produced a bit of a combat system and hoped that it all went well (and they wouldn't be the first overseas defence contractor to take that approach.) But I never got the sense that that was what they were doing, and John Hind and his team were great to work with. Although it was a Swedish thing, it was really the guys in Adelaide at SAAB that did all the work; so again, we had a bunch of good Australians who were motivated in getting a good product. When you get lucky you get the right people at the right time.

Moreover, when he met with his officers he realised that his luck held:

> I had Steve Ford as my WEEO, who I found exceptional; and Geoff McGinley as my OpsO. He's really an engineer masquerading as a seaman officer, which would have been challenging in other areas of his career but he was just the right guy at the right time. He had that technical background as well as an understanding of the operational side of things. Steve Ford was almost the reverse—a seaman officer masquerading as an engineer. He might not find that a compliment but it's meant as one because he was one of those rare engineers who actually had people skills. I'm being slightly flippant but he was just really strong on people skills and he would be able to work with that [ASMD] team to help them.

Captain Wise's first priority was to whip his crew into shape so that they would give the new capability the best possible chance to do its stuff:

> To my mind I had a fairly simple job. All I had to do was get all the people who could make this thing a success to work together, get on with it, and deliver an outcome. And that's probably one of my strengths. So in my mind that was the easy bit. Guys like Rob Elliott had laid the foundation for success. Without that, it wouldn't have mattered how well the people worked together. If the radar didn't talk to the combat system there was not much I could do to change that. That relied on SAAB, CEA and Rob's project team. All I had to do was facilitate that. It was a pretty good gig.

In fact, his strategy to weld the *Perth*'s crew into a powerful team drew upon every tactic in the captaincy textbook and some of his own making. One in particular involved one of *Perth*'s predecessors. His ship was the third in line to sail under the name, the first being a Leander-class light cruiser acquired from the Royal Navy in 1939.

At the start of World War II, she patrolled the Western Atlantic and fought in the battles of Greece and Crete before returning to Australian waters in late 1941. Under the famously grumpy but beloved Captain Hector Waller, she survived the Allied defeat in the Battle of the Java Sea. And in March 1942 she was headed toward the Sunda Strait, which the Allies believed was free of enemy vessels.

Mal Wise tells the story of the ship's famous mascot, a cat that the sailors brought aboard and named 'Red Lead'. They idolised the CO but hated the First Lieutenant, so:

> when they caught this cat and smuggled it aboard they conspired to release it on the bridge in front of the Captain. They figured if he kicked it over the side they would know Hec wasn't a cat guy and if he picked it up the First Lieutenant wouldn't be able to do anything. And of course when they let it go Hec picked it up saying, 'Oh, here's a beautiful pussycat' and it used to sleep on his table. Red Lead became known as 'the cat who knew' because the night before they sailed to the Sunda Strait they were alongside in Jakarta and three times the cat tried to escape down the gangway and the sailors caught it and brought it back.

The official history records that as they reached the strait in company with USS *Houston* lookouts aboard *Perth* sighted a Japanese destroyer and the Australian engaged.

However, as this happened multiple Japanese warships appeared and surrounded the two Allied ships. At midnight, with ammunition running low, Captain Hector Waller ordered his ship to try to force a way through … four Japanese torpedoes hit the cruiser … Waller gave the order to abandon ship after the second torpedo impact … *Perth* heeled to port and sank with 353 killed (including Waller) and the ship's mascot, Red Lead.

Houston went down 20 minutes later. However, there were a total of 328 Allied survivors, and although many perished as Japanese prisoners of war, Mal Wise discovered that three of them still lived in Perth. He invited them to the ship and, as a welcome note, the day before they arrived he had the 'buffer' paint cat's paw prints on the deck. 'I planned it as a nice thing to do for the veterans but the troops absolutely loved them and we ended up keeping them there as the ghost of Red Lead,' he says. And over the long weeks in port he engaged a graphic artist to design a mascot on the same theme, and even encouraged a local boutique brewer to create a 'Red Lead Ale'.

His tactic 'had a real sense of purpose and history to it,' he says. And, most importantly, it worked. 'Once we got the ship to the point where it was going to sea, or even just alongside wharf trials, there was a real sense of cooperation. And once we started to have success it was infectious.'

The first time they took the *Perth* out to sea was a revelation:

> I remember we turned the radar on, and immediately we could see this thing had a lot of promise. We could track the little commuter aircraft coming out of Jandakot Airport against the background of that big escarpment! But literally, to just turn it on and have that capability when it was functioning at a basic level on day one was definitely a moment where everyone was pleasantly surprised.
>
> We were in the upgraded Ops Room and it was a bit like going from black and white TV to a 60-inch ultra-HD smart TV. There was nothing in the middle. It was, like, 'Wow!'

The excitement immediately spread throughout the *Perth*:

> It wasn't just infectious within the operational and engineering teams. It was infectious right across the ship. The mechanical engineers didn't want the ship to break down and miss a trial because they didn't want to derail something that was going so well. They wanted to be part of it. Like all human endeavour, people want to be part of success. So, then I had a ship full of people who were enthusiastic about being at the front end of what was unique in terms of Australian capability at the time.

9. ‘We’re going to try something’

In the Operations Room, one of Wise’s key officers, Lieutenant Commander Geoff McGinley, felt the enthusiasm:

> The process we went through in Western Australia was actually quite enjoyable. One of the things that really stood out was the collaborative approach with the ASMD team. We had the ship; we had the Commonwealth in Rob Elliott; we had SAAB with John Hind and his team; and we had CEA with Ian Croser; and we all had the ultimate goal. It was quite impressive how collaborative that approach was.[33]

McGinley came well prepared. Another Queenslander, he had joined the Navy in 1996 and went to ADFA, where he secured a Bachelor of Science degree in computer science and history before doing honours in history, ‘which is my real passion’. He then trained on various frigates and small boats before undertaking principal warfare officer training in 2008. He deployed with HMAS *Sydney* the following year and in 2010 was appointed Operations Officer in the Anzac-class *Warramunga.* ‘That really set me down a path for what followed,’ he says. When he was posted to the *Perth* in 2010, he went into training on the new systems at the nearby land base, HMAS *Stirling*:

> It was a great place to get familiar with the system. They actually built a new wing to the school which had a replica of the [upgraded] operations room. The functionality was the same. And we probably had more exposure to SAAB than we usually would because they were giving us the background and delving into what the system was doing and why. And it was very much an evolutionary system at this stage.

Its inventor, Ian Croser, was much in evidence at Henderson and on the ship. Mal Wise had met him briefly in CEA’s Canberra facility before taking up his command. ‘He’s a cantankerous guy like all those super brainy types, and I can see why it’s challenging working with Ian,’ he says. ‘In fact, my Dad was exactly of his ilk, but I really enjoyed working with him; and he certainly did come aboard a lot.’

