The Bushmaster

From concept to combat

Brendan Nicholson

ASPI
AUSTRALIAN STRATEGIC POLICY INSTITUTE

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Cover image: Bushmaster protected mobility vehicles from 2nd Battalion, Royal Australian Regiment travel in convoy during a patrol at Shoalwater Bay Training Area in North Queensland during Exercise Talisman Sabre 2017. Photo: Australian Department of Defence, online.

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Preface

Brendan Nicholson's account of the Bushmaster protected mobility vehicle is the classic story of the ugly duckling—an 'armoured Winnebago'—transformed swan-like into the vital lifesaver for Australian and Dutch troops on combat operations in Afghanistan. It was never designed to play that role. Based on South African and Rhodesian experiments with landmine-blast-deflecting V-shaped hulls, the Bushmaster was first conceived as a lightly armoured truck. In 1980s 'Defence of Australia' planning, the Bushmaster would move troops around the vastness of northern Australia pursuing 'thugs in thongs' bent on harassing locals.

Nicholson shows that it took a long time for the Army to come to love 'this massive thing' that wasn't intended to be a fighting vehicle, which was originally sold to government as a simple off-the-shelf acquisition but in fact became a complex development project pushing industry and Defence into new and more productive relationships. Indeed, 'The Bushmaster's capability wasn't fully appreciated until it was in action,' Nicholson argues, and by then it was seen to be a defining reason why so many Australian soldiers survived improvised explosive devices (IEDs) while so many British and American lives were lost. 'Great equipment saves lives,' a British Army officer sadly recalls. 'Soldiers under my command paid the ultimate price' for want of great equipment.

Viewed as a case study of Australian defence equipment acquisition at work, this account of the Bushmaster in development and then in combat on operations offers deep insights based on multiple interviews with people intimately involved with the vehicle. An Army officer confides to an industry mate: 'I can't build without you, and you can't succeed without me.' A cheaper off-the-shelf overseas buy would not have given Australia the flexibility to adapt the Bushmaster to changing enemy tactics in Afghanistan. Indeed, the way industry, the Army, Defence scientists and others worked so quickly and effectively together to harden the Bushmaster against ever more devastating IEDs is a model of the 'fundamental input to capability' idea that promotes innovative work between Defence and industry.

'It's going to be either a complete failure or an absolutely outstanding success,' was how one early participant described Bushmaster. This is the inspiring history of how a project that was almost killed for want of a sponsor came to save the lives of hundreds of Australian and Dutch soldiers.

My thanks go to Tony Fraser, the Head of the Capability Acquisition and Sustainment Group in the Department of Defence, for his continuing support of ASPI's series of case studies in defence capability.

Peter Jennings, Executive Director, Australian Strategic Policy Institute

Prologue: Ambushed in Afghanistan

On a spring afternoon in April 2006, a convoy carrying Australian and Afghan troops grinds up a dirt road near the village of Kakarak in Afghanistan's Uruzgan Province. They're searching through the lush fertile zone at the base of a valley framed by towering brown mountains that march off towards the Hindu Kush.

The line is led by a six-wheeled Land Rover long-range patrol vehicle driven by soldiers from Australia's Special Air Service Regiment (SASR) as it heads deeper into the West Dorafshan district—a Taliban insurgent stronghold.

The end of the harsh Afghan winter has signalled the start of the fighting season, and this is an uncomfortable place to be. The soldier manning the patrol vehicle's 50-calibre machine-gun warily scans the high ground above the road for signs of an ambush.

The SASR contingent is followed by a mix of vehicles carrying Afghan troops and more Australians. At the rear are three nuggety armoured troop carriers—Bushmasters—crewed by Australian commandos. The Bushmasters are new to the Army, and to the theatre, and the commandos of the 4th Battalion, Royal Australian Regiment (4RAR) are wary of them. They enjoy the situational awareness that comes with their wide-open Land Rovers and they're concerned that they'll lose that awareness in the confines of the Bushmaster. 'It seemed very big and put us in a box or a cage where we couldn't really react to situations,' says a commando on that patrol. He was a combat medic then and he can't be identified because he's still serving in the special forces. 'We thought: what's this massive thing? I'm not going in that—everyone will shoot at it.'

The road convoy carries 30 Australians, SAS and commandos, and a 50-strong unit from the Afghan National Army, which the Australians mentor. The convoy includes the patrol vehicles, and four- and six-wheeled off-road motorbikes.

It's close to 3 pm when explosions and long bursts of gunfire erupt from above them. The Taliban ambush the convoy from positions on a mountainside, high over the road, with rockets and AK-47 assault rifles and their old but deadly Russian Dushka heavy machine-guns. As they pour a barrage of rockets and gunfire down onto the soldiers below, the Taliban fighters concentrate on the soft-skinned lead vehicle, deducing from its array of aerials that it's the command car. That's a practice the older among them learned as mujahidin fighting the Russians decades before: hit the command and control vehicle first.

The SASR machine-gunner is hit in the side by a bullet passing between the front and rear plates of his body armour and through his stomach. He collapses to the floor of the patrol vehicle, which is badly damaged and immobilised.

The rest of the convoy fights back, aiming up into the Taliban positions, but the Afghan fighters' main target remains the stricken patrol vehicle. As the call goes out on radio that the gunner is down and badly wounded, other Australians try to reach him on foot but are quickly pinned down by fire coming from multiple directions, above and on their flanks. The commandos in the Bushmasters at the rear of the convoy know someone is badly hurt but they don't know where he is.

Sergeant N, who commands one of the Bushmasters, calls out to the medic: 'Mate, do you want to grab your kit and go to help him?' The medic calls back that he's ready and 'just get as close as you can'. The commandos will later describe the volume of fire from the Taliban as 'impressive'.

The vehicle commander drives the Bushmaster forward to block the fire from hitting the smashed-up SAS vehicle that's still the Taliban's main target.

With that protection, the medic climbs out through the rear doors and searches for the wounded man. He's able to haul him upright and then to drag him onto a sheltered piece of ground. Other vehicles in the convoy are in trouble, so the Bushmaster moves along the line of vehicles, in the words of those who saw it, 'soaking up the rounds' to give their crews an opportunity to regroup. 'It gave the enemy something large to shoot at that was capable of taking it,' says the medic. By then he's revising his sceptical view of the chunky vehicle's value.

When the Bushmaster returns to the shot-up patrol vehicle five minutes later, it stops with its rear doors facing the wounded man and the soldier who's trying to stabilise him. The medic has tied up the wound as best he can. The convoy commander, SASR Captain N, who was in the patrol vehicle, manoeuvres his men to reduce the weight of incoming fire. Just above their heads comes 'grazing' fire from a machine-gun cutting back and forth at ground level, seeking them out and stopping them moving. They prepare to put the wounded man into the Bushmaster, but every time they put their heads up, they're shot at.

At one point, the wounded SASR trooper asks: 'Is it bad?' The medic responds, 'Well, I'm glad it's on you and not me,' and the soldier, he says, 'has a bit of a laugh'.

Told that the men are pinned down, Warrant Officer B from the SASR sends the other two Bushmasters up to further shield the party from the machine-guns.

The medic drags the wounded gunner into the back of his vehicle. There, he and another commando work on him until the Bushmaster reaches a site safe enough for a rescue helicopter to land. The shooting continues until darkness falls, and then the convoy returns to Camp Russell at Tarin Kowt. The grievously wounded SAS trooper survives and will eventually return to the regiment.

By the time they're back in their base, the commandos' scepticism about the Bushmasters has vanished, says the medic. 'Without them, a lot of people on that job would be dead.'

The soldiers who emerged from the ambush were indeed impressed by the strength of the Australian-designed and -built 'Bushie', but they had no idea then that the sturdy vehicle nearly didn't make it into production.

The Bushmaster's uncertain start

The Bushmaster protected mobility vehicle (PMV) is now well known in militaries across the world because of its ability to safeguard soldiers against the massive threat of landmines and improvised explosive devices (IEDs). In Iraq and Afghanistan, it saved the lives of hundreds of Australian and Dutch troops.

But the story of how this extraordinary vehicle was created and how it reached those battlefields is complex and little known. Also little known is the way the battlefield experience of the troops using the Bushmaster was fed back to those running the production line and used to upgrade 'Bushies' already in theatre.

A key to the Bushmaster's success is its wedged or V-shaped hull, which deflects the impact of an explosion blasting up from beneath it. That innovation came out of wars fought in southern Africa from the 1960s through to the 1980s.

Australian troops on peacekeeping missions in the Middle East and in nations such as Namibia and Cambodia saw both the devastating impact of landmines on the occupants of soft-skinned vehicles and the effectiveness of vehicles designed to combat them. The peacekeepers brought home with them insights that, much later, informed the Australian Defence organisation's planning for the Bushmaster project.

The idea that the Army must have a large number of lightly armoured and versatile troop carriers flowed from requirements in the 1987 defence white paper, *The Defence of Australia*, which had a strong focus on a need for troops to move quickly against small groups of foreign raiders who might land in the north.

It was assessed that such raiders would arrive lightly equipped and aim to capture materials to build IEDs, which were later to become ubiquitous in Iraq and Afghanistan.

Despite its promising beginnings, the project was troubled from its approval in the late 1990s to a near-death experience in 2002. Many soldiers deeply resented the white paper's shift in the Army's role from an expeditionary force to one they saw as tasking it with mopping up the survivors of invaders who would have been largely destroyed by the RAN and the RAAF. Even after its early operational success in Iraq and Afghanistan, the Bushmaster was to be haunted by its association in many of the Army's minds with the 'Defence of Australia' (DoA) strategy as well as with big cuts to the service's size, funding and role in the years after Vietnam. Some argued that anything with four wheels and no tracks was a truck and was not to be taken seriously; anyway, its tyres would be chopped to pieces by the rocky Top End terrain.

But countering the naysayers were key military figures who were convinced from their own experience that troops would need this level of protected mobility in wars and peacekeeping operations to come. Among them was Lieutenant General John Sanderson, who commanded UN forces in Cambodia—a nation strewn with landmines. Sanderson saw at first hand the devastating impact of explosives on soft-skinned vehicles and the extent to which those simple devices could limit an army's ability to manoeuvre. Sanderson was Chief of Army from 1995 to 1998.

General David Hurley was chief of the ADF's Capability Development Group from 2003 to 2007, Chief of Joint Operations from 2007 to 2008, Vice Chief of the ADF from 2008 to 2011 and Chief of the Defence Force from 2011 to 2014. Hurley had commanded Australia's peacekeepers in their Somalia mission, which lasted from 1992 to 1995.

Lieutenant General Ken Gillespie, who was Vice Chief of the ADF from 2005 to 2008 and then Chief of Army from 2008 to 2011, was deputy commander of the Australian peacekeeping contingent that served in Namibia from 1989 to 1990. He saw the effectiveness of South African-built mine-proof vehicles obtained for the peacekeepers by the UN.

General Peter Cosgrove headed the International Force East Timor (INTERFET) in 1999 and 2000, when two Bushmaster prototypes were deployed to provide secure transport for local and visiting VIPs. He became Chief of Army in 2000 and was Chief of the ADF from 2002 to 2005.

Lieutenant General Peter Leahy was Deputy Chief of Army from 2000 to 2002 and then Army chief from 2002 to 2008, covering the time of the Bushmaster's first major operational deployment.

Air Chief Marshal Angus Houston put in a long stint as Chief of the Defence Force from 2005 to 2011. As the impact of the escalating bombings in Iraq and Afghanistan hit home, he stepped up efforts to protect the personnel under his command. Force protection in Afghanistan was a high priority of Defence Minister Senator John Faulkner and, in July 2009, as the rate and intensity of IED attacks increased, Faulkner asked Houston for a review of the effectiveness of force protection measures for deployed personnel.

Recommendations included improvements to the protection and firepower of the Bushmasters. That included the addition of electronic countermeasures to prevent bombs being triggered electronically by freezing signals to the devices. Some vehicles were fitted with 'self-protection adaptive roller kits', known to the troops as 'SPARK rollers', to set off explosives ahead of them.

In 1995, government-owned Australian Defence Industries Limited (ADI) was one of three companies short-listed to compete to build the new troop carrier on the basis of a prototype vehicle, which did not yet have the V-shaped hull. Feedback from the Army was that, without this innovation, the Bushmaster would not survive the size of blast set as a benchmark for the new troop carrier. Rapid redesign produced the vehicle that's now in service.

Even then, building a prototype proved to be a world away from creating the high-quality production and reliability systems needed to move on to full-scale production and in-service support. That's where the project came close to stalling. It became painfully clear that both Defence and ADI, which had won the contract in June 1999, had underestimated the scale of the challenge in those fundamental areas.

In December 2001, the senior Defence team charged with oversight of such programs, the Defence Capability and Investment Committee, wrote to Defence Minister Robert Hill, recommending that the project be abandoned.

Hill shared the committee's concerns about the project running late and well over budget but says he was persuaded by the Chief of Army, Lieutenant General Peter Cosgrove, to keep it going because troops in future wars would need a high level of protection.

In parallel with this turmoil in the project, events in the real world created a desperate need for a vehicle such as the Bushmaster. Tragedies in Iraq and Afghanistan showed the vulnerability of troops, even the most capable special forces, when operating soft-skinned vehicles against insurgents with the technical know-how to build IEDs and the tactical skill to employ them well.

The death on operations of special forces sergeant Andrew Russell in a mine blast in February 2002 provided critical confirmation of the need for better protection of ADF personnel against big landmines and the emerging IED threat. A Bushmaster-type vehicle was the logical solution to this urgent operational need—there was nothing else readily available on the world market. US troops in Iraq were welding additional steel plates onto their own poorly protected vehicles.

The contract was renegotiated and signed in July 2002. From there, the path became both smoother and more urgent, driven by operational need. The first Bushmasters were delivered to ADF units in mid-2005, and the 1,000th in about September 2015. Along the way, others went to orders from allied nations.

Ultimately, the Bushmaster proved itself a lifesaver in combat and vindicated those who had faith in it.

The origins of Project Bushranger: 'thugs in thongs'

> *The Army's structure must include highly mobile forces capable of rapid deployment anywhere within Australia and its territories. The ground force must be able to conduct protracted and dispersed operations in harsh terrain, where the existing infrastructure and resources are sparse, and be logistically supportable within Australia's resources.*
>
> — The Defence of Australia, *1987 defence white paper*

* * *

The policy seeds that ultimately produced the Bushmaster were planted in the Hawke government's 1987 defence white paper, *The Defence of Australia*, which raised the possibility of small groups of foreign troops landing in the country's north and identified the need for ADF ground forces to be given the mobility and speed to find and deal with them. The paper assessed that Australia faced no identifiable military threat, except for the remote possibility of global war. It said no regional country had the capacity, or the motivation, to sustain high-level military operations against us. But Australia might be vulnerable to a low-level campaign of harassment by enemy forces.

The DoA strategy said the Army had to have highly mobile and fast-moving ground forces capable of rapid deployment anywhere within Australia and its territories so that, should any hostile forces land, they'd be intercepted. This mobile land force had to be able to defeat hostile incursions at remote locations and take offensive action against an adversary's troops and, with other force elements, protect other areas of our military and civil infrastructure and population. Vital defence installations and isolated national infrastructure would have to be defended.

Mobile ground forces had to be able 'to defeat hostile incursions at remote localities and protect military and infrastructure assets that support the projection of our maritime power'. The white paper also said there was a need for 'ground force surveillance of our northern areas against the prospect of an adversary's raiding forces crossing the sea and air gap and conducting operations on the Australian continent'. This scenario was moderated by the observation that 'Any land forces that were to elude Australian opposition and overcome the maritime obstacles would find themselves in a harsh and inhospitable environment.'

The broad idea that the Army might have to fight invaders on home ground was refined in the Force Structure Review published in May 1991, which warned that

the ADF could be required to respond to land incursions across the north, from the Pilbara to north Queensland, and that the number of locations that would need to be defended was well beyond the capability of the existing Army to protect. While some facilities would have hardened defences and forces in position, others would rely for protection on highly mobile combat forces. To provide the necessary mobility, a new tactical troop carrier was needed to replace the army's M113A1 tracked armoured personnel carriers.

Out of the review came Project Bushranger (LAND 116), with the initial task of providing an interim fleet of unprotected vehicles to improve the mobility of the Army's infantry brigades and to give them 'motorisation' experience. Those would eventually be replaced with a still to be designed and built lightly armoured transport vehicle able to protect the troops from mines and machine-gun fire.

In the years that followed, ADF personnel on exercises were tasked with tracking down and destroying bands of enemy troops from the mythical nation of Musoria—described more colloquially by diggers as 'thugs in thongs', and by less repeatable rhyming tags.

The 1994 defence white paper, *Defending Australia*, maintained the DoA idea—that Australia might need to defend itself on its home soil. It said new land force vehicles would be required to give greater mobility and better protection to personnel and that 'a lightly armoured transport vehicle will be acquired to provide mobility to infantry brigades.' This white paper went on to say that the Army's trucks would be replaced early in the next decade: 'These projects will be managed to provide opportunities for Australian industry and reduce subsequent through-life costs, including adopting civil standards to the maximum extent practicable.'

Therein lay one of the problems that was to haunt Project Bushranger. The view developed strongly that, if most of the components of this new armoured troop transport were bought commercially and assembled in Australia, then it would amount to an 'off-the-shelf' purchase. That dramatically underestimated the complexity of turning a collection of truck parts, even the best commercially available, into a state-of-the-art armoured vehicle able to resist the blast of an anti-tank mine or an IED and capable of preserving the lives of the troops inside it while being driven through an ambush.

Another issue was the extent to which the DoA focus on possible operations on home soil conflicted with the view of many in the Army that they'd be more likely to continue fighting enemies far away, as Australian forces had done for over a century.

In examining why there was such antagonism within the Army to the DoA policy and, by association, what was to become the Bushmaster project, retired Major General Peter Abigail says that, at its base, the strategy had a strong logic to it: 'You can't argue with the fact that the primary task of a defence force is to defend your territory.'

Abigail says his central concern about DoA wasn't the policy itself: 'I understood what the government was on about. They had to give themselves some parameters within which to pursue the reforms they were doing elsewhere and saving money in Defence for a time.' But it was the rigid application of it in Defence that closed off people's minds to realities, and that was at the heart of the Army's frustration.