Steve Ford and Geoff McGinley spent a lot of time with Croser. McGinley says:

> Ian’s the sort of bloke who actually *gets* air warfare and this space better than what many in the Navy do. Of course, he’s a retired WEEO himself but I actually think he’s much more a man who built a company so he could build the best radars possible. And if he makes some money on the side that’s great. Certainly, he is passionate about what he does.

> There's different cultures going on between the DMO and his engineering culture. His is that of the entrepreneur, the innovator; DMO's is [like] someone who's been burnt numerous times; and then you get DSTO on top with their different views. But certainly there's an absolute passion about what Ian does which isn't about money, it's about engineering, it's about radars, it's about ships, it's about capability.

Croser himself later reflected on those early days of testing on the *Perth* in Western Australia:

> There were two disparate views: one which assumed the system was ready in all respects on day one of the trials; and the other which expected the first weeks at least would be a settling-in period—data collection and analysis to confirm the underlying integrity of the solution before proceeding to the more challenging surveillance and weapon control tasks.
>
> We compromised and on day three of the first week successfully conducted detection and tracking of 5-inch projectiles fired from another Anzac frigate just over the horizon. The result was good, and we settled into a gruelling weekly process of travel from Canberra to Perth to be at sea for the months of trials that followed.
>
> In retrospect, it would have been better to have a more structured transition from the first day at sea to the point at which the ship was ready for the test and trials program. But we did not have the time and it was after all, a project of concern.

Nevertheless, Croser says, the reliability of the system started to show through, with the operators quickly getting used to the weekly turn-key operation and predictability of its performance. 'They also embraced the technology with few exceptions, relearning basic operational skills now conducted differently with fewer equipment constraints.'

Geoff McGinley says there were lots of lessons learned in the eight weeks off the Western Australian coast. Each night at 8 pm the ASMD team would muster at the back of the Operations Room, talk about the issues in play and prepare for the next day's test. He says:

> If we saw something that didn't compute, Ian would go 'Huh' and he'd go away and come back four hours later and say, 'I need to shut the radar down to upload the new software; we're going to try something.' Then I'd speak to the operations team and provide the feedback.
>
> We had to break habits. These guys had been trained to do a lot of things manually; when they saw a radar blip they'd put a contact on it and initiate the track. We had to teach them not to do that. 'You leave that be. You need to let the system initiate the track.' It was a real mind shift to change from being combat system operators to combat system managers.

As the trials progressed, they became ever more sophisticated and demanding. The team began aerial testing by tracking small business jets—Falcons and GAT-36s. Geoff McGinley says, 'Then we started using the RAAF's lead-in fighter, the Hawk they use to train fighter pilots.' Then Rob Elliott arranged for the RAAF's newly arrived F-18F Super Hornets to really put the *Perth*'s radar and combat systems through their paces.

Mal Wise says:

> There were more F-18Fs than I'd ever seen before. We wanted to do a supersonic test against a realistic threat. We were all thinking sea-skimming missiles, but of course the RAAF said if you fly an F-18 down at sea level it can only go at whatever speed. But if you get it up at 20,000 feet it can go much faster.
>
> So, we said, 'We really want it up there.' But Ian Croser and the radar team said the radar doesn't look up there; we designed it to look down there, which normally you'd think would be a show stopper. But Ian being Ian (and given the flexibility of the radar), he said, 'Give me half an hour and I'll get it to look up there.' And that's what he did. He even told us the range at which we'd see it.

They had six phased arrays fitted, and Wise wanted to ensure that the radar could track across arrays. 'So we did activities where we had four aircraft coming in and they were crossing quadrants and all that sort of stuff,' he says. 'It gave us an understanding of what range it's able to detect an aircraft of a particular size and what information it can give you back.' And it was a remarkable success.

That was just as well, because they were now working to an unbreakable deadline. The Adelaide-class guided missile frigate HMAS *Sydney* was scheduled to take part in a full test of its capabilities at the PMRF for one week in August 2011. Since it was a highly expensive operation, *Perth* would piggyback on the *Sydney,* use its radar to track some of its operation and then step forward for its own tests at subsonic level.

Geoff McGinley says, '*Sydney* was there to do her thing. They had designed everything around her. But the fact that we'd hired the range for a week, we'd paid for the targets, and given the sensitivities about the project, people said, "I want proof." And the best proof you can get is to test it at PMRF.'

If it failed, the 'one plus seven' strategy would collapse. Only if it passed with flying colours would the ASMD project continue and its sister ships receive the Australian radar and combat system. Stephen Gumley in his Canberra office was obdurate. 'It was the key demonstrator that the technology worked,' he says. 'You could still switch the project off if it didn't work at that stage.'

While the Western Australian trials were positive, and the ASMD team was working like a well-oiled machine, the combat system had yet to fire its ESSM battery to intercept an incoming missile in practice. So, after eight weeks without a break, they sailed around the Great South Land to familiar waters off HMAS *Creswell* at Jervis

Bay. By now it was 2011 and the deadline was approaching. Mal Wise says, 'It struck me that if we had a failure at that point we had no fat in the program.'

The team leader, Rob Elliott, was equally concerned. He had arranged to use an unmanned aerial drone, the Phoenix, made locally by Air Affairs in Nowra. It would fly at 300 knots and provide an ideal practice target for the subsonic and supersonic tests to come in Hawaii. 'That was nerve-wracking,' Elliott says, 'because it was the first time we had used the CEAFAR system with the ESSM. If it failed, my reaction would be, "Oh, my God. My career is over."'

'So,' says Commodore Mal Wise in his office at Fleet HQ in 2017, 'we did the shot.' The ESSM launched towards the Phoenix. 'And,' he says, 'it missed the target.'

There's a long moment of silence before his interviewer responds. 'It missed?'

He grins. 'It missed the target but it wasn't a failure of the radar. The key thing was, "Did the radar support the missile in flight?" That was the question and the answer was "yes". So, from our perspective, even though it missed the target for other reasons it was a success.'

'What were the other reasons?'

'Because there was a malfunction in the missile and it didn't home on to the target. But of course that was nothing to do with the radar.'

'That was the ESSM?'

'Yeah. That was in the actual missile itself.'

Rob Elliott was equally sanguine:

> I trusted Ian and all the testing and de-risking we had done to get to that point. With CEA, SAAB and BAE, the project [the government] agreed on very detailed systems-of-systems de-risking confidence demonstrations. These lasted over a 12-month period where we tested the systems as they came together both off and on the ship right up to the ESSM firing against the Phoenix target off the east coast of Australia—all aimed at providing confidence in this new ASMD system.

That was 8 May 2011. They would be leaving for Hawaii in two weeks; the Phoenix exercise was now behind them. In the next few days, they travelled up the coast to Sydney, where they had some shore leave. Then, on 22 May, HMAS *Perth* eased away from its Garden Island berth and headed down Sydney Harbour towards the heads at a careful 10 knots. Once clear, they would sail the Pacific until the lush Hawaiian Islands hove into view. They were ready for the big one. If the Jervis Bay miss registered on the downside at all, it would soon fade into history; the *Perth* and its crew and its remarkable Australian innovations would rise again. After all, they hoped, that's what phoenixes do best.