'The problem Army experienced was in the way the Defence bureaucracy and some ministers rigidly applied the limitations they construed out of the policy statement to the exclusion of anything that couldn't be found written as a sentence, paragraph, or whatever, in that 1987 defence white paper,' says Abigail, who was Deputy Chief of Army from 1998 to 2000 and Land Commander Australia from 2000 to 2002.

> That's where we ended up with lots of separation between policy and the reality of what we'd always been doing throughout our history. So within Army there was certainly a fundamental concern about the way in which DoA was used by bureaucrats, particularly in Defence, to limit what the services could do.

Abigail recalls discussions about the extent to which the policy would limit the Army's traditional activities:

> Deep in our Army psyche was a view that we're not going to sign on to this because we know in our bones that whatever we will be doing, we'll be going somewhere else, and we need a structure that allows us to do that. We used to talk about deploying the land forces to the north of Australia to look for shade.

Countering that came assurances that the structure being built to meet the DoA requirements would provide all of the options the Army would need to go offshore. 'Well, we were within 12 months of proving that wrong,' says Abigail. A lack of deployable logistics was going to be the Army's Achilles heel.

The Army was very conscious that Australia was so physically large that travelling and fighting within it would require what was effectively an expeditionary capability. 'Any time we went on operations, whether it was DoA or overseas, we would have to have an expeditionary capability because there's next to nothing where you're going and you must take it with you,' says Abigail. 'You might go to the Kimberley, you might go to the Pilbara, but you can't expect the local baker and butcher to feed you. It's not going to happen.' As it turned out, the view that the Army had to be expeditionary wherever it was going to be deployed, including in the north of Australia, started to gain traction.

The biggest risk was the cutback in logistics, including deployable logistics capabilities. If the East Timor intervention had happened a year later than it did, the Army would have had great difficulty making the deployment, says Abigail. He remembers a long committee meeting focused on how more cuts could be made

to Army spending to fit within the overall defence budget. The official in charge did his sums and told those gathered that they were a couple of million dollars short. The collective response was to make more big cuts to Logistics Command.

Abigail says there's sometimes a drive to produce equipment without a clear concept being developed to define what that piece of kit is supposed to do: 'In a way, the Bushmaster fits into that bag. It was learn as you go.' While the intention was to provide the new vehicle to the infantry, in reality, everyone moving around a battlefield needs protected mobility.

Former Army officer Grant Sanderson says some of the problems that confronted the Bushmaster emerged because the Army had long viewed the DoA policy as a way to deprive it of money and structure at a time when its manpower and resources were being cut: 'The Bushmaster got caught up in it. It's where a lot of the negativity came from in the Army, and I remember being quite negative about it as well.'

Sanderson says that, in retrospect, many in the service lost sight of the fact that Bushmaster was a good program in that it fitted into strategies and narratives that were very useful in ensuring that the Army got money, new equipment and capability it could then use overseas if it had to go: 'All they saw was a truck being foisted on us instead of a combat vehicle.'

He muses that if an Army commander had gone to a committee in 2000 or early 2001 and said that a vehicle was needed to keep soldiers alive in an IED-infested environment in the Middle East, he would have been kicked out of the room.

By then, distaste for the Bushmaster project had reached a point where a team within the Army worked on finding an alternative to it. That group, jokingly referred to as the 'Kill Bushmaster Task Force', had a strong preference for buying more Australian light armoured vehicles (ASLAVs). The Canadian-built vehicle had eight wheels, compared to the Bushmaster's four, and it was more mobile across country. With its turret and a powerful cannon, the ASLAV was also designed as a fighting vehicle, and the Bushmaster wasn't.

But Canadian forces in Afghanistan were to lose many soldiers killed and wounded in their 'LAVs', which offered poor protection against IEDs and landmines. 'If we'd only ever had ASLAVs in Iraq and Afghanistan, we would have been right royally screwed,' says Sanderson. 'We would not have been able to protect ourselves—the Canadians are a classic example.'

Sanderson says the Army saw itself very much as the poor beggar inside Defence at that stage and considered Bushmaster a symptom of that: 'It wasn't until it deployed to Iraq in 2005, when everybody else was getting blown up and we had this fantastic capability, that the whole attitude started to change and people realised "We've really got something".'

Soon after that, the Bushmaster was deployed to Afghanistan. Sanderson believes that if the vehicle had not been available, the ADF's mission in Afghanistan would have been over by 2010. At one point, the Americans were suffering almost 1,000 casualties a month, killed and wounded, most of them by IEDs. 'There's no way we as a country would have tolerated that,' says Sanderson.

Despite many bombings, no Australian soldier died in a Bushmaster. While 41 Australians were killed in Afghanistan, the numbers would have been much higher without the vehicle. At what point would public patience and political will have run out?

A respected defence strategist with more than 30 years' experience on the civilian side of Defence, including as Chief Defence Scientist, Dr Richard Brabin-Smith, says that, while cuts to budget allocations are not pain-free, nor always well judged, he's not aware of any systematic plot to bleed the Army of resources.

Brabin-Smith says the post-Vietnam arguments that led to the conclusion that the ADF should focus on DoA were based on hard-nosed geostrategic considerations, and the election of Gough Whitlam's Labor government in 1972 served to give this new policy extra momentum:

> Further, at a time when there was no obvious threat, the defence budget was under severe pressure—it always is when hostilities cease—and there was a need for a conceptual framework within which to argue both within the broader machinery of government and within Defence itself for levels of funding and their subsequent allocation to defence capabilities.

That need was met by the idea of the 'core force and expansion base'—a concept originated by Gordon Blakers, the Deputy Secretary of Defence at the time and a much-revered figure, Brabin-Smith says. The force-in-being would be able to handle lesser contingencies that could occur with little warning. The expansion base would be the custodian of those military skills and capabilities that would be necessary in larger numbers in the event of a significant deterioration in Australia's strategic circumstances over the longer term.

Such policies necessarily give prominence to maritime capabilities, says Brabin-Smith: 'Setting aside the issue of the aircraft carrier, we see that in the early 1980s this is what happened with the decision to acquire the more capable F/A-18 over the F-16, and the headline characteristics of what became the Collins-class submarines.'

Other policy observations at the time embraced the facts that there were limits to Australia's military power and influence, and that our contributions to military campaigns led by others further afield would tend to be valued more for their political significance than their warfighting effect. Further, whether to be involved

in such campaigns would be discretionary, as would the nature and extent of Australia's contribution. Also, the size of armies that countries in our region might aspire to was, by virtue of their larger populations, much bigger than we could contemplate.

This policy framework gave little cheer to the more ambitious members of the Army, says Brabin-Smith: 'Bottom-up proposals for higher levels of capability would usually founder on the reefs of policy-led interpretations of government policy. Let's remember that governments have the key role in setting policy.'

While the Bushmaster emerged from an Australian project at a time of intense policy debate, its DNA contained echoes of wars past and campaigns on continents far away.

And, ultimately, it faced a reality very different from what was envisaged—not a conflict fought on the red soil of northern Australia but a series of brutal battles and running fights in Iraq and Afghanistan.

The beginnings

> *The ADF could be required to respond to land incursions across the north, from the Pilbara to north Queensland. The form of such responses will depend on the nature of the incursions and the extent to which Australian interests are affected by them. It is necessary, however, to have more, readily available, rapid response forces based in the north both to deter and to counter more immediate threats. [Accordingly, the Army should] develop proposals for a new infantry mobility vehicle to support independent brigade group operations.*
>
> *— 1991 Force Posture Review*

* * *

When the Army was required to prepare its troops to track down and destroy insurgents across the sprawling Top End of Australia, it went back to the very basics to work out how to get the troops there. And the first option considered was not necessarily a land vehicle. Ideas bounced around ranged from using the RAAF's fleet of C-130 Hercules transport aircraft to co-opting trucks or buses.

Defence teams talking through the broad scenario for the DoA set about finding a way for the Army to deal with groups of raiders who might be at large and causing trouble in the north. The first issue was to get troops from their base in Townsville to where the enemy was likely to be—probably as far away as Karratha in the northwest of Western Australia—and to do that in two or three days with enough supplies of food and ammunition for an initial contact.

That might have to be done in the wet season or the dry, by air, and by road in trucks or buses. Rail wasn't an option because there was no such link.

Moving such a force by air was not likely to be an option because it would tie up all of the RAAF's transport aircraft, which were likely to be busy elsewhere in such an emergency.

In January 1996, Vietnam veteran Lieutenant Colonel Warren Feakes was assigned to manage the first stage of Project Bushranger and given a small team to work up a concept—basically, how to get troops across the Top End to deal with an incursion by enemy fighters.

Feakes says the team decided 'on the back of an envelope' that what was needed was a troop carrier able to transport a section of fully equipped soldiers and enough food, fuel and other supplies to keep them going for three days: 'It needed to be able to do 1,000 kilometres without refuelling, at 100 kilometres an hour, keep it up

for days on end and arrive at its destination able to disgorge its infantry fit to fight.' And it needed to be able to protect those it carried from very big landmines and improvised bombs.

They decided that, in the unlikely event of such an invasion, the attackers would most likely be special forces intent on disrupting the ADF's lines of communication.

To work out how the attackers would be likely to do that, Feakes contacted a member of the SASR he'd studied with at Duntroon. They surmised that such invaders wouldn't be able to bring a lot of equipment with them and would aim to take materials such as fertiliser and diesel from small towns or farms to make bombs that could be packed into five-gallon or 20-litre containers.

Feakes then rang a colleague at the ADF's Proof and Experimental Establishment at Port Wakefield in South Australia, where he'd been the commanding officer, and asked a munitions specialist there to pack a 20-litre container with 'ANFO' (ammonium nitrate, fuel oil), set it off and measure the 'net explosive quantity' of the mix.

They calculated from that that a 20-litre drum of ANFO could produce an explosion equivalent in intensity to that produced by 9 kilograms of TNT. It was concluded that the vehicle needed to be able to withstand a blast equivalent to that of at least 9 kilograms of military explosive.

Feakes travelled to the US, Canada, Germany, France, Israel and South Africa looking for a suitable vehicle. On an earlier trip to South Africa, he'd been told about the Buffel (Buffalo), a mine-proofed vehicle that was basically a box with a V-shaped bottom on the chassis of a Unimog truck. It was the first mass-produced version of an effective mine-resistant, ambush-protected (MRAP) troop carrier on operations. On his fact-finding tour, the most suitable option Feakes found was, in fact, in South Africa, where a local company offered to build Australia a larger version of a vehicle it called the Taipan. He also visited the Irish company Timoney Technology Ltd which integrated gearboxes and transmission systems for rugged-use vehicles.

Feakes, who'd been a forward observer with the infantry in Vietnam, says his team was aware that it was designing a vehicle that was not intended to fight but that had to be able to survive in a fight. 'The armoured corps and the operational analysis people would not let it fight,' he says. It was to carry the infantry in much the same way as the Light Horse were carried on their steeds. There'd be one bloke left behind to mind the horses while the rest of the section went forward to fight the battle. With the horses would be extra ammunition and extra food: 'That was the Bushranger concept … where the Bushmaster grew from.'

The vehicle envisaged by the Bushranger team could get the soldiers into position fed, rested and refreshed, even in very hot climates:

> At first, a lot of people in the infantry said they didn't want these vehicles because their job was to be dropped in a place from where they would walk and patrol. We gradually won over a whole bunch of them, but some people from the Armoured Corps hated it. The ASLAV operators feared the Bushmaster would replace their fast, light, armed reconnaissance vehicles.

An Army favourite was the ASLAV—an eight-wheeled amphibious armoured vehicle from Canada fitted with a powerful cannon and used for reconnaissance and surveillance missions.

Consequently, the team was warned to be careful with the new vehicle's designation. It wasn't an infantry combat vehicle; it wasn't a fighting vehicle; it wasn't a reconnaissance vehicle. It was an infantry mobility vehicle.

Years later, in December 2007, Peter Leahy, by then Chief of Army, redesignated the Bushmaster infantry mobility vehicle as a 'protected mobility vehicle'.

Project Bushranger came in two major stages. The first was to equip a unit with hundreds of Perenties (a Land Rover derivative) to develop and practise mobility concepts. The Perentie took its name from a giant Australian goanna.

As that was being done, the decision was made to launch the next stage of Project Bushranger by inviting companies to show their interest in tendering to build the new armoured troop carrier.

The contest begins

A team at Perry Engineering in Adelaide built the first model in about six months from mild steel and named it the 'Bushmaster'. With a massive engine, there wasn't a lot of space to work under the bonnet, so the motor was designed to be easily disconnected from the fuel and cooling systems and its transmission and lifted out with a crane.

* * *

Bob Roach is a retired engineer who, now in his 80s, makes radial engines for aircraft as a hobby. In the 1990s, he was based in Adelaide and employed by Perry Engineering, designing and manufacturing a system for unloading heavy pallets from the RAAF's Hercules transports on bush airstrips.

In June 1994, the Defence Department launched the second stage of Project Bushranger and invited expressions of interest from manufacturers who could design and build the vehicle required under the project. It had to be sturdy enough to protect troops from mines and small-arms fire.

A contact in the Army told Roach about the upcoming contract and suggested that Perry Engineering should bid for it. There were mixed views within the company on whether or not to enter the contest. 'I wanted to do it, but some were opposed,' says Bob. He felt the company could handle the job easily. He also understood that management wanted to sell off the Perry Engineering arm. Eventually, he says, management agreed to make a prototype because it would be a good plum to help sell the company.

From the start, the Perry engineers were very conscious that they were designing a vehicle to protect Australian soldiers. 'A terrorist could buy an AK-47 for $25, pick up a couple of landmines and a pocketful of bullets and he's a lethal weapon,' says Roach. 'If we didn't get it right, he could kill a vehicle with 10 of our people in it.' They were conscious, too, that they weren't building a tank: 'It was to be a taxi, a protected vehicle to get troops from A to B—to keep them safe while they went out on patrol. It wasn't an armoured vehicle with a big gun on top.'

The first prototype was to be basically an armoured box on wheels. Out in the desert, the temperature could get to 50°C, so the vehicle had to be air-conditioned and have cold water on board. It had provisions for about three days and enough fuel to travel 1,000 kilometres.

Roach had a Ford Falcon at the time, and he measured the car's seating and steering set-up when researching the Bushmaster. 'When you sit in a Bushmaster, it's as comfortable as sitting in a Falcon,' he says. The American firm Stewart and

Stephenson made trucks for the US Army, so the designers of the original Project Bushranger vehicle adopted the same system of engine, transmission and other parts for their new vehicle. Some of that changed later. 'We thought we'd be in with a better chance in the competition if we had a proven powertrain,' says Roach.

The Irish company Timoney Technology assembled very effective drivelines and suspension systems for off-road vehicles and provided a specialist drafting team to the project.

The first plates for the Bushmaster were cut and the pieces were welded together at the factory in Mile End where the company had, long before, built locomotives.

Bob Roach's team had an isolated section they called 'The Garage', and that's where the Bushmaster was assembled. The first stage was to weld the plates together into a box, and that was done in the workshop: 'It was kept a little bit secret, which was what we wanted.'

In September 1996, Perry Engineering sold the intellectual property rights to Roach's Bushmaster design, along with intellectual property from Timoney and Perry's option to compete for the right to build the vehicles, to government-owned ADI.

The Perry Bushmaster was redesigned later at the ADI plant in Bendigo. 'But,' says Bob, 'it got the company's foot in the door of the project.'

After 47 years at Perry, Roach went to join ADI in Bendigo. He took his box of drawings with him, and the Perry Bushmaster went too. The plan then was for him to stay for about three months to help ADI bed the project down, but he was persuaded to help produce prototypes, and a lot of other test vehicles, and the three months turned into nearly three years: 'We rehashed the design in the first few days and we made three prototypes in pretty quick time—six or seven months.'

At that stage, the Perry vehicle had appealing inclusions such as air-conditioning but did not have the wedge-shaped hull that was to prove a lifesaver.

Faraway wars: southern Africa

By the late 1960s, Portuguese conscripts sent to maintain control of their nation's African colonies of Mozambique and Angola were increasingly reluctant to venture out of their bases because of the landmine threat. By mining roads, well-organised irregular forces such as the Frente de Libertação Moçambique (Frelimo) restricted the ability of government troops to manoeuvre. It was noted with alarm in South Africa, and in what was then Rhodesia, that the nationalist forces achieved that relatively easily.

* * *

Innovation in defence is often a response to an enemy's own inventiveness. Through the 1970s, guerrilla campaigns gathered momentum across southern Africa with the goal of toppling minority regimes in what was then Rhodesia and in South Africa and South West Africa (now Namibia) and to remove Portuguese colonial control in Mozambique and Angola. A weapon of choice of those fighting modern armies was the landmine, which was provided in abundance by China and the Soviet Union.

As those campaigns intensified, engineer Stefan Nell wrote a key section of a South African military handbook on the development of landmine-protected vehicles. He says that cost-effective solutions were developed by trial and error.

During conventional operations, the position of minefields was mostly known and they could therefore be cleared and marked using dedicated equipment. But the positions of these patient killers are often unknown during low-intensity wars, such as those raging at that time in Africa. It was also not possible to sweep every road in a massive area of operations.

On 11 February 1970, the commandant of the South African Defence Force, General Rudolph Hiemstra, wrote to the president of the national scientific research organisation, the Council for Scientific and Industrial Research (CSIR), saying it had become increasingly apparent that the landmine was proving to be a powerful weapon in the hands of those fighting the Portuguese in Angola and Mozambique. 'The effective use of mines is obviously a major factor contributing to freedom of movement problems being experienced by the Portuguese counter-insurgency forces,' he said.

The currently available countermeasures against mine warfare, such as the use of mine detectors and dogs to locate the mines and the use of protective devices such as armour plate, boots and so on, are far from being the complete answer, the general said. An urgent requirement appeared to be effective countermeasures for use by infantry sections on foot and in fast-moving patrols: 'It would be

appreciated if the problem could be given some serious thought with a view to suggesting any possible means of countering this very effective weapon, or course of action or research to establish such means.'