10. ‘These Australians … What can you do?’

They docked at Pearl Harbour on 7 June. It had taken a little longer than usual to cross the Pacific, as they’d made a refuelling stop at Apia in Western Samoa. And before they sailed the final leg to Kauai they began a series of briefings at Pearl with the operators of the PMFR. ‘We did a huge amount of work with those guys,’ Mal Wise says, ‘to make sure that we knew exactly what was going to happen. Because, unlike an operational firing where you want the test to be a surprise, we didn’t want anything to be a surprise here.’

It was important, he says, to do all the calculations behind the trial. ‘If we thought the radar should see what was coming towards us at a given range, that would be the range [we set]. If we saw it then we had an immediate benchmark.’ The fact that CEAFAR was a brand new technology was also an important factor, even though it was combining with an existing missile. In fact, he says, the Americans weren’t particularly familiar with the ESSM, which was a fairly short-range missile. ‘They’re generally not impressed with it,’ he says. ‘But us little fellas, we get over that; we still like it.’

In fact, the PMFR operators were ‘incredulous’ at the faith the Australians seemed to have in their system. However, Wise says, their confidence was well founded. ‘Coming out of the build, right through the trial process and then arriving in Hawaii, my guys on the ship probably knew more about the combat system than anyone since,’ he says.

‘It highlighted to me the challenge we have in training our sailors,’ he says. ‘It’s one thing to do a gunnery shoot or a tracking activity; it’s another to create a training environment that really drives a deep understanding of your combat system.’ He was particularly fortunate in having Ian Croser along to guide the sailors and answer questions. ‘You really had an understanding of where it started, where it had got to, what your expected performance was. So we had a lot of confidence it was going to work.’

Ian Croser and Rob Elliott had flown to Hawaii for the occasion. While Croser boarded the *Perth,* Elliott, as the lead government trials commander, spent most of his time at the US Navy PMRF Command Center on Kauai with the Director of the Navy's Test and Trials Directorate. 'I made sure that I was actively involved,' he says. 'The range is fully instrumented and you're using these targets which are very costly. Fortunately, you can recover the subsonics that we were sending out provided they aren't splashed by the ESSM fired by the ship. The profiles we flew were predetermined so we could trace exactly whether the new ASMD system could do what we said it could.'

Back in Canberra, Stephen Gumley waited anxiously for the first results.

Of the other key Anzac Alliance members, Sheryl Lutz was in Rockingham, while Darren Kirkby returned to Williamstown. 'It was very exciting,' Sheryl Lutz says.

Geoff McGinley spent most of the week in the ship some 50 kilometres off the coast of Kauai. 'The point about Hawaii,' he says, 'is that we were trying to prove that the radar could track the targets to the standard required.' The plan was that the PMRF operators would launch at least three subsonic missiles from Kauai that would head in *Perth*'s direction. Mal Wise says, 'They fly pretty much directly at you but when they're about two miles off they would turn away.' By then, the *Perth*'s ESSM missiles should have taken them out. McGinley says, 'If the enemy's missile is still in the air at two miles [your situation] is pretty bad.'

They would come in at various heights, for which the ship's systems were calibrated. And when Rob Elliott prepared to order the first target released from the island's Barking Sands base in the morning, every one of the *Perth*'s officers and crew was on high alert. This was the culmination of an extraordinary effort by the Navy, CEA, SAAB, BAE and many other elements of Australian industry. And, despite all the tests, no-one really knew how the system would perform under this kind of duress …

The first missile came at them at 'medium' altitude, and right on cue the CEAFAR radar locked on. McGinley says, 'If we'd done it in 2010 it would have been hard work, but now it was like "Huh, that was easy."'

However, no-one relaxed.

In the afternoon, Elliott ramped up a second serial. But then came a twist. Suddenly, the PMFR Control Room was expectant. Elliott as Australian Government lead was stepping outside the usual format. The American operators had agreed, shaking their heads: ‘These Australians … What can you do?’

They launched.

In the ship’s Operations Room, they were all feeling pretty good. McGinley says, ‘One missile was coming in, still at the medium altitude, and I went, “Oh yeah, that’s easy.”’ But suddenly there was another. They hadn’t told me, the bastards. They’d put it in at low altitude and I’m going, “Where the f**k is the other one? What’s going on here?”’

In the Command Center, Rob Elliott was watching intently. ‘I’d decided, “Right, I want to truly test this radar. I’m not going to tell them what I’m going to do to the target.” Since it was a calm day, I took it down to be very close to the sea surface. It’s doing 350 knots but that’s still pretty fast. And I could hear them saying, “We can’t see it, we can’t see it” because they were thinking it was much higher.’

McGinley says, ‘Then it crossed the radar horizon, and then it was “Oh, there it is” and the system executed a fully automatic engagement in a very short period of time and the [incoming missile] was dead. And I was like, “Oh wow!”’

Elliott says, ‘It was truly a test of the CEAFAR model and they picked it up where the model said they would. The test was a success. It was exciting. [The guys on the ship] didn’t like me, but the test was successful.’

In fact, the guys on the ship were thrilled by the result, none more so that Captain Wise. ‘We were confident that we’d done everything we needed to do to show this thing was going to do the job,’ he says. ‘All the predictions we did about when we’d see [the target], when we’d detect it, when we’d be able to engage it—they all turned out to be accurate. They were spot on. So that gave me two things—one was that the radar could do what we bought it to do—anti-ship missile defence—and two, that whenever we used the prediction tool against any threat missile, we’d have good confidence that it was going to predict reasonably close to what we should see. So that to me was the crowning moment for the whole activity.’

And when his ship docked, Ian Croser met with Elliott. ‘What happened there?’ he asked of that tricky second target. But he made no complaint. The endless hours he had invested, the brain-numbing battles with business and bureaucracy, the distance travelled, the tension, the expectation, and most of all the years of hard work were all suddenly vindicated.

The technology worked.

When word reached the Alliance partners, they shared in the celebrations. ‘We were very proud,’ says Sheryl Lutz.

Darren Kirkby says, ‘I was in the office in Williamstown where we did all the design and development work and I think it was Sheryl who told me. I don’t have a perfect memory of that exact time. But from an engineering point of view that trial was really just to prove what we had a fairly confident expectation of what would happen.’

And it did.

Stephen Gumley says, ‘I was back in Canberra on the phone and waiting for an update every few hours as to how it was going. I’d get in at 7 am and then get an update; then there were others a few hours later in the day. The initial updates at times were nothing more than a quick telephone call that it’s going well, we’re getting the outcomes, but later there were fuller reports and everyone was hoping it would be successful.’

And then it was.

Warren King says, ‘Rob kept me informed. The results were spectacular… spectacular!’

After seven and a half years in one of the Australian Government’s more stressful jobs, Gumley decided it was time for a change to private industry. By then he had been honoured with the award of Officer of the Order of Australia. And by then a new broom in the person of West Australian MP Stephen Smith had become Minister for Defence, while Major General Duncan Lewis (Rtd) was preparing to step into the role of secretary of the department. Lewis would remain in the post for just over a year before one of Australia’s most distinguished public servants, Dennis Richardson, began his long tenure in 2012. Gumley’s position as CEO of the DMO would go to his deputy, Warren King.

The *Perth* under Captain Wise completed its PMRF mission by tracking the missile firings of the *Sydney*, while back in Australia Rob Elliott and the department set about securing the government’s agreement to remove ASMD from the Projects of Concern list.

However, Mal Wise wasn’t ready to take his ship home just yet. *Perth* sailed to the west coast of Canada where, Geoff McGinley says, ‘We went to Esquimult, the navy base there, where we did a demonstration of the radar. We took some Canadians out to sea and got some of their fighter jets out and showed them what it could do. We then went down to San Diego,’ he says, ‘and again we got a whole bunch of US Navy jets and we showed off to the Americans.’

In Canberra, Warren King told a Senate Estimates Committee:

> Earlier this month, in the [PMRF] trial, contrary to my extreme pessimism, [the radar] executed flawlessly and on schedule; and in the earlier part of the month we did a successful ESSM firing from the *Perth*.
>
> The level of support and cooperation from industry, from Navy, from the commanding officer of the ship, was just outstanding. This will be world-beating technology the likes of which this country hasn’t put together for 20 or 30 years.
>
> CEA is a small Australian company. I think they are to be commended for the work they have done. We have an issue now to go back to government and outline the cost and schedule to install on all the ships. It’s not for me to say, I guess, but the enhancement in capabilities that this brings to the Anzac ships is quite phenomenal, and at a reasonable cost. I have no doubt that many countries of the world will be coming to look at this company and acquire this technology.

He was accompanied by Stephen Gumley, making his farewell appearance before the committee. Gumley said, 'There will be a real cost increase to the project but it is one that in my view is very justified, given the capabilities being demonstrated.'

On 30 November 2011, Defence Minister Stephen Smith and Minister for Defence Materiel Jason Clare made the joint formal announcement:

> The Government has approved the upgrade of all eight of the Navy's Anzac-class frigates with an advanced Anti-Ship Missile Defence System (ASMD). Total project cost is in excess of $650 million. The ASMD project has been removed from the Projects of Concern list …
>
> Following extensive testing, including in the United States, the Chief of Navy agreed to the operational release of the system. The Government has now approved the installation of the system on the remaining seven ships by 2017.

11. ‘I don’t know if I’m in trouble or not’

The government’s announcement was a rare ‘good news’ story in the political ferment that had gripped the nation almost since the election of Kevin Rudd as Prime Minister. The first ripples occurred in the Liberal opposition, when Leader Brendan Nelson was summarily replaced by Malcolm Turnbull after less than a year in the job. Then, 13 months later, Turnbull himself was supplanted by his conservative rival, Tony Abbott.

The ripples rose to a stormy turbulence in June 2010, when Rudd fell victim to a revolt within his party that saw his deputy, Julia Gillard, claim the prime ministerial mantle. And after the subsequent election her minority government depended on the votes of two independents. While Abbott ramped up his no-holds-barred opposition, Rudd secured the post of Foreign Minister, much to the disappointment of Defence Minister Smith, who made no secret of his wish to transfer to that portfolio. So the Defence Department, under the hand of a reluctant and distrustful minister, relied heavily on Dennis Richardson to forge a steady path. In such a febrile atmosphere, news of the ASMD success barely registered on the national consciousness.

It was, however, of enormous satisfaction to the Navy, and no more so than to Captain Mal Wise, who took the *Perth* back to North America for the biennial RIMPAC exercise in 2012. Under the command of the US Pacific Fleet, RIMPAC is the world’s biggest live-fire maritime exercise and is conducted mainly around the Hawaiian Islands. Prior to the formal start of the exercise, Wise took the *Perth* to the US Navy base at San Diego, where he and his officers did the planning for the firing of a Harpoon surface-to-surface missile at nearby Magu Island.

‘We shot a shipping-container stack and hit within inches of the centre,’ he says. ‘We did a second shot and both were successful.’ Then they joined up with RIMPAC. Geoff McGinley says, ‘It’s a four-week exercise and we fired two more ESSM against targets at tactically relevant heights as part of a [group] of Australian, Canadian and US ships.’ They, too, were right on target.

However, when he returned to Australia, Mal Wise got good and bad news. He was to be appointed as Frigate Group Capability Manager, but that meant that the command of the *Perth* for the final supersonic tests at PMRF would go to another captain. In the event, Lee Goddard was given the job. Looking back, Wise grins, a little ruefully, and says:

> I would have loved to do Lee's [operation]. I won't deny that. But as Group Capability Manager I owned all the Anzacs. I wouldn't go so far as to say Lee was working for me but I was trying to support all the other COs and all the Anzac-class frigates. I had to make sure the ships not only went through the ASMD but that all the engineering and maintenance challenges were dealt with.
>
> I would have loved to, but, hey, that's the way it goes.'

Geoff McGinley would also be absent from the Perth's wardroom. 'By that stage I was pretty exhausted,' he says. 'I'd been at sea for four years; I was ready for a break.' He handed over to Dylan White, whom Goddard would come to regard as 'one of the best warfare officers in the fleet'.

At the great Henderson dockyards, preparations were underway for *Perth*'s sister ships to be refitted. In fact, BAE had become so confident that the *Perth* would come through with flying colours that Darren Kirkby had begun costings for his company's tender to upgrade the other seven ships months before the PMRF trials:

> It wasn't an open competition. The procurement strategy of the Commonwealth team was actually a question at the time—whether they wanted an open competition or not. They certainly wanted to maintain an environment of competitive tension … we didn't know whether they would go to an open tender or not.
>
> We delivered our pricing progressively in March, April and May of 2011 and delivered that through Rob Elliott. Then we were asked in August to respond again with some final adjustments. We did that and then were invited into sole-source negotiation by about November; and we closed the door by December and had the contract signed in January 2012. [34]

The price agreed was $270 million, and a further $65 million would be added later.

However, because of the ‘one plus seven’ strategy—and the fallow period before work could start on the new contract—BAE had to correct some serious staffing problems. Its workforce at the Henderson yard had fallen to only 32 people by the end of 2010. Kirkby says:

> We did start to reinvest when we thought that we’d be successful in getting the contract for the next seven. We then started to turn the corner and try to build the capability again. It was essentially a second first of class again.
>
> There was actually a technical difference in the baseline of the ships. HMAS *Perth* had already had its ballast upgrade—with lead placed in the keel of the ship—before we took it in for its ASMD. So we did the upgrade in the water. The strategy for the follow-on was to do all of that work concurrently, to minimise the time [each] ship was away from the Navy. So that was a complicating factor at the start of the program.

Another was the ‘learning curve’, which assumes that the task will become less expensive for the later ships. ‘That was built into the estimate that we contracted with the government,’ he says.