In response to the general's call for a technological solution, the CSIR recommended the development of mine-protected vehicles. A fact-finding team from the CSIR was sent to Angola in September 1970 to determine what measures were taken by the Portuguese to counter the landmine threat. Nell says the team noted that the Portuguese Army was passive and defensive in its approach and stayed within its bases. Supply was mostly from the air. When troops did leave their bases, they packed sandbags into their trucks to provide some form of protection. Foot patrols moved in front of the convoys and continuously swept the road with mine detectors or with prodders. As well, an extra set of wheels was fitted in front of a truck to set off mines.

It was clear that the driver was still going to be in serious danger, and a local civil engineer developed a cabin with a V-shaped hull to deflect the worst of the blast. Pressure tests inside the cab indicated that this was effective.

The South Africans and the Rhodesians worked on a range of mine-protected vehicles with distinctive wedge- or V-shaped hulls. They included Rhodesia's Leopard security vehicle, which was widely used during the bush war, the Buffel, in which troops and police travelled high off the ground, and the Casspir.

This lesson seems to have spread very slowly elsewhere in the world, and it was several years before even the powerful US military–industrial complex began mass-producing vehicles incorporating the crucial 'V'. US and British forces began operations in Afghanistan and Iraq equipped with lightly armoured and flat-bottomed Humvees and soft-skinned 'snatch' Land Rovers developed for use in Northern Ireland.

But the lessons from these distant wars were noted in Australia, whose troops had confronted the threats of mines and bombs on peacekeeping operations in Somalia, Cambodia, Rwanda—and, crucially, Namibia.

Namibia: peacekeeping in African minefields

During the 1989 peacekeeping mission to Namibia, the UN provided Australian military engineers with mine-proofed armoured vehicles obtained from South Africa. Importantly, impressions of these curious vehicles from another continent lingered in the memories of the engineers. 'The concept of a mine-protected vehicle having a V-shaped hull was certainly set in the minds of our army engineers as being something that was necessary for them to operate in the sorts of environments we thought we were likely to find in the future,' recalls Ken Gillespie. The deputy commander of the Australian contingent, who later became Chief of Army, says the faith in what those vehicles were able to do and their cross-country mobility were factors used by the Army in setting its requirements for what turned out to be the Bushmaster.

* * *

Gillespie had a close look at mines and mine-proofing as second-in-command and operations officer of the 2nd Australian Contingent to the UN Transition Assistance Group (UNTAG) in Namibia.

The UN was aware of the landmine threat in the territory and obtained for its peacekeepers three types of mine-proofed vehicles used by the South African police and army: the Buffel, the Casspir and the Wolf. Australian Army engineers were lent those vehicles when they joined UNTAG in 1989 and 1990. That provided the beginnings of an answer to concerns about the threat posed by landmines, which had grown during previous Australian peacekeeping deployments. The first Australian contingent deployed to Namibia in early 1989 and stayed for six months. The second arrived in July 1989 and stayed until the end of the mission in April 1990.

Some earlier versions of the South African vehicles were built very high off the ground to enable the troops on board them to see far out into the surrounding veldt, making each effectively a fort on wheels.

'When we were asked to do this job for the United Nations, we hadn't bought any special equipment for it. It was almost a come-as-you-are operation for us,' Gillespie recalls.

The Australians found a twofold threat awaiting. The first threat was from mines around many villages and surrounding the old South African Defence Force bases. Extensive minefields had been laid throughout the long conflict there, and some of them had been incompletely cleared. The Australians were alerted to that when villagers who unknowingly walked into them were killed.

'The South Africans built minefields the way we would,' Gillespie says. 'They were fenced; there was a doctrinal structure to them. When they left these places and they'd done their preliminary clearing, they left the minefield fenced and marked.' But once these areas were no longer supervised, local people removed sections of fencing to contain their herds. The result was minefields that hadn't been fully cleared lying there unfenced.

The challenge for the Australian engineers was to remove them. That often meant clearing a path into a previously unknown and unmarked minefield to extract somebody who'd been badly injured.

A second threat was posed by the more widely scattered mines laid by the South West African People's Organisation in its war against the South Africans in Namibia and Angola over many years.

The Australian troops got on with the South Africans 'quite well', says Gillespie, 'but they challenged us on many occasions'. That applied to minefields, and the South Africans were reluctant to give the Australians records of where they were and what state they were in. 'In some ways it was a test of our people,' Gillespie recalls. He was told by South African officers that the ADF was a modern military force and shouldn't need maps to clear a minefield. The South Africans then watched as the work was done.

'I don't think it was sinister—just soldier versus soldier,' says Gillespie.

The South African protected vehicles provided to the Australian contingent were painted white and bore the letters 'UN'.

The nature of those vehicles was interesting to the Australians, says Gillespie, because they didn't follow the European model of armoured vehicles, which were close to the ground and had a low profile:

> The Buffels were quite tall. They had some mine-proofing and hardened metal protecting the troops in them and they were open at the top, giving the soldiers firing positions. They were people-movers designed to allow them to do a number of things, including to charge through the savannah-type country in which they were operating. Those in these vehicles were high enough off the ground to see people running through the scrub.

The Buffel's height had the added benefit of making the V-shaped hull more effective at protecting those on board from mine blasts. The Casspir, which flowed from the Buffel, was closed in, and the troops were protected if they rolled over.

Because of apartheid and international sanctions, Pretoria had little support for its war machine, and Gillespie says the South Africans became very inventive in designing their own vehicles, guns and attack helicopters. One of their guiding principles was that they never gold-plated any of their equipment and went for the most fit-for-purpose, cost-effective solution.

When the Australians were using the borrowed vehicles, parts would break all the time, says Gillespie. 'They didn't try to harden them through the engineering process but they simply ensured there were spare parts available to fix them. That kept the cost of the vehicles right down. It fitted the South African culture and permeated through their troops—"If it breaks, fix it and then crack on with the job",' he says. 'We don't do that. We tend to go for the best engineered solution.' In those days, a Wolf cost about $20,000. Decades later, the Bushmasters ended up costing from $600,000 to over $1 million each, depending on the vehicle's role and the equipment fitted to it.

Members of the Australian contingent were so impressed with the vehicles that they plotted to acquire one. When they were leaving at the end of their deployment, they drove a Wolf from Grootfontein to the Namibian port of Windhoek and stashed it in a warehouse at the wharf. Ultimately, there was no opportunity to winch it surreptitiously aboard the ship carrying their equipment home, and they left without it.

Cambodia and the Army's ability to manoeuvre

> *If you're going to ask young people to do very dangerous things, you've got to provide them with equipment that gives them a reasonable chance of survival.*
>
> *— Lieutenant General John Sanderson*

* * *

Soon after UNTAG in Namibia came an even more complex and dangerous mission, the UN Transitional Authority in Cambodia (UNTAC). More than 20,000 soldiers, police and civilians were commanded by Australian Lieutenant General John Sanderson. Again, this mission demonstrated how forces' ability to manoeuvre could be curtailed by landmines.

When he arrived in Cambodia, Sanderson found a nation infested with landmines. He recalls terrible incidents in which whole vehicles were shredded. Personnel did not want to move from their bases for fear of being blown to pieces, and he quickly realised that his contingent's ability to travel was under threat. Sanderson says:

> When you see a vehicle that's been opened up by a mine, it's demoralising. People thought, 'I'm here on a peacekeeping mission and I don't want that to happen to me, so I'll sit in the base.' I had people there from armies from all over the world just stop manoeuvring. And I had the Khmer Rouge and the state of Cambodia saying, 'Look at the UN. They're useless. And vote for us because we're the only ones who can protect you.' This is peacekeeping, but if you're not out in the road showing your face, then you can't do your job. If you can't manoeuvre, then you should go home.

Again, South African mine-proofed vehicles were brought in to provide a measure of safety. 'At last', says Sanderson, 'I started to get troops to actually move outside their bases.'

Sanderson, who went on to be Chief of Army from 1995 to 1998, had learned his military skills in an expeditionary army with a national policy of forward defence that 'went off and fought with other people'. He says he understands why the government of the day adopted the DoA strategy following US President Richard Nixon's warning that, after Vietnam, nations such as Australia would have to look after their own defence. Sanderson says, though, that if he'd suggested in the days of the DoA policy that he was preparing the force to fight in Iraq and Afghanistan, he would have been 'tarred and feathered and run out of town'.

The general's previous role was as Chief of Defence Development. In line with the DoA strategy, a key goal was to be able to move new motorised infantry battalions over significant distances with a reasonable chance of surviving a mine incident or even an attack by reasonably well-armed soldiers.

Cambodia reinforced his concerns about the extent to which cheap and abundant landmines could limit an army's ability to cross ground. One element of manoeuvre is to cover and control great distances, he says. The enemy wants to inhibit your manoeuvre, so you need something that can move fairly fast over such distances but still provide protection to its occupants. The other element is to manoeuvre in the face of the enemy, which requires very heavy protection.

Australian infantry had long resisted having their own vehicles, Sanderson says. They liked to have someone take responsibility for equipment and pick them up and take them places. They wanted to just go and fight alongside somebody else, not to fight in their own country.

When he returned from Cambodia, Sanderson pressed the case for developing a vehicle based on the principles of the South African vehicles and capable of protecting Australian soldiers against mines, IEDs and reasonably heavy weapons. It was never meant to be an armoured fighting vehicle, he says, but it would allow infantry to manoeuvre: 'I committed the Army to buying several hundred of them, partly on the basis of my experience in Cambodia and partly on the requirements for the defence of Australia.'

Sanderson says that because the Bushmaster was conceived for DoA, it was able to manoeuvre over great distances, very fast, and gave the troops confidence that they'd get to where they were going: 'Whether the reasons we got the vehicle were right or wrong, it wound up perfect for the sort of wars that came along. It's manoeuvring over big distances against an anti-movement threat.'

As a footnote, Sanderson says the strategic situation has now changed to the point where the ADF must think once more about DoA: 'We're obviously going to have to contemplate controlling territory in the archipelago, including Papua New Guinea, and controlling the north of Australia. The big thing is to get yourself into a position where nobody attacks you because it's not worth their while.'

The project gets underway

As the development project gathered momentum, two of the prototype Bushmasters, dubbed B1 and B3, were sent to East Timor to provide protection for travelling VIPs. Passengers included Xanana Gusmão, who was to become the new nation's first president. The vehicles were affectionately known there as 'battle taxis'.

Engineer Chev Viviers recalls some of those who'd been most strongly opposed to the Bushmaster concept changing their minds after the East Timor deployment. The naysayers decided the Bushmaster provided great mobility and excellent protection. It performed well in a harsh environment and it was versatile. Even some of those devoted to tracks, not wheels, came around, says Viviers.

* * *

When Australia's Defence Department called on manufacturers for expressions of interest in building the new vehicle, 17 companies responded. Requests for tenders were issued to five short-listed manufacturers in August 1995. That soon came down to three contenders.

Stefan Nell was the manager in charge of testing, evaluation and vehicle technology at a South African company, Reumech Ermetek, when its marketing manager, Koos de Wet, heard of Australia's Bushranger project and encouraged the company to bid. That was approved, and de Wet, who had worked on South Africa's Buffel and Casspir vehicles, then directed the development of a vehicle, the Taipan, to be built on a Unimog truck chassis.

'The idea was that we should make use as much as possible of Unimog components, as the Australian Army had a large number of Unimogs,' Nell says. 'I remember the vehicle gave a lot of problems, as it was difficult to match the heavy armoured body to the flexible chassis of the Unimog. The vehicle did not do very well during trials in Australia.'

A second contender was the Foxhound, produced by Britain's BAE, which was to replace the 'snatch' Land Rovers used in Northern Ireland. The Foxhound dropped out soon after the project was launched. It could carry only six soldiers with their equipment, while the ADF wanted, at that stage, a vehicle that could carry nine. That requirement was later increased to 10.

The third proposal was for ADI's Bushmaster.

Ultimately, de Wet and Viviers, who was Reumech's product development engineer, were to play vital roles an ocean away, developing the Australian Bushmaster after it won the competition.

Reumech partnered with Australian National Industries as Australian Specialised Vehicle Systems to bid for the project. Eventually that consortium and ADI, with its Bushmaster, were awarded contracts for trials.

After the Bushmaster was short-listed, the ADF raised concerns about its mine resistance and ballistic protection. As Project Bushranger program manager, Warren Feakes advised ADI that, with its flat bottom, the early version of the vehicle would not pass a mine blast test. He suggested hiring South African engineers who'd done advanced work on mine protection.

In 1996, ADI asked de Wet to come to Bendigo to examine the vehicle design it had bought from Perry Engineering. De Wet identified major problems in both mine resistance and ballistic protection and was contracted by ADI to redesign the vehicle. De Wet was in regular contact with Viviers, a brilliant engineer, and asked him to come to Australia. Viviers was in charge of Reumech's Taipan project but he resigned and arrived in Bendigo in September 1997.

De Wet and Viviers basically changed the vehicle from the Perry design to the Bushmaster that eventually went into production. The original flat bottom was replaced with the 'V' designed to deflect blast. One additional innovation was a 'banana' curve at the bottom of the V. Thus transformed, the vehicle went on to pass its landmine tests.

Looking back, Viviers says that building in protection against landmines and IEDs involves several key principles. A priority is to deflect the blast: hence the V-shaped base. Another is to get the crew compartment as high as possible above the ground and the source of the explosion. 'A simple law of physics, mass times acceleration, means the heavier you are the better,' says Viviers. 'You deflect and then you absorb—and you must ensure there's no penetration to let through the high-pressure blast wave.' It's vital to avoid having loose objects lying on the vehicle's floor becoming lethal missiles in the event of an explosion. And a flat bottom is a total no-no in any mine blast.

Gradually, three prototypes were built—B1, B2 and B3. B2 and one of the Taipans were blown up in blast tests.

The Bushmaster was a bigger vehicle than the Taipan and had a more powerful engine. It also had independent suspension, which Defence wanted, while the Taipan had beam axles. The Bushmaster had an automatic transmission, which, again, Defence had asked for, but the Taipan had a manual gearbox. Viviers remembers Warren Feakes telling the Taipan team members that if they didn't provide an automatic gearbox they were likely to lose the contest: 'All of a sudden, in a vehicle which was relatively mature, they had to take out the transmission and redesign the hole to fit it in. That gave them enormous problems.'

Building in Bendigo

The Bushmaster design team took protection levels seriously. The tyres had 'run-flats' in them so that if they were shot out the vehicle could keep driving. For extra strength, each vehicle was welded together in monocoque style as one large box. The external spaces created by the V-shaped bottom were filled with storage lockers and fuel tanks. All of that was on the outside of the vehicle and if it were hit by a bomb it would absorb some of the blast and end up many metres away. There was a separate 20-litre fuel tank inside the armour to get the crew out of trouble if the vehicle was still capable of being driven. 'You could still drive yourself out of the killing zone,' Bob Roach says.

* * *

At ADI's Bendigo plant, Roach would do his design work on paper and hand it to the drafters, who would load it onto computers. Some of the work was fundamental: 'We had to get air into the engine and air out of the engine and air for the people in the back, but at the same time bullets weren't allowed to get in.' The bottom of the hull had to be made from material that would flex, but not break, if it were hit by an explosion. The engineers were aware that, in the sort of blast the new vehicle might encounter, expanding gases travelled at up to 8,000 metres per second and it had to be able to withstand them.

'After the three vehicles were finished, we needed to do a certain amount of testing ourselves to be sure everything was tickety-boo before the Army got them,' Roach says. They took other test vehicles they'd constructed out to a firing range at the Army's Puckapunyal camp, north of Melbourne, to ensure that heat-affected areas alongside welds would withstand high-powered rifle fire and that they'd survive bomb blasts.

Towards the end, when the vehicles were being proven and mileage was being built up to test them, the construction team would drive them around the streets of Bendigo, but the prototype troop carriers would sit in the factory all weekend. Roach was working in Bendigo, but his wife was still in Adelaide. 'I decided this is not much good—I'll drive it home.' And so he did just that, every second weekend. The vehicle was registered. Those were different times.

'I parked it in my front drive, which caused a bit of a stir with the neighbours. I even took it to church a couple of times,' he says. It caused an even bigger stir when he was driving down the highway and pulled out to pass someone. With its big 7.3-litre Caterpillar diesel engine producing 300 horsepower, and an automatic transmission, the prototype would, in his words, 'go like a rocket'. It was good fun, he says:

'It would get along! I was doing 110 kilometres an hour: the legal limit. Don't get me wrong, but it was capable of 130 kilometres an hour if you put your foot down.'

After 12 months of trials with the Army, the Bushmaster won the contest, and in June 1999 ADI was contracted to build 370 of them for $170.04 million.

Bob Roach turned 65 and retired.

In November 1999, ADI was sold by the Australian Government for $346.78 million to a 50:50 partnership made up of the Australian company Transfield and the French military engineering company Thompson-CSF, which later became Thales. In October 2006, Thales bought Transfield's 50% share in ADI to become the full owner of the company, which was renamed Thales Australia.

Chev Viviers was tasked with working on the engineering changes required to produce the six Bushmaster variants Defence wanted at that stage: 'That was very easy for me because I did the variants for the Taipan in South Africa. I quickly created all the data packs, where all the stuff would sit.' In 2007 a seventh variant was ordered for the RAAF's airfield security personnel.

He shrugs off his colleagues' suggestions that he is the 'grandfather of the Bushmaster'. 'Any project is a team effort,' he says.

Over long months, problems with the power pack and the drive train were gradually worked through: 'There were very good engineers at ADI and, when there was a problem, I'd show them how it was done in South Africa. Most of the problems are virtually the same in any vehicle—driveline angles, suspension and cooling.' Welding techniques evolved, based in some crucial areas on the South Africans' experience.

The engineering team made its own innovations, rounding the bottom of the protective V to accommodate the transfer case—part of the drive train that transfers power from the gearbox to the axles. Further blast-testing demonstrated that this banana shape did not lessen the deflective effect of the V. It was a similar effect to the strength provided by the curve in the hull of a submarine. 'You get the strength of the curve,' says Viviers.

The early days of blast-testing were much less scientific than they are now: 'We didn't have a lot of instrumentation. We had water dummies, and if they burst then that indicated that the person would die. The instrumented mannequins now are very, very accurate.' As an additional complication, the impact of a blast would vary if soil were loose, compacted or wet.