Meanwhile, Captain Lee Goddard was heading across the Pacific for his own date with the American sceptics in the PMRF Command Center and the final Navy operational test and evaluation of the ASMD system before the Chief of Navy could claim initial operational capability. Now the targets being fired at *Perth* included two supersonic Coyote missiles—each costing $4 million—which would come screaming out of the blue, cutting a path across *Perth*’s station as the combined radar and combat system on board responded with the ship’s own relatively slow ESSMs in the hope of intercepting the incoming target. In addition, *Perth* would track at least seven subsonic missiles, some of which would be in combination with supersonics.

Goddard was understandably tense: 'We were conscious that we'd been allocated a lot of assets—not just a warship and lot of people, but a lot of missiles and a lot of very expensive targets. It wasn't just testing systems, it was also a testing of people.' But he was encouraged by a crew trained to a peak by Mal Wise and his own experience with the CEA radar during the early trials on HMAS *Arunta*. Moreover, there were also CEA technicians aboard the ship.

'We went through all the safety procedures you had to follow with the Americans,' he says. 'We had Swedes observe some of the things we did. I had a Spanish vice admiral who was invited to come and watch me—in fact, he stood next to me saying remarkable things like, "You can't do this, it's impossible, you'll never achieve this profile." So did our American friends … and the Swedes … they were all quite sceptical, though they admired our intent.'

First up, he says, they did the seven subsonics but on occasion they were mixed with supersonic interference. The test, he says, 'was designed so you could potentially be attracted to the subsonic target at the expense of the supersonic. And in fact I can assure you each of them was a success—in fact probably more successful than we thought possible.'

He says they had to intercept targets at distances from the ship that had probably never been done before:

> The ESSM missile has traditionally been a point defence system designed for a weapon coming in directly, which is easy [to take out]. But once it starts crossing—heading for a high-value unit, especially if it's doing mach 3—then it becomes exponentially more difficult.
>
> We'd simulate being a short distance from a high-value unit on its quarter, so when we'd take out the incoming supersonic mach 3 missile with the ESSM, they'd never seen it done before.

> On one occasion—I think in profile three—we actually lost the target momentarily—and that happens sometimes in the fog of war—and when it came up again a young operator, a sailor who was literally in front of me in the Operations Room—saw it and intuitively pressed a ‘hostile’ and a missile went and took it out at the minimum engagement range. So at the last moment we were able to save the [high-value unit].

The Spanish vice admiral didn’t believe it had struck the incoming target. ‘Then the command reported, “Hit target”,’ Goddard says. ‘The young sailor looked around at me and I said, “How do you feel?” He said, “I don’t know if I’m in trouble or not”. I said, “Did you know what you were doing?” He said, “No, I just intuitively did it” and when I said, “Well done, mate,” in a classic Australian way, he said, “Thanks so much. Do you mind if I go to lunch now?”’

They saved the last two profiles for the supersonic Coyotes. The first one, Goddard says, came at them skimming at its minimum safe height. ‘You probably have 10 to 11 seconds to react, and as soon as you’ve made it “hostile” the system just automatically does it and of course it’s just “hands off.”’

In fact, when that first Coyote came at them the system fired two missiles. The first smashed into the target and the second took out the debris. ‘The Americans said “We’ve never seen that. You’ve actually taken out the target and we thought the second missile would just disappear. But all of a sudden it turned and actually took out the debris on the way through.”’

On the second attack, only one ESSM was needed—the Coyote was pulverised. However, a ‘ghost’ image had appeared briefly on the screen and Lee Goddard actually fired three ESSMs, two of which weren’t needed. ‘So it was all very positive,’ he says.

He goes further:

> I would argue that at that time we probably had the best anti-ship missile capability in the world. From where the Anzacs were in the mid-1990s, when they were described as 'the best informed targets in the world', we'd gone to having arguably the most capable frigates in the world … And we've proven that the upgraded Anzac can take out threats in really challenging scenarios; it can defend higher value units as well as itself, which should give us great comfort.

After the Hawaiian test, the *Perth* set course for home, but on the way she joined an international search and rescue of sailors off the New Zealand coast. Then she joined the Fleet Review, presided over by Chief of Navy, Vice Admiral Ray Griggs. 'He was able to show his counterparts in other navies—as well as the department's own acquisition organisation—this is what we've done,' Goddard says. And Ian Croser was on hand, he says, to share in the achievement. 'He's got great sense of humility,' Goddard says, 'But his is a story that we're really proud to sell.'

Goddard says that, having been promoted to Commodore and Commander of Surface Force, servicing the two new LHDs (HMAS *Canberra* and HMAS *Adelaide*) since the 2013 test, he'd become aware of just how important high-value unit (HVU) protection was. 'Their precious cargo [includes] potentially 1,000 soldiers, all their combined arms, artillery, tanks and landing craft as well as helicopters. That's one great system,' he says, 'but it needs to be protected and you need area air defence; but you also need close-in, high-value unit protection and we proved that with the Anzac-class ships.'

Warren King, who had taken over from Steve Gumley, says, 'Those two captains—Mal Wise and Lee Goddard—played an extraordinary role. They were as fundamental to the success of ASMD as Rob Elliott.'

12. ‘It’s exceeded all our expectations’

By the end of 2013, the turbulent political scene continued to buffet the Australian polity, including the Defence Department. The year before, Kevin Rudd had resigned his Foreign Affairs portfolio and mounted an abortive challenge against Prime Minister Gillard. Defence Minister Stephen Smith once again failed to secure his preferred portfolio, which went to former New South Wales Premier Bob Carr. But Opposition Leader Abbott had mounted a devastating frontal attack on Gillard and her government; as the election approached, the Labor Party faced a trouncing at the polls. Led by the same coterie that had brought Rudd down, the party room turned back to its former leader to ‘save the furniture’.

The tactic was judged at least partially successful, but the Coalition easily won the election and Prime Minister Abbott promised—and delivered—a substantial increase in defence spending. He appointed Senator David Johnston to the Defence portfolio, which Johnston had shadowed in opposition since 2008. However, his tenure would last little more than a year before he was replaced by Victorian MP Kevin Andrews, a close associate of the Prime Minister.

In 2016, Abbott suffered the same fate as Kevin Rudd, when Malcolm Turnbull challenged successfully for the leadership; once again, a prime minister was toppled in his first term of government. Turnbull took the government to the 2016 election and scraped back with a one-seat majority. He appointed the Defence portfolio’s first female minister—the well-respected Marise Payne—and South Australian frontbencher Christopher Pyne took the upgraded cabinet post of Defence Materiel. Turnbull not only maintained the additional defence budget but announced a greatly expanded warship-building regime for South Australia.