As tough trials continued, some of them in the Monegeetta vehicle testing ground, Defence came back to the company with a list of changes it wanted before the Bushmaster could go into production.

But, even at that late stage, there were those who still wanted the project to go away. On several occasions, the engineers gained the impression that some in the company and in Defence were keen to opt out of it, and the 'wheels versus tracks' debate was alive and well.

At one point, the engineers were told that Defence considered the vehicle too expensive. Viviers responded that the military insisted on an automatic gearbox, while a manual box would have been much cheaper. It also wanted independent suspension, while beam axles would have been much less costly. Some more minor changes were made, but the main components remained the same.

The project unravels

In October 1999, four months after the contract to produce the Bushmaster was signed, Defence came up with 23 major changes to be made to the vehicle. One of them is described as 'the mother of all engineering changes'. That was to insert a 10th seat by stretching the vehicle, which made it heavier and required a significant redesign of the driveline. These modifications created serious problems in the prototypes and inevitable reliability issues that persisted for years.

* * *

In early 2000, Army engineer Major Mark Eggler was delighted to hear that he was to be promoted to lieutenant-colonel and appointed director of Project Bushranger from 1 July. He recalls, soon after, the director of the Force Development Group, Colonel Steve Quinn, telling him: 'Mark, this is a very difficult project. It's either going to be a complete failure, or an absolutely outstanding success.'

Eggler interpreted that as a warning that there was not a lot of 'political' support for the project within the Army but the colonel could see a time when such a vehicle would be badly needed in a number of scenarios. And that turned out to be exactly the case.

Eggler's determination to save the project proved crucial to the Bushmaster's survival.

When he arrived to take charge, the warnings became more specific and the scale of the challenge clearer. He was told the project was not going at all well and there were indications of schedule and quality issues coming from ADI in Bendigo. Eggler was told Bushranger appeared to be on a difficult path and he would have to 'grip the project up'—bringing it under control, ironing out difficulties that were emerging and getting it all back on track.

In those first months, it gradually emerged how serious and widespread the problems were. An audit of project health revealed that the 'work-breakdown structure' was inadequate. It was supposed to divide the work to be done into manageable chunks but effectively covered only some sections rather than the whole project. There was no systems engineering management plan, and the project management system was inadequate and placed a heavy load on the project team. These were management problems but they were also tied up with vehicle quality, reliability and performance issues.

'When I first arrived, I was on promotion and it was all very exciting. But within about six weeks I'd realised that it was a real problem project,' says Eggler. There were issues with the contract in terms of what ADI was doing to create the prototypes and

meet the schedule, and there were big gaps in the strategic documentation needed to guide the project.

The project team was much too small to handle the workload. 'It can't all be done by the contractor,' says Eggler. 'They're doing work and sending us things and we need to have sufficient horsepower on the government side to be able to answer and to make sure that we take full account of what's being put in front of us so that we know the contractor's doing what's required.'

By August 2000, Eggler realised that the contract was not fit for purpose and that he didn't have enough staff to oversee it properly. He told his team to focus on finding the best way to straighten the project out and to manage its problems.

That involved creating the key documents that the project needed to organise itself, including a project management plan, a systems engineering plan and an integrated logistics support plan. While that was happening, the team and ADI had to do their best to work together to progress the project.

It also became clear to Eggler that there wasn't a particularly good understanding within the Army of what the capability was all about. He then spent many months developing and re-energising the existing operational concept document covering how this vehicle would be used by the infantry and what logistical support it would need. That included a week-long workshop at Brisbane's Enoggera Barracks. That was very useful, says Eggler, because it forced the Army to think about why this new capability was needed and what it would be used for. The original major capability submission approved by cabinet three or four years earlier was good, but it had what he describes as the 'Defence of Australia shadow' hanging over it: 'We wanted to have another look at it.'

He suspected that those who approved what was effectively a review and an update saw it as an opportunity to kill the whole project off. It became clear later that, despite strong support from some senior Army officers, others were very much against the project and would have happily seen it abandoned.

As he 'read himself in', Eggler discovered the long list of major engineering changes that Defence wanted made to the vehicle:

> No-one should have been surprised because ADI was dealing with a relatively immature design when the contract was signed and the department poured fuel onto the change fire. And, of course, ADI was still shaking out. They weren't set up for this level of design and development effort. Again, no-one should have been surprised that we had major problems with the quality of the build state and poor reliability.

By late 2000, Eggler had determined that Project Bushranger was in serious trouble. To strengthen the project team of just eight people, he requested 11 more to rectify the project strategy and to prepare the documentary framework to ensure it stayed on the rails. There were public service hiring limits in place, so he was given approval to take on seven consultants.

Most of the specialist staff brought in from industry went into the key areas of the engineering and logistic support teams, which were the most underdone.

To salvage the situation, a very large and focused reliability growth program was built into the engineering project. 'That worked a treat,' says Eggler.

That program was prepared by one of the consultants with the help of a 'reliability, availability, maintainability' team from what was then the Defence Acquisition Organisation. Ensuring reliability was crucial to avoid constant repairs, increased operating costs and low availability.

'That reliability program was new to Army. It was a great piece of contracting. And, by all reports, today the vehicle has excellent reliability and the soldiers report that it rarely breaks down,' says Eggler. The program became the formula for future reliability growth programs in the Defence Materiel Organisation.

The team worked hard to put the contract in order and to develop a good working relationship with ADI under what it regarded as very difficult circumstances.

In the meantime, the first two prototypes had been delivered by ADI in April 2000, three months late. They were the first Bushmasters built by ADI out of the Bendigo facility under the contract signed on 1 June 1999, and Defence used them for prototype testing and reliability trials. 'Both vehicles had significant quality problems and deficiencies in their design', says Eggler. The quality of the build wasn't good: 'That wasn't surprising to me because ADI had never done this before.'

By then, Defence and ADI were managing around a hundred engineering design changes. A lot of remedial work was done and many of those problems were fixed, but there was no way to deal with the size issue. The dimensions of the vehicles had been carefully worked out to ensure that they could be carried on the RAAF's C-130 Hercules transport aircraft but they turned out to be five or six millimetres wider than intended. 'Imagine a massive jigsaw puzzle of steel plates,' says Eggler. 'Depending on how you weld them together you'll get different dimensions due to heating effects. There's a lot of art in this as well as science and they hadn't cracked the problem at that point.'

Five or six millimetres does not sound a lot, but Chev Viviers recalls that it was enough to make the vehicle too wide to comply with the Australian Design Rules governing its use on the road. The width of the lockers along each side of the hull was reduced

and mudguards were changed to make it fit within those specifications. The vehicles were also significantly overweight and Viviers says that was because of frequent changes to requirements.

Defence also noted that reliability issues identified during the original trials hadn't been rectified. The project team added a hefty load of additional work to the already formidable list of engineering changes.

Towards the end of 2000 came another report highlighting very serious reliability problems with the vehicle. Many more engineering changes were then injected into the design. Once made, the changes had to be proved because ADI had no time to go through its internal test programs to confirm the changes. It's good engineering practice to verify that changes have worked as expected and had a positive impact on the overall design.

When the vehicle's reliability was measured, it was still getting on average only about 200 kilometres between failures, which Eggler describes as 'absolutely woeful':

> Coming to the end of 2000, we've got a project that, internally, hadn't been structured and set up properly, a contract that wasn't working properly, and a contractor in ADI that had never done this before on this sort of scale. That caused growing pains and clearly the company did not have the appropriate manufacturing and quality procedures to develop prototypes that met requirements, matched the drawings and delivered a reasonable standard of reliability. So, at the end of 2000 and early 2001, things didn't look good at all.

Eggler went to the assorted committees he was dealing with and told them there were major problems with the project. To get it running properly, the contract would have to be recast to include additional work packages to deal with the technical development risk and other shortcomings in the integrated logistics support program.

This was when it became clear that, while the project had been sold to government back in 1997 as an off-the-shelf procurement, that wasn't the case. The individual components, such as the engine and the transmission, were selected from what was commercially available and certainly came off the shelf, but a whole system could not be sold as off-the-shelf until it had gone through the appropriate development and verification procedures. The Defence trial was not able to do that.

'The original contract was rattling along in the background,' says Eggler, 'but with this short trial we realised the reliability was no good and the contract had a whole range of problems.' Design work was continuing on the Bushmaster variants.

Eggler's concern was backed by the Australian National Audit Office (ANAO), which noted in a 2004 report that Defence had generally considered that it wanted a modest, lightly armoured, vehicle with commercial truck components. The ANAO said the vehicle ultimately procured by Defence was largely of an unproven design and capability and was far more developmental than originally intended. 'However, Defence initially managed the project as though it was a commercial off the shelf procurement, rather than recognising the developmental nature of the project,' the ANAO said.

The vehicle needed significant further engineering design and development to meet its function and performance requirements and its reliability requirements.

Another large and unexpected shortcoming in the contract's technical specification that Eggler inherited was the frequent use of the word 'should' instead of 'shall' in setting out requirements. He says:

> In any enforceable contract, you've got to use the word 'shall' in your specification because then it's very clear that the contract must meet that requirement. But we had all of these things that 'should' be done which weren't reflected in a contractually enforceable way. As a result, ADI didn't actually have to deliver. They could just say, 'We've used best endeavours, and this is all we can do for you.'

That was done because there was a rush to get the contract in place in 1999, apparently because the Defence Department had underspent its budget. To plug this budgetary hole, it was able to pay an advance of $42 million to the company that won the contract.

These were issues that should have been dealt with before the contract was signed.

Fuel on the fire

At a meeting of the Defence Capability and Investment Committee in December 2001, there was virtually no enthusiasm for proceeding with the project. At the time, relations between Defence and industry were strained by regular media headlines about 'dud subs', embarrassment over the Sea Sprite helicopter project and the troubled M113 armoured personnel carrier upgrade program. 'Bushranger was just another one added to the list,' says Army engineer Mark Eggler. Some in Defence saw this as an opportunity to give industry a real kicking and were openly saying, 'Let's give it the chop.'

* * *

As late as November 2000, the vehicles were still suffering serious reliability problems. 'Engineering control is absolutely essential in these big projects,' says Eggler. 'In the early stage of the project, engineering control wasn't there either within the Commonwealth or within ADI.'

In December 2000, more fuel was poured onto the fire with the arrival of a one-paragraph letter from ADI saying that it had become clear to the company that it had underestimated the number of hours it would take to build the vehicle and that costs had blown out by $37 million. 'That's basically all it said,' Eggler recalls. 'Didn't say they couldn't do the project, and so they were going to stop. Didn't say that they wanted the Commonwealth to do anything. It was just basically a letter of fact.'

That demonstrated to the project team that ADI knew it had problems.

Eggler got the go-ahead in February 2001 to create a 'contract change proposal', later known as CCP14, which included an upgraded systems engineering program, reliability program, test and evaluation program, and integrated logistic support program to ensure that Defence and the Army had confidence that what was ultimately delivered would meet the requirements of the specification.

By May 2001, the project had reached a decision point on whether ADI should be given the green light to begin production. Eggler told ADI that as project manager he had to reject the design as it then stood and that the company would have to do more work on it to convince the government that the build standard and configuration were good enough to begin full-rate production.

Unhappily, the contract had no mechanism to deal with rejection by the government. 'It was not designed that way,' says Eggler. 'It was all designed around this idea that it was an off-the-shelf procurement, we're just going to basically get a couple of prototypes, give them a quick early run-over with the tape measure and the weigh-scales and we're going to get on with it. Well, that wasn't the case.'

All of the emerging problems had to be addressed through the contract change proposal process. Lawyers were engaged to help draft a new contract to deal with the project's developmental nature. That took three months to prepare and had to be endorsed by the Army and by the Defence Acquisition Organisation. Final approval to release the contract change proposal to ADI came in June 2001. Eggler received it back from the company early in October.

> They did a reasonable effort to respond and it came back with price adjustments and schedule adjustments based on what they thought was reasonable to keep the project going.
>
> Obviously they had price pressures, and they'd underestimated how much it was going to cost to set up the factory, and then to build this vehicle using modern manufacturing techniques.

But, along with the cost escalation, it emerged that the project was set to run three years late.

Eggler says the contract parameters suggested by ADI in October 2001 were still fairly unsatisfactory from the government's perspective because of the overall schedule increase and price escalation. He wrote a source evaluation report in which he set out issues that must be addressed:

> I said there was reasonable expectation that ADI had now understood the problem. They had hired the appropriate people with the expertise to get the production line squared away and all the supply chain logistics and all those aspects associated with the manufacturing of a complex vehicle. Assuming we could deal with schedule and price, and obviously the reductions in capability, then there was every chance the project would succeed.

ADI's engineering director, Mark Diedrichs, wrote to Eggler as part of CCP14 suggesting a contracted change to a manufacturing schedule known as 'low-rate initial production'. It would get the factory going and prove the production tooling and production processes and procedures, and reduce the risk to the build standard of the vehicles.

'That turned out to be a great idea, and something that I took up,' says Eggler. But he decided not to put it to company executives at that stage and asked the lawyers to produce a revised contract along those lines. He planned to take that to a crucial investment committee meeting in December and hoped he'd be able to negotiate an outcome acceptable in terms of price and schedule.

The government wasn't going to agree to an increase in the overall project price, so the Army had to give up a number of vehicles, he says. The order shrank from 370 vehicle plus 12 prototypes down to 299 vehicles with 12 prototypes.

'So, ultimately, just to sort out the mess, the Army had to swallow a significant reduction in capability. In time, they ordered a whole lot more.'

The Army also had to scale back some of the capabilities on the vehicles and accept them being fitted 'for but not with' some of their planned equipment. That included the automatic fire and explosion suppression system. The attachment points were in the vehicle but the system wasn't installed. It was fitted later for operations in Iraq.

The project team was keen to have a vehicle information and monitoring system, which would have been very early-adopter technology for the Army, but that was declined in order to save on costs and reduce project complexity.

Diedrichs had a clear view of the project from the manufacturer's perspective. In 1997, he was general manager of ADI's facility in Bendigo. With the end of a number of big defence programs and a slowdown in the mining industry, the company was facing its own version of the 'valley of death' and was looking for new projects.

The rights to compete in Project Bushranger were bought from Perry Engineering along with its Bushmaster models.

That plan had a rocky start and quickly became what Diedrichs recalls as 'a bit of a black hole … As we threw more money at it, the money disappeared.'

In 1999, after a Thales/Transfield joint venture bought ADI, Diedrichs was appointed director of engineering and vehicles and was told there were big concerns about the project's viability. It didn't stand up well to the company's risk profile.

'The more we dug into that, the more we started to find issues around the costings of the project, and the technical risks started to emerge,' says Diedrichs. 'Equally, on the other side, the Commonwealth had some concerns technically, so there was a lot of emotion floating around.'

The task then was to rebaseline the whole project to see where it was going: 'That basically occupied the rest of 2000, and we embarked upon preparing four vehicles.'

Diedrichs recalls being told by an Army officer that 'A dead cat's been thrown over the fence and it's over to both of us to fix it. I can't build without you, and you can't succeed without me.'

Getting the project on track took years of very hard graft by Thales/ADI from the contractor's perspective, and from Defence's perspective, says Diedrichs:

> There were a lot of good relationships formed, there was a lot of heroes, there were a lot of untruths, a lot of things that floated around where people embellished their own particular role as to what they did and didn't do. But we all worked extremely well together to bring it to a conclusion.

Because of the way the project had been costed in its early stages, the company found it would be selling the completed vehicles at a substantial loss:

> There's no way Thales would have done that. And there's no way that the Commonwealth would have wanted that to occur because they had sold the business to Thales. So, there was a lot of complexity in that whole deal.

Diedrichs recalls Eggler as a 'very detail-minded guy': 'That's what was needed on the military side of it because he had a lot of people that were just seagulls. They'd fly in, fly out, shit all over the whole project and everybody would be cleaning up the mess.'

He remembers Chev Viviers and his team as bringing intellectual rigour to the engineering side of the project: 'Chev is a very quiet person. He doesn't blow his own trumpet. But he brought that rigour because he wasn't bombastic or domineering.'

An American military vehicle specialist was brought in, and he concluded that a group of amateurs had produced a good vehicle but one that wasn't anywhere near 'manufacturable'.

In the early days, there were some attempts to sell the vehicle in Europe and in Africa, but they were made too early to be successful as the Bushmaster hadn't been delivered to the ADF at that stage.

Diedrichs says the project was a great learning experience and enabled him to manage difficult programs he became involved in later: 'It was probably the best MBA I could've got.'

Ultimately, at the end of 2007, Thales bought Transfield's 50% share in the joint venture and became 100% owner of the company from 1 January 2008. The name ADI was phased out.

The project proved that a world-class vehicle could be built in Australia, but what was achieved was not fully understood here. Diedrichs says:

> At the end of the day, a vehicle is an integration exercise, so you're a system integrator and the whole thing is a whole lot of subsystems. The hull is little more than a bracket that you attach all these subsystems to. We have that capability in Australia, but our minds get lost about the system integration. We either want to sell the vehicle or we want to sell a subsystem, as opposed to selling the concepts and what we have put together. And that system integration skill really is something that could be sold.
>
> We didn't really capture that. We wanted to race off and sell the package, but we could've sold those skills and that knowledge. But, unfortunately,

> everybody gets lost in thinking, 'Oh, that's not putting hours of work into my fabrication shop or my paint shop.'
>
> That's what we focus on, instead of saying, 'Hey, we're selling our knowledge.'
>
> We wanted to sell a Bushmaster. But if we'd offered to send people a package to build the vehicle and then supported that package, would we have made a lot of money and built a bigger reputation?

Once the early vehicles were produced, Diedrichs took one to a major military equipment show in London. An American officer told him: 'A US soldier wouldn't be seen dead in this thing.'

Diedrichs responded: 'Well, that's the whole idea, you know?'

Eggler took his recommendation to a meeting of the Defence Capability and Investment Committee in December 2001 and found no support for it. His reading of the meeting told him the Army wasn't keen to proceed with the Bushmaster but it didn't want to lose the funding.

Crisis point: the project hangs in the balance

While others have credited the then Defence Minister, Robert Hill, with saving the Bushmaster in its early days, he declines to take the credit for what turned out to have been be a fateful decision. 'That's not true,' he says. 'As I recall it, I wanted to scrap the project, which was massively over budget and going nowhere, and was talked out of it by Cosgrove, who had an inkling that one day the extra protection might be necessary. Anyway, as it turned out, he was correct. So he's the hero, not me!'

* * *

Everything came to a head after the December 2001 meeting when the Defence Capability and Investment Committee wrote to Hill recommending that the project be terminated.

Hill, a lawyer by training, wrote back a ministerial note saying to the effect of 'That's fine. But how much is it going to cost?' He also noted that it seemed that the Army did not actually want the vehicle.

As project manager, Eggler wasn't privy to whatever higher level discussions were going on, but, in the background, some key officers and officials took the view that, because the project was late and over budget and struggling with quality problems, it should be abandoned. The Army wanted the capability but it was prepared to consider options such as securing the project's funding to buy hundreds more ASLAVs or Land Rovers.

And, not for the only time in the sometimes precarious Bushmaster saga, fortune had intervened in 1999 when the two prototype Bushmasters were sent to Australian peacekeepers in East Timor. The vehicles impressed INTERFET Commander Major-General Peter Cosgrove, who went on to become Chief of Army and then Chief of the Defence Force. Cosgrove became a strong supporter of the Bushranger Project, and Robert Hill says the general persuaded him to keep the Bushmaster going.

Cosgrove's personal support changed a lot, says Eggler:

> When we got into the really difficult times in the back half of 2001, it was definitely Cosgrove who kept the project afloat. When we got to pivotal decision points and the minister and other senior executives were consulting about what to do with this problem project, it's my view that it was Cosgrove's support that kept the Defence Minister, Senator Robert Hill, and the Army just saying, 'Okay. We'll give it a little bit more support to see if we can square it away.'

Eggler discussed Hill's response with ADI and recalls the company coming back with options ranging in cost from $200 million to $500 million. The estimates included what it would cost to retrench the workforce with severance packages, along with remediation of the Bendigo site. That was a huge amount of money—about three times the value of the actual contract.

ADI said it would be more than happy to terminate the contract on the basis of convenience. That meant that the government would shut it down, which would have left the Commonwealth fully exposed to whatever the final agreed figure was. All of the costs would go directly to the government.

The company rejected termination by default because, it said, the project's closure was the government's fault. 'Well, it wasn't all the government's fault, and it wasn't all ADI's fault,' says Eggler. 'It was a combination of errors. And termination by mutual agreement was also not an option. So they were only prepared to accept the termination by convenience on behalf of the government.'

Discussion and debate on the project's fate continued inside Defence and within the company until Hill decreed that they would all give it 'one more go'. The minister warned all the parties that they had to get the project squared away over the next quarter or he would terminate it.

Eggler went back to the company and said it had six weeks to refresh its proposal for low-rate initial production as suggested by Mark Diedrichs:

> I said they had to come back to us with better parameters around pricing and schedule. We would consider the company's response and put a final proposal to the government.
>
> They came back very promptly. We did a quick review and it looked reasonable. Sometime in May 2002, we sat down with ADI over one week and sorted out all of the strategic issues that were at play in the contract. That negotiation went very smoothly. The parties were working together to get an outcome. When that week ended, we'd basically squared everything away.

Final changes to the specification went back to the investment committee. The Army agreed that it was happy to proceed on the basis of a reduced number of vehicles, based on Eggler's team's evaluation that ADI was now on top of the project.

The government approved the changes to the contract and, in early July 2002, the amendment was signed that put the project back on foot. From that point on, the project got well, says Eggler: 'That's not to say there weren't other difficulties encountered, like there are always problems in these big projects.' But the hard strategic work had been done. The project had been reoriented in terms of cost, schedule and performance. The Army was happy with the capability that it was going to get, and the project set sail.

Given the angst involved in getting the project to that stage, did it make sense to build these vehicles in Australia, or should Defence have just bought some from overseas?

There was no vehicle available anywhere in the world that would meet the ADF's requirements as written, says Eggler:

> Should we do these projects in Australia? My view is absolutely. We're a smart nation. We've got good engineers. We've got good companies that can hire good project managers and other key people to do these things. But where there's development, there needs to be strategic patience.
>
> In terms of developing industry capability, we can do these things. Now, clearly, there are limits in terms of what we can and can't do. But in the vehicle space, there are definitely projects like Bushranger that we can do. And there is no reason why we shouldn't do them.

Eggler says the other reason why it was important for Project Bushranger to succeed was that Australia had made only one previous attempt to build an armoured vehicle. The first was the Sentinel tank during World War II, and that failed because the Americans pulled the rug out from under the project in 1942.

For Eggler, it was important from the perspective of national engineering prestige to make this project succeed: 'I worked very hard to make sure it didn't fail. It would have been remembered as a scar on our engineering capability if that project had not succeeded.'

Eggler left the project towards the end of 2002, feeling close to exhausted by his efforts. His place was taken by Lieutenant Colonel Louise Abell, who guided the Bushmaster through its complex production stage. Diedrichs says Abell had a very different set of complex risks to manage, along with the introduction of the Bushmaster to service. If that had gone wrong, the vehicle could have ended up with a bad reputation: 'And if it does get a bad reputation, a vehicle does not live it down.'

By then, the Australian special forces operations in Afghanistan after 11 September 2001 had provided painful evidence that the Army needed a vehicle to protect troops on the move from landmines and IEDs.

Operational necessity

Late in the afternoon of 16 February 2002, Sergeant Andrew Russell is one of five SAS soldiers leading a small convoy searching in Afghanistan's Kandahar Province for arms caches left behind by retreating Taliban and al-Qaeda forces. Pummelled by an icy wind, the five are on board a patrol vehicle designed to operate off-road and fitted with a machine-gun to fire over the driver's head. The long-range patrol vehicle is a formidable Land Rover derivative designed to give the special forces soldiers speed and mobility. The downside is that it's soft-skinned and lacks the protection of an armoured personnel carrier.

These men are skilled and tough, trained in mobile warfare, far from their base but heavily armed and confident they can take care of themselves. They're aware that the land around the weapons dumps they're looking for is scattered with landmines.

The blast that hits them is sudden and devastating. Designed to carve through armour, the anti-tank mine explodes under the vehicle, its blast tightly focused. The mass of tightly compressed gas and metal tears through the floor, fatally wounding Sergeant Russell but leaving the other four men uninjured.

Temporarily deafened by the explosion, the soldiers frantically scan the landscape for signs that they're being shot at. As the blast echoes through the hills, they realise this isn't an ambush. But that's not the end of the fear. They've no way of knowing whether there are more mines around. Those who plant anti-tank mines often scatter smaller antipersonnel mines around the area to catch survivors diving for cover. The soldiers use an old emergency technique, probing the ground around them with bayonets or combat knives.

The unit includes a combat patrol medic, who's treating Sergeant Russell as he's lifted from the wrecked vehicle. The Australians send out an emergency call, and American search-and-rescue helicopters take off from the special forces base at Kandahar.

Minutes later, a C-130 Hercules transport aircraft lifts off with a specialist medical rescue team. It overtakes the helicopters and three American medics brave the possibility of more landmines to parachute onto the site of the blast. Within minutes of landing they've treated Sergeant Russell and prepared him for helicopter evacuation.

His injuries are massive, and 30 minutes after he arrives in Kandahar the sergeant is pronounced dead.

As the US helicopters head off into the gathering darkness, the Australians know the explosion and the activity that followed may well have signalled their presence to enemy forces.

They're left with the cold, the memories of a mate and the suddenness of it all and, for each, the lingering fear that they could be next. The SAS men have trained to the limits for the job and they've all been selected for their mental and physical toughness. They are hard hit when word comes back that Sergeant Russell didn't make it, but abandoning the patrol is not an option.

Sergeant Russell leaves a wife and a daughter three weeks old he's never seen.

* * *

Ken Gillespie had close involvement with the Bushmaster when he was Vice Chief of the ADF from 2005 to 2008. The Vice Chief's role then was 'double-hatted', and Gillespie was also Chief of Joint Operations and responsible for managing the ADF's missions around the world.

He was intimately involved in planning for the wars in Afghanistan in 2001 and then in Iraq.

'Though our young people were brave and dashing and went out to do all the things we asked of them, they were working in an environment that was becoming increasingly hostile, with threats like big landmines,' Gillespie says. He recalls the shock of being told of Sergeant Russell's death.

The 33-year-old veteran of operations in Iraq, Kuwait, East Timor and Afghanistan was the first Australian soldier killed on military operations since Vietnam. (Another Australian soldier, Captain Peter McCarthy, was killed when his jeep hit a landmine while he served with the UN in Lebanon in 1988.)

Sergeant Russell's death demonstrated the vulnerability of soldiers on distant operations to relatively cheap landmines—and later to IEDs, which became a brutally effective weapon in Iraq and Afghanistan—and hammered home to Australia's military leaders the need to better protect soldiers on the move. It was clear that, as the threat increased, the vehicles being used by the SASR and the commandos left their occupants dangerously exposed.

'That was devastating, and he was in a vehicle that did not have any protection against that sort of attack,' Gillespie says. 'Mines and IEDs became a real challenge for us.'

Prepared for production

As it comes close to entering production, the Project Bushranger vehicle is still regarded by some in Defence as an armoured caravan rather than a serious military vehicle, and word has spread widely that it's a problem project. Late in 2001, Lieutenant Colonel Louise Abell is up for a new job within the ADF and tells her posting officer: 'Whatever you're looking at for me, there's only one thing I ask. I do not wish to run the Armoured Winnebago project. I don't want Bushranger.'

* * *

At that stage, Abell knew of the project but not in any detail. 'I knew it had been through the mill and that it had not been well defined,' she says. She was aware, too, that sorting the project out had pushed Mark Eggler to the limits.

One thing led to another, other people were unexpectedly redeployed and Abell found herself appointed to run Project Bushranger. She says:

> Mark did an extraordinary job. That project would have gone for all money, if it wasn't for Mark understanding what needed to be done. Nobody knew the capability process better than Mark. If anyone else had been left to sort it out, it would have been absolutely poorly crafted. He's not like most engineers. Mark can write and can put a cohesive and coherent message together. Most engineers can't. So, the process probably wouldn't have survived the scrutiny it was getting if Mark hadn't been there. Just the relentless paper trail, the relentless committees, the relentless 'That's not good enough', and always fighting a rearguard action. I don't know that I could have done that.

Eggler was very committed and driven and saw the value in the capability probably even beyond what it was being asked to do, says Abell: 'He followed the capability process better than anyone I've ever seen.'

Abell was always supportive of the idea that, even on peacekeeping missions, troops might well need better protection than they'd get in a civilian or other soft-skinned vehicle. Some peacekeeping missions can be potentially dangerous, Abell says: 'If you're in a soft-skinned vehicle and you've got 10 people on the side of the road, five of them with an axe, four of them with machetes, and one with a big baseball-type club, they're not looking to have a cup of tea with you.'

So, what made her so reluctant to take on the job? The project was, she says, steeped in politics—both Army politics and national politics:

> I recognised the job for what it was: the hottest potato in town. And Mark saving it didn't stop it from being a hot potato. It just created a focus for people to target,

> and I could see that the wheels would fall off very quickly if one of those who hated it was in a position to actually shoot it. And I could see that I could end up in the same position Mark was in.

Abell took over the project during the vehicle's reliability trials and began fielding regular phone calls from the Defence Minister's office and from her superiors asking how the testing was going.

The vehicles ultimately passed that rigorous process and were certified, but then another issue had to be dealt with. To keep costs down, some of the Bushmasters were being 'fitted for but not with' key equipment. One example was the 'run-flats'—inserts that would allow the vehicle to drive on if its tyres were shot out: 'That was fine except half of the fleet was going to have run-flats and half weren't. Half were having normal tyres because they couldn't afford the run-flats in all the vehicles.'

Abell searched through the budget to gather the required money from other areas of the project to ensure that all of the Bushmasters had run-flats:

> If you're out in a patrol with three of the vehicles, how do you know which one has them and which one doesn't and, by the way, does that mean you've got to operate one of them differently in terms of the tactics you use because you won't be able to drive it if it gets a tyre shot out? That's a nonsense.
>
> Not only the tyres would be different with run-flats. There's a major knock-on effect. The wheels are different, the central tyre inflation system is different. And there'd have to be two lots of tyres in the inventory.

In the longer term, the upfront cost of fixing the problem was a saving downstream.

To accommodate the 10th seat, the vehicle had to be 'stretched' by about a metre. That made it significantly heavier, and it no longer met the requirement that it must be able to be carried aboard a RAAF C-130 Hercules transport aircraft. As well, the hull is designed to handle the loads coming from the wheels, the drive train and the torsional movement of the vehicle as it travels along a road. But when a monocoque hull is stretched, it's no longer structurally stable.

Along with the need for more of the heavy steel armour that made up the Bushmaster's body, the drive train became longer and heavier. 'You've got more steel down the middle turning your wheels. Your suspension doesn't operate the way it did and the torsional movement is completely different,' says Abell.

Then came the issue of blast performance: 'You've got more surface area for that blast to try to penetrate. You're probably moving the windows, and you're increasing the length of your welds, so your heat-affected zones are greater and probably more exposed.' Welding armour is a specialised skill, and the goal is a continuous weld along each join in the metal sheets. The longer a sheet is, the less chance there is

of a continuous weld. Excessive heat during the welding process can weaken the armour: 'You may now have patches of the vehicle that are no longer bulletproof, let alone blast-proof.'

The third problem was with the process of acceptance testing and what to do when a piece of equipment failed. 'I personally do not know of a factory acceptance testing regime that has ever been 100% perfect,' says Abell. But the test program was so jammed that there was no time to fit retests into it. And, when a piece of equipment was changed so that it could pass the test, five other items might have to be retested in case they were affected.

A classic example was the discovery that the vehicle's alternator didn't generate enough power at idle to charge the radios. That was fixed by using a more powerful alternator. The batteries charged. Problem solved? Not quite. Abell then insisted that the electromagnetic radiation output be retested.

The new alternator emitted like a beacon. That would provide a much greater radiation signature to an enemy's scanners and give away the vehicle's location.

The next thing tested was the level of electromagnetic interference, and it turned out that the new alternator reduced the radio's range by close to 20%. It later emerged that a satellite navigation system destined for the Bushmaster reduced the radio's range by 50%. Abell says:

> When you go to test anything for compliance against requirements, you need to leave time for rectification, retesting, before you get into production. And that was never in anyone's schedule or cost and was another absolute hot potato. Nobody wanted to hear about it. The drive is always for delivery to schedule and dollars.

Later, when the decision was being made about whether the Bushmasters should be sent to Iraq and Afghanistan, Abell had to sign off as project director on whether the vehicle was safe to send on operations. One issue was a formal decision on how well it would survive an explosion. While some argued that conditions were too wet to do a final blast test, she insisted that it had to be done, and it was.

Her insistence on testing and retesting sometimes elicited a 'cranky' response, but it was done and the product was the better for it.

At Thales, Chev Viviers says this was an example of how some of Defence's project managers showed the company 'tough love': 'Sometimes we didn't like it, but generally speaking it was good for us. It was good for the program because it got us to the position where we are today.'

But while some in the Army were slow to appreciate what they had in the Bushmaster, most had no idea of the biggest threat that was to confront Australian and other coalition troops in conflicts to come.

Iraq and the bloody end of the ‘soft-skinned’ era

Despite the effort that has long gone into strategic planning, wars tend to be fought with what’s available when the fighting begins. While it was designed to help defend northern Australia, the Bushmaster proves to be a timely and unexpectedly successful lifesaver in conflicts far from home.

* * *

On 11 September 2001, the world was changed by the terrorist attacks on New York and Washington DC. Then followed the invasion of Iraq and the steady build of the insurgency there that was to signal the bloody end of the soft-skinned vehicle era. The challenge of moving troops across a landscape strewn with landmines and IEDs was to intensify as Australia committed its forces. In February 2005, the government announced that Australia would deploy an Army battle group to Iraq’s Al Muthanna Province to protect Japanese engineers working on reconstruction projects there and to help train Iraqi forces.

Many of the soldiers of Australia’s powerful allies, the US and the UK, went to war in Iraq in vehicles that proved frighteningly inadequate in this new form of combat as evidenced in the shockingly blasted vehicles dragged away to a vehicle graveyard.

Thirty-seven British soldiers were killed in southern Iraq while travelling in soft-skinned ‘snatch’ Land Rovers. Once used by the paras in Northern Ireland to grab key IRA figures out of crowds, their most substantial protection was a wire grill that had been placed over the windshield to protect the occupants from thrown rocks.

Andrew Harrison, once a British unit commander in Iraq, and later, as a major general, to command Britain’s forces in Afghanistan, has described the pain of seeing his men killed, effectively by poor equipment. For a time in his two years in southern Iraq, Harrison’s men used the British Army’s notorious snatch vehicles and he saw them repeatedly shredded by Jaysh al-Mahdi’s brutally effective explosively formed projectiles. ‘In “capability” terms we were overmatched. Soldiers under my command paid the ultimate price,’ says Harrison.

Conversely, in Afghanistan he spent six months deep in Taliban-held country. Twenty-six times, vehicles in his battle group were struck by IEDs, some of them massive. By then, his soldiers were using vehicles that were purpose-built and well protected. This time, none of his troops was killed.

‘From this experience, and dozens of similar examples, I’ve learned the unequivocal lesson that great equipment saves lives,’ Harrison says.

In Iraq, American soldiers were driving through perilous areas in their own replacement for the once ubiquitous jeep—the Humvee. Again, the vehicle arrived on the battlefield lightly armoured. Troops were fearful of bombs and ambushes and some took to driving on patrol with tourniquets in place around their upper thighs, to be tightened if they hit a mine or an IED and lost their legs.

US soldiers also improvised by scavenging for scrap metal, from abandoned armour to barbeque plates, to strap onto the panels of soft-skinned vehicles, which were inevitably dubbed 'Hillbilly Humvees'.

The Australians were saved from that by the Bushmaster.