Meanwhile, work on the upgrade of the seven Anzacs was proceeding apace at Henderson dockyard. By February 2013, some $654 million had been expended on the ASMD program. And official reports confirmed the extended capability of the frigates following the successful trials. According to the department, ‘The upgrades will ensure the Anzac frigates will not only have an increased level of self-defence against modern anti-ship missiles, it will also enable Anzac class to give close-in protection to amphibious ships, supporting the Navy’s future Air Warfare Destroyer’s area defence capability with a local defence inner layer for a Task Group.’[35]

The upgrades would incorporate:

- the leading-edge CEA phased array radar
- the Sagem Vampir NG infrared search and track system

- the Kelvin Hughes Sharpeye navigation radar system
- an upgraded SAAB 9LV Mk 3E combat management system.

About 250 tradespeople as well as more than 30 subcontractors were now involved in the project, as each ship required about 600,000 hours of work. The material involved in each vessel included 28,000 metres of cable, 4,000 square metres of steel and alloy sheet and 375 kilometres of welding wire. Some 9 tonnes of lead ingots would be fitted as ballast, while 28 tonnes of old paint would be removed and 14 tonnes of new paint applied.

HMAS *Arunta* was completed in June 2014 and HMAS *Anzac* the following month. The ASMD Program Delivery Manager, Lieutenant Commander Felicity Petrie, said the program was having 'an enormous positive impact' on local industry and was running to schedule.

Merv Davis, by then CEA's Chief Operating Officer, says, 'By that stage we had funding to get the materials to follow on. It was just a matter of ramping up to a steady state of production to meet the ASMD schedule in the west. And we coped with that pretty well.'

Next in line were HMAS *Warramunga* in 2015 and HMAS *Ballarat* and HMAS *Parramatta* in 2016. Later that year, HMAS *Toowoomba* and HMAS *Stuart* reached the dry dock in that order. Navy personnel joined counterparts from the Australian Public Service, BAE Systems, CEA Technologies, SAAB Systems and a number of other organisations on 2 September to witness the final time two Anzac-class frigates would be in dry dock together.

Surface Combatant Group Capability Manager Captain Michael Turner said that, with HMAS *Toowoomba* due to undock on 13 September and *Stuart* deep into her upgrade, the end of the ASMD Program was now in sight:

> It's important for us to pause and acknowledge both the significant achievements made by the people here today, and those who couldn't be here, to deliver these world-leading upgraded frigates and also the incredible reach this project has in terms of the people required to deliver it. Each ship docks for approximately 12 months to facilitate the significant structural work required to install the new mast to support the phased array radar system, a coating of the new haze grey livery and other docking-dependent tasks.
>
> This has been followed by several months alongside conducting harbour acceptance trials and system work, and culminates in a month-long sea trial period before the ship is formally returned to full Royal Australian Navy service.

In 2017, when HMAS *Stuart* was about to be delivered, ASMD Program Delivery Manager Felicity Petrie, who had been involved with the program since 2014, spoke at a ceremony at the Henderson complex before an audience of government, industry

and Navy representatives. She said she was proud to see what had been delivered in the six years of intense and productive industry:

> It's impressive to take in the sheer number of personnel here today and to understand that this is not everyone who has a hand in the delivery of this cutting-edge technology to Navy. This program has had an enormous positive impact on local industry and on Navy capability.
>
> Each docking and upgrade is a complex operation managed by an integrated project team comprising Navy and contract personnel responsible for project and engineering management. This ranges from various maintenance jobs to trade work, painting, cleaning, safety and security tasks.
>
> In the background, hundreds more people have 'touched' the project in design, contracting and other aspects—it's estimated that more than half a million hours of work are expended on each ship as it progresses through the upgrade.

The upgraded capabilities of the Navy's Anzac-class frigates had been on display in various parts of the world over the past few years. 'As well as performing operational duties in the Middle East, upgraded frigates have deployed all over the globe,' Petrie said. HMAS *Anzac* proceeded on a world deployment in 2015, culminating in participation in the 100th anniversary of the Gallipoli landing in Turkey, while both *Warramunga* and *Ballarat* recently completed successful deployments as part of Exercise RIMPAC.'

Stuart's delivery back into Navy service would conclude one of the most significant upgrade programs ever undertaken by the RAN.

BAE's Darren Kirkby says:

> The way it looks now is that the first couple of ships in the program were more expensive than we estimated—for a number of reasons—but we've been able to achieve more of a learning curve so that the two factors balance each other out.
>
> I'm very proud of what the project team and all parties involved in the project managed to achieve by working together towards a common objective. I think it's been a somewhat under-recognised success story. Now that all eight ships have been upgraded to their new mast configuration, and I see them in the water, I sometimes think back to those early working groups in our engineering office in Williamstown more than 12 years ago. I recall drawing pictures on the whiteboard of what the mast and ship could look like as technical details on the phased array radar progressively emerged from CEA.
>
> The success of the ASMD project has been instrumental in the growth and development of BAE Systems' engineering capability for complex platform system integration work in Melbourne, and our production capability for the implementation of major ship refit and upgrades at our shipyard in Henderson,

> both of which are critically important in-country capabilities supporting Navy into the future.

SAAB's Sheryl Lutz says, 'It was a new capability that we were introducing; there was a lot of risk, so it took a lot of analysis and a lot of effort to ensure we were able to deliver. In the end it was very satisfying.'

John Runge, the ASMD Program Manager under Rob Elliott, was transferred by the Defence Department to liaise with CEA. He says:

> Once they got the requirements right, it took a couple of ships and then the learning curve happens. So we applied that to our costings and we had some nice, strong figures. We then went to government and they said, 'Yep.' So CEA has actually delivered ahead of schedule because they've had a greater learning curve in the build than originally predicted.
>
> When we initially did the cost model we put depot-level maintenance at every eight or nine months; but after tests and trials we were able to go to three years because that was the ship-docking cycle. But as that cycle went to four years we were able to move it out to four years as well. And now it's going to be 'by inspection' because its reliability has exceeded all our expectations.

But while the ASMD project was nearing completion, it was not the end of upgrades for the Anzacs. Indeed, the need to continue to make the Anzac-class capability available to the government until its replacement by the Future Frigate in the mid-2020s means that the ships will continue to be upgraded. Rob Elliott says:

> As the Navy's program sponsor for our surface combatant capability, we are now working towards the government making another call to again continue the journey of the CEAFAR technology in the Anzac class with the replacement of its long-range radar with the next-generation CEAFAR radar system. The Navy's relationship with CEA remains exceptionally strong, and we're excited about working with CEA to further increase the capability edge that their radar systems bring to our Navy and the ADF as a whole.

The $2 billion, six-year Anzac Midlife Capability Upgrade Program—scheduled from mid-2017 to 2023—includes improvements to engines, propulsion, lighting, heating, cooling systems, communications systems, torpedo self-defence and Nulka enhancements. In 2017, BAE Systems Australia CEO Glynn Phillips says, 'We are now preparing *Perth* for some initial work as part of her Anzac Midlife Capability Upgrade Program, which will take several months. She'll return at a future date for the remainder of the upgrades to be implemented.