The then Chief of Army, Peter Leahy, says that when the decision was made to send troops to Iraq, those planning the operation quickly found that the Army's transport was not up to the job in an environment in which landmines and IEDs were a growing threat. 'We were looking at an army that couldn't be deployed,' says Leahy. The ASLAV had an effective gun but it proved vulnerable to bombs and, even though M113 armoured personnel carriers had been extensively upgraded, they still provided scant protection against anti-vehicle landmines and bombs.

The Army lacked armoured protected mobility, says Leahy:

> Because the Leopards weren't any good and we were worried about the ASLAVs, there were great concerns about main supply route security—on the road north out of Basra to Baghdad. We finished up protecting the Japanese in the quiet province of Al Muthanna.
>
> So the fact that the Army that had been prepared for the Defence of Australia was not even up to the sort of conflict we could find in the more intense parts of Iraq was an indictment of the Army's lack of preparation for the future.

Ken Gillespie, too, recalls well the search for better protection for the troops. By then the Bushmaster was in production but, while hundreds were being built, they hadn't been formally introduced into service or placed on the Army's order of battle. 'It was homegrown,' says Gillespie, 'and we Australians often take the view that if something's homegrown then potentially it's not as good as we could get overseas.'

Leahy and Gillespie decided the Bushmaster could, however, be the solution. 'The big risk for us was that because the Bushmaster was regarded by the ADF as untested and because Army hadn't become used to operating it, if we put it into theatre and it failed, then that acquisition program would be tainted for the rest of the time we'd have that vehicle in service,' says Gillespie. But that institutional risk was outweighed by operational necessity—the need to provide the troops on the battlefield with better tools. They got together some Bushmasters and put them into theatre.

The Army had no clear idea of what was likely to break or wear out as tough weeks passed on operations, requiring what spare parts, so it worked with Thales to get a lot of spares into containers and moved them overseas.

The first 10 Bushmasters went to the Al Muthanna task group in southern Iraq in May 2005. In September 2005, more were sent to special forces soldiers then back in Afghanistan as the Special Operations Task Group.

'We put them into theatre hoping the risks we were balancing were going to produce the results we required,' says Gillespie. History says they did and the Bushmaster turned out to be a winner. 'It provided fabulous protection for our people. We never had a fatality and I don't think any other country involved in those campaigns can make the same claim about their protected vehicles.'

There was push-back, says Leahy. Some in the Army still wanted ASLAVs, and some wanted American Bradley fighting vehicles.

When the Bushmaster was sent to Iraq, it was largely employed at first as a tractor—a tow truck pulling eight-tonne trailers. Soldiers said that, with their big diesel engines, their 'Bushies' could tow the heavy trailers as if they weighed almost nothing.

As the troops started using the Bushmaster, they saw its versatility: 'It was able to move people around the battlefield in comfort and it extended the capability of infantry because they arrived rested. They had a life-support system close by. We looked at fitting different weapons on top.'

Fortuitously, a vehicle designed for the arid and rugged conditions of northern Australia was well suited to the heat and dust of the Iraqi landscape. Drivers, passengers and convoy commanders were impressed by them.

Troops working in temperatures of 50°C or more while wearing body armour found they could retreat to the air-conditioned Bushmaster for a short time and recover enough to resume tasks outside. That meant they could work longer. With its automatic transmission, its powerful 300-horsepower Caterpillar motor and very effective suspension, the vehicle was easy to drive and much more comfortable than most military transports. Their central tyre inflation system meant they could go almost anywhere. The tyres could be deflated to drive over soft sand and then reinflated for hard ground or roads. To bring the cost down, the Army had agreed to produce some Bushmasters without winches, but that was later found to seriously reduce their crews' chances of recovering their vehicles if they became bogged and so the winches were retrofitted. So, too, were the internal firefighting systems that were initially left out.

Leahy says:

> We couldn't deploy the M113s into Iraq or Afghanistan because of the mine and IED threat, and there were limitations on the ASLAVs for the same reasons. The ASLAV was a good reconnaissance vehicle with good observation and surveillance and it had a pretty decent gun on it but it couldn't be used extensively on the roads because of the nature of its hull. Any sort of mine is going to have a devastating impact on them. Bushmaster, with its added levels of protection—which, frankly, I don't think we were expecting—turned up trumps and was used extensively.

The new vehicle's utility and its acceptability grew as people saw it operating, says Leahy: 'In Afghanistan it was being used by the infantry and then the commandos got a look at it and then the SAS thought: "This is all right".'

The Bushmaster made the Army more protected and more mobile, he says:

> It certainly added to our capabilities and it could be used in these wide-open places with deserts in both Iraq and Afghanistan. In many ways it was a godsend. We hadn't planned it for the tasks it ended up doing but it did them wonderfully well. It provided that protected mobility, it saved lives, it meant that we could deploy much more quickly with much better stores and equipment and, in many ways, it was a mini-base for an infantry section which allowed them to go out and do three or four tasks in a day rather than one or two. It was unexpected but a very welcome capability enhancement on the battlefield.

If the Bushmaster hadn't been available, the ADF would have been faced with a choice of accepting much higher casualties than the 41 personnel killed in the Afghanistan conflict (none of whom died in a Bushmaster) or else severely limiting the troops' travel and, hence, their effectiveness. Leahy says:

> If we hadn't had the Bushmaster we wouldn't have done anywhere near as much. You've got to get to the point of battle—and think of the Chora Valley and similar areas in Afghanistan. You're not going to march up. We wouldn't have put the troops in trucks with tin and canvas, so the alternative was some armoured protection, which the Bushmaster provided, or it would be movement by helicopters.

Australia didn't have its own Black Hawks in Afghanistan but did deploy Chinooks later.

An alternative might have been for the ADF to buy a lot of the big MRAP troop carriers and other vehicles the Americans had developed. They were very expensive and much in demand by the US forces, so it would have been hard to get them.

Another tick for the Bushmaster was that Australia controlled production and the rate of production.

Leahy says, however, that while the Bushmaster is undoubtedly a lifesaver, it's not a tank. It worked well in Iraq and Afghanistan but if an enemy had serious anti-armour weapons or armoured vehicles of its own the Army could have had a problem: 'It's in that motorised space where it's providing some protection but it's not the vehicle you'd take onto a position; nor is it a vehicle you'd use to fight on the position. It's more a battlefield taxi to deliver troops who then have to go forward, walking.'

Gillespie says the Bushmaster was designed for the DoA Army, which had shrunk in size, thanks in part to a much stronger focus on the RAAF and the Navy. It was designed to fight a lightly equipped enemy in Australia's north:

> The enemy we were anticipating was of a raider type, so it was lightly equipped and it was under-strength because the RAAF and the Navy had hit them on the way through the sea–air gap.
>
> So, we were an army that had got smaller, which had older capabilities like our Leopard tanks, which weren't deployable—they would have been sliced. We had very limited mobility and limited logistics and that's what we were prepared for—light-scale combat in the north of Australia. And then through Cambodia, Rwanda, Somalia, many of us realised that our operations were offshore. Then we found we had, fortuitously, not engaged in a big battle. We fought enemies that were not well equipped and the forces designed for low-level conflict in the north of Australia fortuitously fitted in to the type of conflict we found ourselves in.

The enemies who ultimately confronted Australian soldiers in Iraq and Afghanistan were inventive enough to produce weapons that came close to bringing modern armies to a standstill.

The threat: a simple path to carnage

On a patrol through Afghanistan's Mirabad Valley on 13 August 2011, an Australian soldier driving a Bushmaster sees two men standing on the roadside with a motorbike. One thrusts his arm upwards with fingers suddenly splayed in a gesture signifying 'Boom!' Moments later, a bomb explodes under the vehicle.

The diggers on board that Bushmaster escape the blast unhurt, but a second vehicle sent to recover the first runs into a similar bomb hours later and two soldiers are wounded, one of them seriously. He's flown to a US military hospital in Germany for specialised treatment by doctors experienced in dealing with wounds suffered in Iraq and Afghanistan.

The Taliban are quick to issue a media release saying they have destroyed two 'tanks' belonging to the infidel invaders and that a helicopter has been flown in to recover the dead and wounded.

Specialist teams of Australian and other coalition crime-scene, explosives and forensics experts examine the debris left after these attacks in the hope of identifying the bombers. The investigation reveals that the men with the motorbike on the roadside were spotters signalling the patrol's approach to an accomplice hiding 70 metres away in a cornfield. That insurgent yanked on a kite string to set off a spring-loaded trigger linked to a battery pack, completing an electrical circuit and detonating a container of home-baked, fertiliser-based explosive buried in the dirt road.

The investigators' goal is to identify those responsible and to gather enough evidence to have them charged by Afghan police and prosecuted in an Afghan court. That process involves troops photographing and fingerprinting people behaving suspiciously and then feeding the information into a database. Soldiers involved in such incidents are instructed to collect and bag the debris from the bombs. If the investigators discover several bombs made the same way, then it's likely they were made by the same insurgent or cell. On the ground, combat engineers use metal detectors and dogs trained to find explosives. When bombs are found buried on roadsides, hidden in animal carcasses, in caches or pointed out by locals who want them removed, they are, where possible, dismantled by the explosive ordnance disposal teams and the parts are examined by the forensic experts.

The key ingredient, the commonly used fertiliser ammonium nitrate, is illegal in Afghanistan, but it's manufactured in neighbouring Pakistan, and the insurgents who carry it across the border rebag it as legal fertiliser. In an effort to thwart the smugglers,

the soldiers carry ammonium nitrate testing kits. Stacked landmines and artillery shells are also popular IED ingredients.

While most detainees picked up by the soldiers are released after four days in detention for lack of evidence, their fingerprints, photographs, home locations and other details are recorded, kept on file and shared with allies.

* * *

First in Iraq, and later in Afghanistan, insurgents using homemade bombs blunted the effectiveness of the world's most modern armies by inflicting casualties to slow their adversaries' rates of advance and patrolling. The internet enabled insurgents in Iraq to learn in 18 months techniques it took the IRA 30 years to develop in Northern Ireland. Later, bombs used in southern Thailand were to use similar technology to that developed in Iraq.

In the years before the invasion, Iraq's schools and universities produced a large number of engineers, many of whom specialised in electrical or chemical engineering, making them well qualified, should they be so inclined, to build bombs out of household goods and leftover munitions. As well, the US decision to disarm and send home almost all members of Saddam Hussein's armed forces meant there was a vast reservoir of soldiers without jobs, bitter and disillusioned and easily recruited by Iraqi insurgents or foreign terrorists.

Collectively, they knew where there was a nearly limitless supply of munitions scattered across their country, hidden in caches or simply abandoned in ammunition dumps.

For many in the coalition forces, the development of precision-guided munitions, combined with dominant air power and highly mobile special forces, was regarded as a silver bullet that would help ensure a swift and unequivocal victory. Such a combination had already helped drive the Taliban from power in Afghanistan in 2001.

But, in a classic example of asymmetrical warfare, the smart use of resources and backyard technology enabled outgunned insurgents to close the gap to a remarkable extent, doing damage out of all proportion to their numbers. Insurgents using equipment as simple and available as washing-machine timers and garage-door openers that send a radio signal and an unending supply of powerful explosives soon made road travel prohibitively dangerous in many areas. (It's ironic that the kite-string trigger proved simple but effective given that the Taliban once banned kite-flying in Afghanistan.)

IEDs could be set off using a mobile phone, by a simple timer, by a pressure plate as in a landmine, or using a command wire or cable, which meant the bomber must remain nearby. Pressure-plate triggers could be improvised easily by using, for instance, a flexible saw blade above a metal plate so that weight made them touch to complete

an electrical circuit when a vehicle drove over them. High-frequency remote-control systems such as garage-door openers became increasingly common.

IEDs exploded at the rate of 50 to 100 a day, mainly in the Sunni Triangle. Australian soldiers had narrow escapes. In 2004, a suicide car bomber badly damaged an armoured vehicle of the Australian security detachment protecting the embassy in Baghdad. Only the commander's protective equipment saved his sight. In 2005, an improvised bomb on a country roadside narrowly missed Japanese soldiers being guarded by Australian troops in Al Muthanna Province. Two former Australian soldiers who were working as security contractors in Iraq were killed by roadside bombs while they escorted civilian convoys outside Baghdad.

The situation became so serious that the key coalition nations set up units to study the threat and to bring down the casualty rate.

American investigators used forensic technology in the arrest of two Iraqi men living in the US after they discovered that the men's fingerprints matched a set of prints taken from bombs that were set to kill US troops in Iraq but failed to explode. The men arrived in the US in 2009 as refugees.

When Australian troops were sent to Iraq's Al Muthanna Province in 2005, it was clear to analysts in the Defence Intelligence Organisation (DIO) that coalition forces there were being hit hard by IEDs and that began to dominate their reports. Deeply concerned about the safety of troops on operations, ADF chief Angus Houston asked Brigadier Phil Winter to prepare urgently a report on the bomb threat and options to deal with it. Winter recommended the creation of a highly specialised Counter-IED Task Force to assess the threat and devise countermeasures. Airfields, ships and road transport had all been targeted by the bombers and Houston told Winter to enlist explosives specialists from across the three services. Winter was told he could have all the resources and whatever personnel he needed to improve the safety of the troops in theatre.

Houston was true to his word, and Winter's team—known quickly through the ADF as 'CIED TF'—began assembling within hours. Its members included Army engineers, Navy clearance divers and RAAF explosive ordnance specialist along with specialists from the Defence Materiel Organisation and the Defence Science and Technology Organisation (DSTO). Strong links were established quickly with the Australian Federal Police Bomb Data Centre, which provided forensics training.

Investigators from Australia and elsewhere were soon studying the bombers' techniques closely so that they could be more effectively countered. They examined the aftermath of attacks, and unexploded devices where they could find them. That helped the unit develop countermeasures and find evidence to help track down the bombmakers. It also used DIO networks to develop links with teams in the US and Britain and with non-traditional allies from across the globe.

The task force quickly dovetailed into the Joint-Improvised Threat Defeat Organisation (JIDO) set up to support the US Defense Department and it worked closely with the British and the Israelis. 'The generosity of the UK in 2006 helped us develop our manpack and vehicle-mounted ECM [electronic countermeasure] capabilities, to defeat radio-controlled IEDs,' says Winter.

'We were flat out and the work was exhilarating,' says Winter. 'It was like a mini Manhattan Project and we had nearly 20 of the best brains in the ADF on it.'

CIED TF still exists with an enduring role providing agile responses to asymmetric threats.

The situation of coalition forces in Iraq was indeed dire. The numbers of casualties soared and the demand for additional armour plate caused a shortage of high-grade steel in the US.

Lessons learned in the field were passed on to personnel in their pre-deployment training. Some of it was as simple as avoiding unnecessary trips and predictability—not using the same route twice. In southern Iraq, four British soldiers were killed in November 2006 by a bomb placed under a bridge by insurgents who saw them set off in boats in the morning and knew they would come back that way in the evening.

To keep its members focused, the counter-IED unit's office had on its walls in the DIO building pictures of shattered vehicles and massive holes in the ground. The unit's mission statement was to do everything possible to protect Australian service personnel and others from IEDs. But, with an eye on the possibility of similar attacks in Australia, it stressed that the unit must be ready to support domestic security efforts.

'Our job is to do what we can to prevent casualties, to understand what our allies are doing and to get information fast to our troops,' Winter said at the time. 'But this is not just about Iraq and Afghanistan. It's about what terrorists anywhere can do cheaply. They can chip away at Western forces and can erode our national willpower.'

While there was nothing new about irregular forces bombing troops, the rate and scale of the attacks in Iraq stunned coalition strategists. 'I don't think anyone foresaw the scale of this or the success they would have,' Winter said. 'We'd entered a new age of irregular warfare. It was a whole new ball game.' The IEDs were particularly dangerous because they could come from anywhere at any time. Closer to home, one of the 2002 Bali bombs was made from cheap fertiliser and was triggered with a mobile phone.

The Iraqi insurgents even used a 450-kilogram aircraft bomb to destroy an Abrams tank. The blast upended the 62-tonne armoured giant and tore its turret off.

Many bombs were ingeniously disguised. They could be hidden under piles of rubbish, rubble or dead animals or built into concrete kerbstones that looked like part of the roadway. Everything became suspect. Try identifying as a bomb a block of concrete in a country littered with rubble. Sometimes the bodies of victims of sectarian killings were booby-trapped in particularly callous attempts to kill emergency workers.

It became so dangerous to travel on many roads in Iraq that coalition forces relied heavily on air transport, but, in a follow-up phase, insurgents began ambushing helicopters with massed rocket and missile attacks. Insurgents constantly used the internet, reading everything from news reports to transcripts of US congressional hearings for weaknesses in coalition vehicles or tactics they could exploit.

The insurgents were sophisticated enough, too, to carefully note the tactics used by troops who came under fire and used that information to set up complex ambushes designed to bring coalition armoured vehicles, and people, within range of their bombs. The first sign may have been a burst of gunfire from an AK-47 to send the members of a foot patrol diving for cover. Responding to their intensive training, the soldiers would take positions to protect themselves and each other. Then another insurgent in a higher vantage point and armed with a sniper rifle would aim to pick off individual members of the patrol: the unit leader, the radio operator and the medic. As an armoured vehicle moved up to rescue the pinned-down soldiers, the insurgents would detonate an IED next to it.

The most dangerous development was the ‘explosively formed projectile’—a cylinder that blasted out a large blob of metal at 2 kilometres a second that could pass straight through the armoured sides or the belly of a vehicle.

In the task force office for a time was a life-sized cut-out of a dog with fluorescent tape as eyes. Coalition troops in Iraq were warned not to run over animals they saw watching them from roadsides because they might be cut-out shapes hiding a bomb. Stray dogs roamed in large numbers in Iraq and were feared because they could carry rabies, so truck drivers were inclined to run them over. Insurgents created bombs with the trigger mechanisms hidden behind fake dogs whose gleaming eyes made them look realistic in a vehicle’s headlights.

Thousands of coalition personnel and civilians were to be killed in Iraq and Afghanistan by bombs. Over the three years to mid-2007, they’d caused around 70% of the US casualties in Iraq (more than 3,200 dead and 22,000 injured). Many of the estimated 1,000 civilian contractors who died were killed by IEDs. Those figures don’t include thousands of Iraqi civilians and security personnel killed by bombs.

In a secret report written in 2012 but since declassified, *The Australian Army and the war in Iraq 2002–2010*, Dr Albert Palazzo of the Directorate of Army Research and Analysis said the greatest threat to the lives of Australian and coalition personnel in Iraq was the IED. Palazzo observed that explosive mines and booby-traps had been in use for centuries and that there was little new about the use of IEDs other than their 'home-made' nature:

> What was new was the unpreparedness of Western military organisations and the ability of a simple tactical weapon system to reverberate at the strategic level of war.
>
> IED's come in numerous types and insurgents equip them with a variety of firing mechanisms including command, pressure plate, passive infra-red beam and suicide. They truly are an 'improvised device' and can be effectively constructed from recycled ordnance, homemade explosives or a combination of the two, and detonated by something as ubiquitously available as a mobile phone or garage door opener. Large IEDs are capable of destroying a main battle tank while even small ones can reduce an unarmoured vehicle to a smouldering wreck. The advent of explosive formed projectiles (EFP) only served to make the IED even more formidable. In sum, IEDs are cheap to make, easy to set up and highly effective when activated. In Iraq the insurgents have used them in their thousands.

Palazzo warned that the emergence of IEDs 'has led to a cycle of invention and response in which the US-led coalition has struggled to keep up with the insurgents' rate of weapon evolution'.

The insurgents had been able to improve their devices faster than the coalition could develop and deploy countermeasures:

> In effect, the Coalition has been losing the IED adaptation cycle in Iraq. Coalition weapon development practices and timelines, doctrinal revision and dissemination policies, and a preference for technological over other solutions has assured that its forces cannot match the pace of change imposed by the insurgents in developing the next version of IEDs.

That was not to say that the coalition hadn't made considerable progress, Palazzo said. It had implemented great changes in how it equipped and operated. The advances made included the revision of doctrine and tactics, purchases of improved individual protection equipment, the deployment of mine-resistant vehicles, the acquisition of armour enhancements for existing vehicles, the use of platforms in novel ways, and the mobilisation of science to help develop countermeasures.

But he said that, significantly, in addition to winning the adaptation cycle, the insurgents had also won the cost cycle. IEDs were low-cost and low-tech and the perfect weapon for an insurgent, but the task of countering IEDs was expensive and complex, and the cost continued to mount, Palazzo said:

> Insurgent simplicity has been met by counterinsurgent complexity and budget bulging expenditure with the result that the cost of defence has greatly exceeded the cost of offence. It is not yet clear what the great cost differential in the IED campaign means for the art of war, however, it would be in the interests of Coalition societies they find the means to close this gap.

Palazzo said the ADF did not ignore the threat IEDs posed to its forces in Iraq. Ordinary civilian SUVs and military trucks were replaced with PMVs, ASLAVs received enhanced armour and spall liners, small unmanned aerial vehicles flew ahead of convoys scanning the ground and relaying data back to controllers, and the RAAF's PC-3 maritime patrol aircraft operated largely over land rather than sea.

When the Army's security detachment (SECDET-I) arrived in Baghdad to protect the Australian Embassy, it used hired civilian vehicles, and supply runs to Camp Victory were done in an ordinary Unimog truck. As the threat grew, the civilian vehicles and the Unimog were up-armoured until they were replaced by improved ASLAVs or Bushmasters.

By then, the Taliban were back in Afghanistan in strength and using tactics imported from Iraq. When coalition forces were sent to confront them, Winter and his colleagues were concerned that the IED threat would follow Australia's soldiers there. But their warnings of what might be coming appeared to be largely ignored and the view seemed to have taken hold that the diggers would face a less sophisticated enemy in Afghanistan. Winter found himself earmarked for other tasks, and IEDs seemed to have become a lower priority.

But he was right.

In October 2007, Winter took leave and was checking in at accommodation on the New South Wales coast with his family when he received a phone call asking him to return to Canberra urgently. A popular soldier, Trooper David 'Poppy' Pearce, had been killed in Afghanistan when the ASLAV he was driving detonated an IED. The Afghan insurgents, too, had quickly become masters of the internet and used the satellite systems of the West to import bombmaking instructions. Said Winter in a 2007 interview: 'They are intelligent, skilful, desperate people, who want us out of there.'

Soon after the double Bushmaster blasts in the Mirabad Valley, the then head of the ADF's Joint Operations Command, Lieutenant General Ash Power, told troops in Afghanistan that evidence they collected would be kept on file and might well be

used if bombers arrived in Australia as asylum seekers. Specialists on operations searched for fingerprints and traces of blood or tissue left by bombmakers who cut themselves while building the devices. DNA could often be extracted from that material. By keeping detailed records, the investigators picked up patterns, such as specific bombmakers moving from one province or district to another. They worked out that kite-string bombs were likelier in August, when the corn crops were high enough for triggermen to hide in them. On one occasion, two Australian snipers moving into position encountered a kite string, which led them to a bomb.

An officer who worked with the task force said its forensic investigators operated like television's *NCIS*, 'but without the one-liners'.

In the film *The Hurt Locker*, a bomb disposal specialist in Iraq finds wires buried in the dirt and uses them to drag to the surface a pile of artillery shells set up as a massive multiple bomb. Somehow he isn't blown to bits. The real thing was very different. The Australians and coalition specialists scoffed at the Hollywood dramas. They were equipped with sophisticated equipment, including remotely controlled robots complete with long metal feelers and cameras, that allowed them to examine and deal with bombs from afar. But when they found wires partly buried in the sand they proceeded with extreme caution, and their favoured tools were a prodder, similar to a sturdy screwdriver, and a household paintbrush.

At the Australian base in Tarin Kowt, forensic investigators examined bomb parts collected by diggers in the field. Among the variety of explosives included in IEDs were old Soviet artillery shells left behind after the 1979–89 occupation. Dismantling the bombs had additional risks. Some were fitted with anti-handling triggers that could set off the whole lot. To the experts, a bomb with a second explosive inside it is a 'trojan'. When the team members reached a bomb, they set up a safe area and then one of them made what they called the 'long, lonely walk' to the bomb. An explosives specialist, who can be identified only as Warrant Officer G, described the silence of that walk:

> Once you're down range, it's quiet and it's peaceful. You can concentrate on doing the stuff you're there for. There's a big surge of adrenalin. It's your wits versus the wits of the guys who made the bomb. You know they're trying to kill you or your mates and you need to think outside the box to deal with the device.

When the specialists found buried wires, they handled them gently and used soft strokes with the brush to clear the sand away. They had to be constantly aware of the danger of being lured into a trap—there might be more than one bomb. 'You've got to be very aware of being sucked in,' said Warrant Officer G. 'It could be a "come-on".' A 'come-on' is a trap set with wires to entice one of the team to follow them to another bomb that's well hidden and set to be detonated remotely by an insurgent or by a buried pressure plate.

The explosive ordnance disposal teams carry portable X-ray equipment that enables them to check inside devices for 'trojans' or booby traps. Warrant Officer G said the team was well aware of the need to make good first choices: 'If you've got your head over something and it goes "Bang!" then you don't get to do it again.' He said he enjoyed the work, despite the danger and pressures: 'You can't get the same mateship anywhere else.'

Complementing the investigators' efforts, special forces teamed up with elite Afghan police units in the valleys and mountains to hunt down bombmakers. Capturing or killing skilled bombers removed a key part of the insurgents' corporate memory and saved lives by making the bombs more amateurish and easier to deal with. Each bomber has his own style and leaves his trademarks. Some bombs are simple and deadly. Other bombers, with less experience, get it nearly right, but their bombs are flawed and don't explode or only partly detonate. There's a Darwinian element, too: bad bombmakers don't tend to survive.

The bombmaker's vessel of choice is a yellow palm oil container, which can hold 20 kilograms of home-baked explosive. That's enough to tear apart trucks or a farmer's tractor and trailer. Bombs can be recognised through the nous of a soldier who sees a disturbance in the soil or notices material that's out of place or an animal carcass that needs to be checked out.

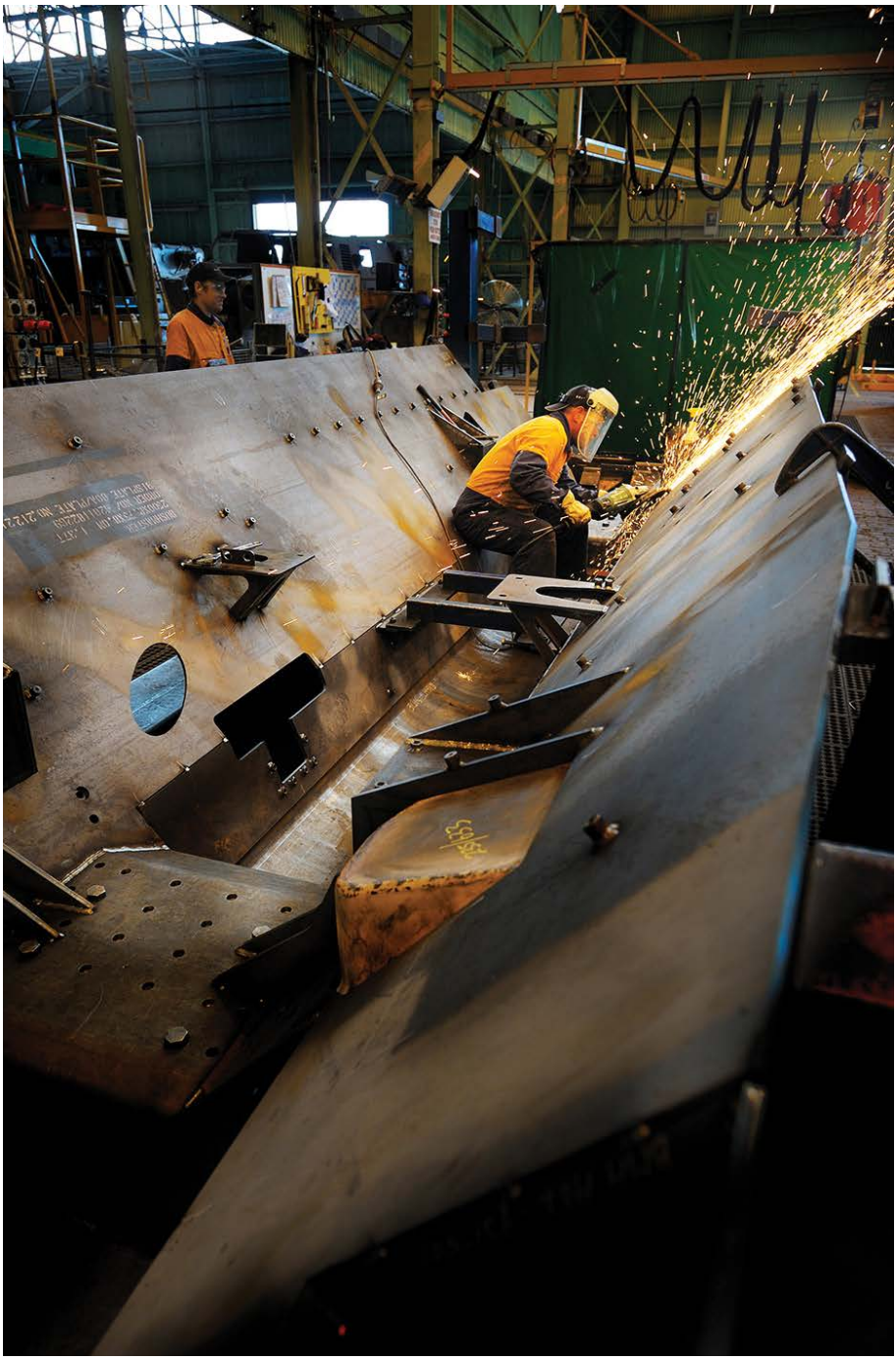
In 2011, the then director of the counter-IED unit in the Joint Task Force HQ, Lieutenant Colonel Matthew Jones, said the team treated each site as a crime scene and aimed to learn from every event.

The insurgents had been fighting for 40 years, Jones said:

> It's almost in their blood and they're quite savvy in how they go about their business … We can't stop everything. We can't be lucky every time but we're going to die trying to ensure we've done everything possible with every resource we can throw at the problem.

Australian members of the United Nations Transition Assistance Group aboard a South African–built Casspir armoured personnel carrier in Ondangwa, Namibia, in November 1989. Note the V-shaped hull. Photo: Australian War Memorial, Collection P01754.018, online.

Bushmasters were sent into harm's way long before they were officially cleared for operations. Two prototypes—B1 and B3— were sent to East Timor in 1999, during Operation Stabilise, as convoy escort and VIP protection vehicles. While proving sturdy and reliable, they also did much less damage to farmers' fields and fragile roads than tracked vehicles. The third vehicle in this early trio, B2, was destroyed during blast testing. Photo: Australian Department of Defence, online.



Building the Bushmaster from the V-shaped hull up at the Thales plant in Bendigo, Victoria. Photo courtesy of Thales.

The V-shaped hull and monocoque construction are apparent on this Bushmaster under construction at the Thales plant in Bendigo, Victoria. Photo courtesy of Thales.

A Bushmaster that had seen action in Afghanistan, and its crew of military crash-test dummies, were selected for a violent experiment, designed by Defence scientists and Thales engineers, to examine the likely impact of a bomb on the vehicle and the soldiers aboard it.
Photos: Australian Department of Defence.

Bushmasters of Australia's Overwatch Battle Group cross the Ad Dibdibah Desert in Iraq's Al Muthanna Province in January 2007. Photo: Australian Department of Defence, online.

A Bushmaster convoy on the move in Uruzgan Province, Afghanistan, in April 2007. Photo: Australian Department of Defence, online.

A Bushmaster from Reconstruction Task Force Three in Afghanistan's Chora region in February 2008. The Australians and a contingent from the Afghan National Army built the ANA a forward operating base. Photo: Australian Department of Defence, online.

An Australian Bushmaster on patrol in Afghanistan's Uruzgan Province provides overwatch for a reconstruction task force in July 2008. The task force built a series of patrol bases for coalition and Afghan security forces. Photo: Australian Department of Defence, online.

A soldier dismounts from a Bushmaster to fire an 84 mm rocket launcher on the Camp Holland range, Tarin Kowt, Afghanistan, in July 2007. Photo: Australian Department of Defence, online.

The wreck of Royal Netherlands Army corporal Rick Smulders' Bushmaster, which was immobilised during a fight with the Taliban in the west of Afghanistan's Uruzgan Province and later destroyed by a Dutch Apache helicopter. Photo courtesy of Rick Smulders.

Wheels versus tracks? A Dutch Bushmaster towing a YPR near Tarin Kowt, Afghanistan, in August 2007. The YPR is an upgraded version of the American M113 armoured personnel carrier used by the Dutch forces. Photo: Netherlands Ministry of Defence, online.

Bushmasters surround the construction site of a checkpoint near the mouth of the contested Baluchi Valley in southern Afghanistan in February 2008. Australian infantry, cavalry and combat engineers fought off repeated insurgent attacks as the project progressed. Photo: Australian Department of Defence, online.

One of several Bushmasters from the Special Operations Task Group during a counterinsurgency operation in Afghanistan's northern Uruzgan Province in November 2009. Photo: Australian Department of Defence, online (image altered for operational security reasons).

Australian soldiers at a roadblock on the outskirts of Tarin Kowt, Afghanistan, in July 2007 as a search operation takes place in the town. Photo: Australian Department of Defence, online.

A Bushmaster from Australia's 1st Mentoring and Reconstruction Task Force splashes its way along the main road in the Baluchi Valley in southern Afghanistan in January 2009. Sleet and rain made the Afghan landscape a boggy quagmire in winter. Photo: Australian Department of Defence, online.

A Bushmaster, flanked by soldiers from Australia's 1st Mentoring and Reconstruction Task Force, patrols through the Baluchi Valley in southern Afghanistan in May 2009. A joint force of Australian, Dutch and Afghan troops searched for weapons caches during Operation Mani Ghar. Photo: Australian Department of Defence, online.

Vehicles are dwarfed by the blast as an Australian Special Operations Task Group patrol, mounted in Bushmasters, triggers a controlled detonation of one of 16 improvised explosive devices uncovered as it cleared a path through an area heavily sown with the bombs in Afghanistan's northern Kandahar Province in October 2010. Photo: Australian Department of Defence, online.

Soldiers retrieving a Bushmaster hit by a large bomb in Afghanistan. Photo: Australian Department of Defence.

David Nicolson survived four Bushmaster bombings on Route Whale in 2011. This embattled road runs through southern Afghanistan's Mirabad Valley. Photo courtesy of David Nicolson.

A Bushmaster with a self-protection adaptive roller kit (known as a 'SPARK roller') clearing roads of improvised explosive devices near Tarin Kowt, Afghanistan, in November 2012. Photo: Australian Department of Defence, online.

Bushmasters ford a river in Afghanistan's Mirabad Valley in June 2012. The vehicles were part of a convoy visiting patrol bases Musazai and Hamid. Photo: Australian Department of Defence, online.

A 2nd Cavalry Regiment Bushmaster near the Australians' base at Tarin Kowt, Afghanistan, during a patrol in November 2013. Photo: Australian Department of Defence, online.

An Afghan family crosses ahead of a Bushmaster patrolling in Afghanistan's Chora Valley in December 2008. The troops from Australia's 1st Reconstruction and Mentoring Task Force worked on schools, health facilities and government buildings. Photo: Australian Department of Defence, online.

Australian Army engineers at a patrol base remove a remote weapons station from a Bushmaster for maintenance during operations near the village of Kakarak in southern Afghanistan in April 2009. Photo: Australian Department of Defence, online.

Bushmasters landing during an amphibious assault on Langham Beach in north Queensland during Exercise Talisman Sabre in July 2017. Photo: Australian Department of Defence, online.

A Bushmaster and Afghan ‘jingle trucks’ share the highway—and the ever-present threat of bombs and ambushes—during resupply mission Operation Tor Ghar IV in southern Afghanistan in October 2010. Photo: Australian Department of Defence, online.

A Bushmaster is loaded onto a C-17 Globemaster at RAAF Base Amberley in southeast Queensland in March 2017 for delivery to Fijian peacekeepers on the Golan Heights. The giant transport aircraft can carry five Bushmasters, three Blackhawk helicopters, or up to 75 tonnes of equipment and supplies. Photo: Australian Department of Defence, online.