'HMAS Arunta is scheduled for docking at Henderson in September this year to receive all of her upgrades during her 12 months on the hard stand at Henderson.'

13. ‘How good can it be?’

In many ways, ASMD had by now become CEA’s story as well.

CEA CEO Rob Forbes told a Senate Estimates hearing in 2014 that he was ‘quietly confident’ of the company’s long-term success. Forbes was asked about the effect that the department’s new Priority Industry Capabilities program had on CEA’s operations. The program’s task was to identify and assist Australian industry capabilities that confer a strategic advantage to the nation. ‘It is one of the things that’s the perception of people about how companies [such as CEA] operate,’ he said, ‘but if we go back to the 1990s we were developing the radar technology with our own dollar. We would estimate that we spent millions of dollars developing phased array technology.’

Merv Davis says:

> There were any number of naysayers who didn’t understand the technology, who didn’t know how we could produce the goods. Yet there were others who could see through that fog and say, ‘Yep. If this comes off, oh boy!’
>
> Payback is recognising that it is strategically important nationally. We’re now producing arrays that are substantially more powerful but, equally, the processors—the receivers, if you like—are so much more capable. You can do a whole lot more in the same time frame.

John Runge recalls:

> We were very much a political pariah. We were high risk, and no-one wants to attach their name to you until you’re successful. But once you are, everyone’s your friend. Our capability is continually evolving. And part of my job is to focus the enquiries into CEA. Every man and his dog from Australia and overseas has been interested in this capability and wanting them to do work for them. My role is to be a one-stop shop; if someone approaches CEA direct, they send them up the hill to me. I do the filtering. If several people want to do similar things, I try to bring them together at portfolio level so we can bring several programs together and simplify CEA’s operations.

> We're managing it [in Defence] because there's a lot of inherent sovereign capability and we have to be very careful what knowledge and what data is being supplied to customers. I'm also a foreign military sales office. We've had all the US admirals out here and they say, 'Oh, that would solve all our problems and you're about a quarter of the price of anyone.' This has to be very tightly controlled. I basically approve all releases of data to these people to ensure that we're not giving away the crown jewels. And we manage capability so there's no leakage and thereby prevent reverse engineering.

Ian Croser still works 18-hour days at CEA's Fyshwick HQ, which has now expanded to a second building atop a rise. He says the company could easily do without him now. He smiles: 'All I seem to do is show people over the place.' And, indeed, the company is host to a continuing stream of eager visitors from around the world seeking access to the breakthrough technology he and his team have created.

He has time for all, including this author, who was duly bedazzled by the extraordinary range of inventive technology within the company's purview. As we stroll through the several floors where PhDs in casual dress sit before monitoring screens tapping their code into keyboards, or arranging tests of phased array faces in a rubber-lined room the size of a lecture theatre, he greets them all by first name, and they respond in kind.

'In most cases we are seven to eight years ahead of the rest of the world,' he says in the most matter-of-fact manner. 'Most radar programs are seen as discrete events, and the system in its form after it's delivered will remain in that form for a long period of time. When we digitised the radar completely, it meant we could evolve the design without ever changing the physical form, and then at a future date introduce a new physical form and take all of the software and all of the capability into that new physical form and reduce the development time enormously. There are some very big systems we are building now. A lot of these are going to export.'

CEO Merv Davis, in a modest office, offers coffee and says, ‘I don’t know that many people realise the value Ian brings—the commitment to ensuring that the capability to provide to the ADF is as good as it can be. He’s literally dedicated his life to it. I’ve never known anyone who works as long, as many days a week. Even international customers are taken aback by his total commitment.’

The ASMD was very much a part of the company’s growth pattern, he says. And in a sense the Navy grew with it. ‘In the days of Anzac’s conception we called it a second tier ship,’ Davis says. ‘There was lots of talk about it being “fitted for but not with” the additional armaments. I remember thinking at the time, “What a shame that’s the case.” But now, pound for pound, it’s probably the best warship of its size in the world. It’s been a fantastic story. For us at CEA, it’s very special. It demonstrated how brilliant that capacity is and paves the way for bigger, better, more capable arrays for applications beyond maritime.’

Rear Admiral Chris Ritchie says, ‘The great thing to come out of this is that this is an Australian product, that we can do these sorts of things in Australia. We really do have an inferiority complex—people think, if it comes from Australia, “How good can it be?” And that’s part of the reason why it took so long for CEA to convince people that this is something that really does work.’

It’s a sentiment we’ve all heard before. But companies like CEA and men like Ian Croser are the agents of change. And they have learned lessons that are worth remembering. Indeed, Croser compiled for us ‘a few lessons/fundamentals learnt and/or reinforced along the way that are worthy of mention’.

It's entirely appropriate that he should have the last word:

1. *Requirements* should adequately describe the end-user needs independently of the solution. The expectation should be that the requirements may not all be met by a solution constrained by cost, weight, power, size, technology and time.
2. *Specifications* should describe the solution-specific implementation and its characteristics. This should represent an agreed functional baseline for the implementation, and its relationship to fulfilment or otherwise of the *subset of requirements* is understood and agreed as early as is practical.
3. The *validation* program should describe the way in which the agreed *specified capability* meets the *subset of requirements* to be fulfilled.
4. The *verification* program should show how and when the *specified capability* has been met.
5. Attention to detail in all aspects is fundamental to overall success. Assumptions that elements that seem simple aren't worthy of the same attention to detail and early scrutiny as the most complex generally result in issues less able to be mitigated later in the program. As an example, the lowest performing part of the ASMD project should have been the simplest to design and implement. The cooling system remains a challenge for the ships, even six years after HMAS *Perth* first went to sea for first-of-class trials.
6. Above all else, it is individuals, their drive and commitment which, combined with capability and confidence in the outcome, will produce a successful delivery of capability.
7. Team selection and leadership can never be replaced by process.
8. Engineering big systems is not solved by process. Engineering will always depend upon process and tools but fundamentally relies upon the ingenuity and cooperative capability of well-motivated teams. Trust is the glue.

9. It is trust between the key individuals that enables the resolution of engineering issues and trade factors without the confusion of political, commercial and preconceived workshare boundaries.

10. The understanding at the beginning of the program by key individuals and the simple description of the intended outcomes and constraints enables confident progression to a successful integrated capability.

11. It’s a given that this understanding and simple description of what is to be delivered are also at the most naive point in the project. The *requirements* may need to remain the same, but the *specified capability* should evolve as issues accrue and are resolved or not. It is the *functional baseline* represented by the *specified capability* and the *validation* process that adequately represents the project deliverable.

12. Workshare is an outcome of, not an input to, good engineering design.

13. Hardware and software simplicity and functional modularity facilitate good outcomes.

14. Blind adherence to and misuse of process tools obfuscates the true objective.

15. Interfaces don’t drive good design outcomes. Therefore, predefined interfaces shouldn’t be allowed to drive design until they have been proven against the understanding of functionality to be allocated on either side of the interface.

16. The availability of funding at the optimal stages of the program’s progress underpins the success of the outcomes. Practical and government-approved progress constraints inevitably impact the integrity of the outcome.

17. A good program management team is essential to ensure that pragmatism is applied at all levels to enable the detailed work to continue.

18. A high-risk development program such as the ASMD program continually lives on the edge and is at risk of falling into a circular argument trap, which may extend the schedule of critical early development beyond the breaking point of the program schedule:
    - Demonstration of progress is used to underpin approval to proceed to following stages.
    - Work required to be done to demonstrate progress requires approved funding.
    - Approved funding is dependent upon the demonstration of progress.
19. A program in this position can easily fall into a circular trap and quickly lose the confidence of those recommending and approving following stages. The program leadership team can make or break the outcome (Point 17 applies).
20. The value of a developmental high-risk program, such as the Anzac ASMD Program, grows a national capacity to succeed over and over again … if we both enable it and recognise the value to the nation.
21. Never ever give up. Persistence above all else will most likely win out.

Ian Croser says:

> I would like to thank both the supporters and the detractors of the program, as they both contributed significantly to the outcome. The former gave us the encouragement when we most needed it; and the latter gave us the drive to succeed. The success hopefully makes the detractors a little less so next time.
>
> The ASMD success is of course the product of many individual and company efforts, too many to name, but the team at CEA has done, and continues to do, incredible things.

Notes

1 Interview with the author, April 2017.
2 Interview with the author, March 2017.
3 Interview with the author, March 2017.
4 Report to the Minister for Defence on Collins Submarine and Related Matters, June 1999
5 *7.30*, ABC TV, 19 August 1999
6 Interviews with the author, March–May 2017.
7 Interview with the author, March 2017.
8 Interview with the author, April 2017.
9 Evidence given to the Foreign Affairs, Defence and Trade References Parliamentary Committee, 3 July 2006.
10 Jervis Bay was conceived as a port for the Australian Capital Territory and transferred from New South Wales to the Commonwealth in 1915.
11 Interview with the author, 21 April 2017.
12 Interviews with the author, March–April 2017.
13 Interviews with the author, March–April 2017.
14 It was better known outside Canberra as a source of pornographic films and literature, as well as the site of a range of 24-hour brothels. Indeed, it was the birthplace of the Australian Sex Party co-founded by Fiona Patton and Robbie Swan. Ms Patton conducted annual guided tours through selected brothels for all comers. However, with the spread of internet pornography, Fyshwick has taken on a more respectable air. Fiona Patton has relocated her Sex Party to Victoria, where in 2014 she was elected to the Legislative Council.
15 Interviews with the author, March–April 2017.
16 Interview with the author, April 2017.
17 Interview and correspondence with the author, May 2017.
18 Interview with the author, April 2017.
19 Interview with the author, April 2017.
20 Interview with the author, April 2017.
21 Interview with the author, April 2017.
22 Interviews with the author, April 2017.
23 Gregor Ferguson, Daniel Cotterill, Tom Muir, editor and senior writers of *Australian Defence Magazine*, 'Section 8—Top 24 Projects 2004', *The Cost of Defence: ASPI defence budget brief 2004–2005*, ASPI, Canberra, online.
24 The capital letters are in the original: DST Group, www.dst.defence.gov.au/.
25 Email from Ian Croser, 25 April 2017.
26 Evidence to the Foreign Affairs Defence and Trade References Committee, July 2006.

27 Correspondence from BAE to author, May 2017.
28 Defence Department, *Annual report 2008–2009*, Volume 2, Chapter 3.
29 Interviews with the author, March–April 2017.
30 Interviews with the author March, April, May 2017.
31 Telephone interview with the author and James Mugg, May 2017.
32 Interview with the author, April 2017.
33 Interview with the author, May 2017.
34 Telephone conversation with the author, May 2017.
35 As quoted by Kym Bergman in *Anti-ship missile defence impressive progress*, Asia Pacific Defence Reporter, March 2013.

Acronyms and abbreviations

ADF	Australian Defence Force
ADFA	Australian Defence Force Academy
ASMD	anti-ship missile defence
AUSPAR	Australia US Phased Array Radar
DGMD	Director General Maritime Development
DMO	Defence Materiel Organisation
DSTO	Defence Science and Technology Organisation
ESSM	Evolved Sea Sparrow Missile
HCS	Head of Capability Systems
HVU	high-value unit
PAR	phased array radar
PMRF	Pacific Missile Range Facility
RAN	Royal Australian Navy
VSRAD	a very short-range air defence
WEEO	Weapons Electrical Engineering Officer
WIP	Anzac Warfighting Improvement Program

ASPI Case Studies

ASPI case studies in defence projects is a series dedicated to telling the 'warts and all' stories of major undertakings in Australian defence procurement and project management. The 'dates and dollars' of defence projects are available in reporting from Defence and the Australian National Audit Office, so this series explores the less quantified but nonetheless crucial aspects of project management—the organisational, human and technological challenges that occur along the way. ASPI hopes that future project managers will be able to turn to this series to see how their predecessors dealt with the problems they faced, and be able to see how outcomes—good or bad—were shaped by events along the way.

Rearming the Anzacs is the first in the series, and tells the story of how the air defence systems on the Royal Australian Navy's Anzac-class frigates were upgraded to be among the best in the world. It's a story that ultimately turns on taking an innovative Australian idea—the CEAFAR radar—from a gleam in a naval engineer's eye through to a deployed system that can down multiple inbound supersonic missiles. It is a story with a happy ending—not always the case with defence projects—but it was not always a happy journey. Author Robert Macklin describes the ups and downs and the eventual success of the project.

The next book in this series will tell the story of the Bushmaster protected mobility vehicle—another Australian product, which has proven its value in saving the lives of defence force personnel in Afghanistan.

Robert Macklin

Robert Macklin is one of Australia's most respected and popular authors of Australian history and biography.

His four novels and twenty-three books of non-fiction have won many prizes including the prestigious $30,000 Blake Dawson award for his history of BHP Billiton, *The Big Fella* in 2009. His controversial history of Norfolk Island, *Dark Paradise* in 2013 won the Canberra Critics Circle award for the best book of the year, as did his *One False Move*, the story of four Australian naval officers who travelled to Britain in WWII and volunteered to defuse the massive German parachute mines being dropped on English cities and ports.

He is the authorised biographer of former Prime Minister Kevin Rudd and prior to the bestselling *Hamilton Hume* he has written three biographies of SAS soldiers and the authoritative history of Australia's Special Forces and intelligence agencies entitled *Warrior Elite*.

His new work *Dragon and Kangaroo*, the hidden history of Australia–China relations was published in August 2017.

Born in Queensland and educated at Brisbane Grammar School, the University of Queensland and the ANU, he has been a jackaroo, a leading journalist, documentary film maker, university lecturer and in government the press secretary to an Australian Prime Minister, Sir John 'Black Jack' McEwen. He lives in Canberra and Tuross Head with his wife, Wendy.

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Canberra, 2017
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