Peshmerga and British troops in a Bushmaster patrol the town of Bashiqa, just north of Mosul, in November 2016, during operations to recapture Iraq's second-largest city. In 2008, Britain bought 24 Bushmasters for use by its special forces, who know the Australian-built vehicle as the 'Escapade'. Modifications include the addition of a bull bar. Photo: Hamit Huseyin/Anadolu Agency/Getty Images.

A study in steel

The test blast confirms the accuracy of the computer modelling. The explosion is massive and its intensity chilling to see. The scientists are given a confronting view of the reality faced by troops on operations as the 15-tonne vehicle is hurled high into the air and slammed down again with a ground-shaking thump.

* * *

Steel is a remarkable material, but so widely used that it's taken for granted in the modern world. Many of those who sail in steel ships, cross steel bridges, cut with steel knives or shave with steel razor blades might be vaguely aware that it's an alloy of iron and that it's made in furnaces.

But steel isn't just steel, and there's an art to producing different types of the metal with the specialised qualities to meet different situations. As the Bushmaster project approached the production stage, the quality of the different types of steel used in the vehicle was crucial to its ability to protect those on board it. Metallurgist Dr Janis Cocking had come to the Bushmaster project after long experience as the chief of DSTO's Maritime Division and as coordinator of its Submarine Science and Technology Group.

While its experience had been with ships and submarines, Cocking's team brought that seagoing expertise to assess and improve the 'survivability' of the Bushmaster. There were some similarities between the results of a blast on a submarine's hull and the impact of an IED or a mine against an armoured vehicle's hull.

The scientists brought crucial knowledge of the impact of pressure on steel—the long, slow pressure of depth on a submarine's hull and the near instantaneous shock created by a weapon exploding near the boat. They had the experimental background and the scientific underpinnings to understand what happens when a blast hits a vehicle and how important shape is in dealing with blast. The team had been building that expertise over many years and applying it to maritime craft in survivability trials. It had also been involved in the early Project Bushranger vehicle tests.

Some of that research and experimentation was done in the 1980s in the qualification tests to choose the steel for the Collins-class submarine.

The toughness and resilience of steel depend on the impact of small amounts of other elements, such as carbon, silicon, chromium and cobalt, added to the much more brittle iron, and how it is treated with severe heat and quickly 'quenched' in cold water to change its molecular structure, making it harder or more flexible.

That defines its ultimate tensile strength (what it takes to break it) and its ductility (how much it will deform before it starts to crack).

It takes great skill to create blast-resistant steel armour plate, and an Australian company is a world leader. Wollongong-based Bisalloy Steels produced 8,000 tonnes of 'quenched and tempered' high-grade steel plate for the six Collins boats. Knowledge from the submarine project on the nature of steel and the results of blast-testing flowed on into the Bushmaster, and Bisalloy was chosen again to produce its armour—hard, bulletproof metal for the vehicle's upper body and more ductile steel, able to absorb a blast without shattering, for the V-shaped hull.

That led to the choice and qualification of the new steel. The understanding that the DSTO team had from its submarine studies of the impact of blast and fragmentation was then applied to the Bushmaster.

Into the Bushmaster project came another echo from a past conflict: knowledge gleaned by the DSTO team when it advised the 2009 commission of inquiry into the World War II loss of HMAS *Sydney*. The light cruiser and pride of the RAN was sunk by the German raider *Kormoran* off Western Australia on 19 November 1941. None of the *Sydney*'s 645 crew survived, but shots fired from the fatally wounded cruiser crippled the raider and the German captain opted to scuttle his ship to avoid it being captured.

When the *Sydney* came upon the raider, the German vessel was disguised as a merchant ship, the *Straat Malacca*, flying the Dutch flag. Under interrogation by Australian intelligence personnel after their capture, the Germans insisted that they lowered the flag and ran up the German naval ensign before they opened fire.

The fact that there were 318 survivors from the *Kormoran* and none from the *Sydney* gave rise to decades of speculation in Australia that there must have been foul play on the Germans' part—that the *Sydney*'s crew were massacred as part of a German cover-up.

HMAS *Sydney* was eventually discovered on the seabed off Western Australia, very near to where the German survivors said it was likely to be.

Such was the intensity of public interest that the government of the day commissioned the inquiry. One key question was how so many Germans survived while Australians did not. The Defence scientists were asked to examine photographs and video of the wreck for answers. They confirmed that the cruiser had been shockingly blasted by the German guns and left heavily ablaze, and concluded that most of the crew would have been dead or incapacitated within minutes.

To convey their conclusions, the scientists produced a computer-generated visualisation of the likely consequences of the shellfire on HMAS *Sydney* and its crew.

When IEDs were an escalating threat in Afghanistan, Winter visited the Defence science team and was shown the visualisation. He asked whether similar technology could be applied to IED impacts on the Bushmaster.

Chief Defence Scientist Dr Bob Clark went to Afghanistan to see at close hand how the ADF used the Bushmasters there and the nature and scale of the threats they faced. After talking to the troops and hearing their accounts of facing the IED threat daily, Clark was able to talk with real authority and passion inside the department at the right sort of levels.

When Clark returned to Australia, the team discussed the increasing size of IEDs and their impact on vehicle survivability. Clark joined the dots and picked up Winter's idea that constant computer modelling was necessary.

By this time, DSTO had set up flyaway 'tiger teams' for the Bushmaster project. They were made up of scientists and technicians from different disciplines who would share their expertise and learn from each other, and they were ideal for quick and detailed assessments in war zones.

A very effective process evolved for getting information back from a blast scene in Afghanistan to the Defence scientists and to the engineers and researchers at Thales. After each attack, details were loaded into a database to which the scientists in Australia had access. 'We understood the damage, the injuries, how it happened,' says Janis Cocking. Some vehicles were brought back to Australia for examination. 'We put in place volunteer teams to go into theatre and better understand what had happened.'

The scientists assessed the size of individual explosions and the impact they had. Forensic science and technical intelligence were applied in a bid to work out who the bombmakers were and how sophisticated they were getting as a way of mitigating their threat. Teamwork was crucial to success, and DSTO worked closely with the Army's Counter-IED Task Force and Defence's Strategic Command Group on how to enhance the vehicle's survivability, given the growth in the explosive capability of the IEDs.

'Some people were not convinced that in modelling we could produce a result in the time they had,' says Cocking. 'We needed to be able to convince them that we could come up with an answer quickly. It was very important to prove the science behind what we were trying to do. Our aim was mission driven.'

Senator Faulkner initiated a major review of force protection soon after he became Defence Minister and at a point when the casualty rate was increasing.

There was a sense of great urgency in DSTO. Cocking says:

> People in this project were really passionate about saving lives. They knew there'd been casualties and the threat was ever increasing. It was very important to them to be able to make a difference. Many scientists could spend their lives working on something without necessarily knowing that it's made a difference, but the people on this team knew they'd made a difference and that was always incredibly important.

There was urgency too in the team at Thales in Bendigo where engineers had developed a number of design modifications to the vehicle to improve its protection levels.

The push to save soldiers' lives was capped with a million-dollar experiment. 'In the end, you have to convince people,' says Cocking. 'I went to a meeting of the Strategic Command Group with the Secretary, Ian Watt, and the CDF, Angus Houston, to ask them if I could blow up a Bushmaster. I needed to convince them that what we'd designed was right—and they let me have one.'

The vehicle used in the tests had been slightly damaged by a bomb strike in Afghanistan, but the team was able to work that into their calculations.

To confirm that its computer modelling was accurate, the team had to decide how the trial would be conducted and where to place the cameras and equipment to measure the impact and results of a massive blast on soldiers' seats, and the crash-test dummies in them, and the extent to which those aboard would be thrown around. The use of sophisticated instrumented dummies meant they could measure the impact on different body parts, such as feet that might be resting on the floor.

The goal was to produce an even tougher vehicle able to confront increasingly potent bombs. Cocking says:

> We laid out the steps we were taking to demonstrate that the proposed upgrades to the Bushmaster would mean it would be survivable against what we understood to be the emerging threats for an appreciable time. We needed to be able to validate our modelling to have the confidence to transition it into fielded equipment. We'd done a lot of homework and we were confident in what we were proposing, that this was not just, to use a Dennis Richardson term, a 'frolic'.

Central to the process was physicist Christine Scala, who, as a persuasive research leader, assembled the multidisciplinary team of scientists, engineers and technicians. Not all of the scientists involved had the same opinion, Cocking says. Scala had to take a lot of varying views and synthesise them, work it out and make the judgement on what the team was going to do.

Houston and Watt approved the tests without hesitation.

Explosives were set under various parts of the vehicle to see what the impact would be under particular scenarios. Once the team validated its work with a big test, then it had confidence that if it placed a theoretical bomb in any place in its computerised model, it could trust the results.

Instruments recorded every detail of that blast, and modifications based on those measurements went into the production line to improve protection levels. Bushmasters already being used on operations were retrofitted in theatre. With the resultant modifications, the engineers were able to significantly improve the chances of those in the Bushmasters surviving much bigger blasts. As with any modification, there were concerns that such improvements might create problems elsewhere, and those were tested for, too.

That work was done in August 2012, and a Bushmaster was hit by a very large bomb in Afghanistan in November. Thales CEO Chris Jenkins recalls strong feedback from Defence saying, 'Thank God we did this. It was just in time.'

Cocking says the relationship with Thales was very good. The company had its own modelling capability and, while the DSTO team couldn't release all the information it had about casualties in the field to the company, it could share the modelling and the reasons for its conclusions: 'If they hadn't been open-minded about collaboration, we would never have been able to achieve what we all achieved together.' To Cocking, that was the perfect combination of science, knowledge generation and knowledge exploitation through industry, but with the oversight and agreement of the other parts of Defence to be able to realise it: 'If we hadn't been able to conduct these sorts of trials, which involved Land Engineering Agency and Army as well, it would have been a wasted effort.'

Houston says the whole system worked the way it should: 'There was no lack of cooperation anywhere. It was all collaborative, collegiate, and fully cooperative.'

He says the priority placed on vehicles such as the Bushmaster increased once the ADF started losing people:

> Afghanistan demonstrated to us and other Western nations that this notion Rumsfeld had at the beginning of the war in 2001—that you didn't need armoured vehicles, just some special forces on horses—was horribly wrong. You've got to protect your troops. And if they're in an environment like Afghanistan—indeed, if they're in an environment like we've seen elsewhere in the world in recent years—they need armoured vehicles to protect themselves and their friends.

On operations

It's 11 August 2008, near the village of Kakarak, and Trooper Mark Donaldson is part of a special forces team pursuing an insurgent bombmaker. He's sitting on swags on top of a Bushmaster scanning the high ground ahead for signs of trouble as the convoy proceeds slowly, with engineers clearing its way. Just before midnight, Donaldson hears what he remembers as a 'loud crack'. His ears are ringing and he feels weightless. As he tumbles and spins through the air, completely out of control, he realises the vehicle has hit a bomb and he's been propelled upwards. Thirty kilograms or more of explosive have torn the wheels off the Bushmaster but did not breach its hull.

Donaldson's totally under the control of the blast's momentum. He describes in his book, The Crossroad*, how he reaches the apex of his flight feeling his stomach floating as his body 'stalls'. Training kicks in and he keeps a firm grip on his rifle. Then he's on his way back down. 'Holy fuck,' he thinks, 'I still haven't hit the earth.' Then with a bang he's on the ground, stiff, sore and bleeding. In order of priority he checks that he's in one piece—penis, legs and arms. Donaldson says he wouldn't still be around if it weren't for the Bushmaster.*

* * *

The Bushmaster's capability wasn't fully appreciated until it was in action. Those who backed the concept, including the teams at Thales, were well aware that some senior officers didn't believe the Army needed the vehicle and that they considered it too expensive and wanted to know why Defence couldn't buy an existing vehicle from somewhere else.

Iraq and Afghanistan upended everyone's idea about how such wars would be fought, what would be needed to fight them and the speed with which everything can change. Those operations brought an abrupt shift in thinking about the nature of army transport as the abundant IEDs brought a new level of conflict.

The concerns that had been raised about the vulnerability of other vehicles, such as the M113s, and the lessons learned in Cambodia, Namibia, Somalia and elsewhere were totally vindicated. Thales CEO Chris Jenkins says the Army was able to use the Bushmaster exactly how it was intended, and the way it was designed was a lifesaver: 'It proved every cent of its value in all of its specifications.'

With their 25-mm cannons, the well-armed ASLAVs were intended to lead road convoys, but it quickly became clear that their lack of adequate protection underneath left them dangerously exposed to IEDs, so Bushmasters often replaced them as the lead vehicles.

At that stage, most people didn't 'get' the idea of a Bushmaster leading an ASLAV, but when there was a blast the Bushmaster crew had the greater chance of surviving. Drivers appeared to be the primary target of IEDs, which would often explode on the right-hand side of the vehicle.

As the fighting in Afghanistan intensified, an integrated project team was established. It included Dr Janis Cocking's team of engineers and scientists from DSTO working closely with Thales engineers in Bendigo. Every time something happened to a Bushmaster on operations, whether it indicated a need for better mine protection or countermeasures or other protection levels of the vehicle, the expertise existed to make changes quickly. That brought a dramatic and rapid improvement to the safety of troops deployed in Afghanistan. 'What Army experienced, which they probably hadn't experienced to anything like that extent before, was that the vehicle adapted very quickly to their needs,' says Jenkins.

Australia was able to take charge of its situation and decide that the Bushmaster needed to be an ambulance now, or be a command and control capability, or have an increase in protection level. Jenkins says the cost of doing that was very low compared to similar programs in the US, where much of the ADF's equipment came from. It all happened with Australian knowledge and engineering capability. The members of the team from Thales were continually enhancing their engineering models of the vehicle so that, when a bigger blast happened on operations, they could reproduce that effect on computers and make the changes needed to counter it. Wollongong University did work on welding techniques.

It's about intrinsic sovereign capability, says Jenkins. That was all in Australian hands and it was a breakthrough for the Army to realise that that was very important: 'That's what I saw happening from 2006, when the vehicle was hitting its stride. There was a constant demand for evolution, which was great. It was exactly what was needed.'

By 2005 and 2006, when operations were heating up, everyone involved, especially those troops on the move in Iraq and Afghanistan, were very glad the Army had the Bushmaster PMVs. The doubts were gone and it became obvious that the Bushmaster was badly needed. 'Bushmaster has real capability beyond being a truck, and it needs it,' Jenkins says. 'Every vehicle over there has to have that sort of protection level.'

The next issue to arise was how the vehicle would be used. As the armoured replacement for the tin and canvas of a truck, the Bushmaster was considered a vehicle that could take troops close to the fight but not right into the fight. It changed attitudes significantly. Those who were hanging on to previous views, such as 'It's just a truck', were assuming that if you're not in the front line, it doesn't matter. The practice had been for troops to travel in their vehicles and stop 200 or 300 metres from their objective. Then they'd advance on foot.

In Afghanistan there was no '300 metres'. The soldiers were always in danger of finding themselves on top of a fight. They could come under attack just 100 metres outside their base fence and they had to be ready for it.

IEDs could be anywhere. The front line was no longer well defined, and the risk went on until troops were inside their base fence. 'People were transiting normally from one place to another and suddenly there'd be death all around them,' says one of those involved.

But it took a while for that to work its way through to some of those who weren't there.

Because the Bushmaster was the most highly protected vehicle the soldiers had, they were going to take it to the points of intense conflict, and they did.

By the Special Operations Task Group's rotation 5, from September 2007 to February 2008, the commandos were familiar with their Bushmasters and confident about what they could do.

As they ventured further out into Uruzgan Province on dirt roads and through mountainous terrain, ambushes became more frequent. In one case, a whole company was hit by a barrage of rocket and machine-gun fire from high ground. Those on board thin-skinned patrol vehicles and quad bikes were right in the killing ground. With bullets hammering on their armour plate, the Bushmaster crews locked down their hatches and moved forward. Soldiers walked in the shelter that their bulk provided on their 'safe' sides to rescue the wounded and recover scattered equipment.

Previously, they'd transit from one conflict area to another in soft-skinned vehicles, and the shooters would have to be aware constantly of what was going on, so they never really had downtime. In the safety of the Bushmaster, they had time to rest.

There were IEDs everywhere, and the only way to mitigate that threat was with the Bushmaster.

Before the Bushmasters arrived, the troops were using four- and six-wheeled Land Rovers—surveillance reconnaissance vehicles and long-range patrol vehicles—and four- and six-wheeled motorbikes.

As the IED threat grew, the way the troops moved changed with it, says a commando who served then:

> The IED threat was through the roof, so you couldn't drive soft skins any more, you'd definitely get IEDed. Before we moved to helicopters, the Bushmaster was the primary means of movement. It was great. It was comfortable and carried abundant supplies.

Even with a wheel blown off, a Bushmaster could still drag itself forward for some distance.

When his unit was given the Bushmasters, there was a strict rule that it was only a mobility vehicle: it wasn't to move into the fight but should stop a safe distance away and deploy the troops on foot. The commando says:

> But over that last 300 metres, troops are very vulnerable. Taking the vehicle right up to the fight was better than losing our guys. Then we found that with our 7.62-calibre light machine-guns, we were outgunned. The Taliban had Dushkas, which were able to repel us, and we couldn't get close.

Alternatively, when the commandos in their heavy body armour tried to close with the enemy the 'traditional' way, by dismounting from the vehicles and advancing on foot, the Taliban would melt away.

In the early days, some units illegally modified the front cupola to take a 50-calibre heavy machine-gun:

> That meant we could fight all the way up to a compound or to high-threat areas. With the 50s, we could essentially fight our way all the way to the doorstep. It was safer for the boys to reach the target and then get out the back of the vehicle.

For a time, the commandos were told that modification was not permitted and they must remove the heavy machine-gun mounts. Some removed them; some didn't and simply placed canvas covers over the weapons when they left Tarin Kowt.

Now, remotely fired 50-calibre machine-guns are the norm on Bushmasters.

Grant Sanderson, who served as an SAS troop commander in Afghanistan and worked later for Thales and then for Electric Optic Systems, which makes the remote weapon stations now fitted to many Bushmasters, says the vehicle was never intended to take troops into a fight against heavy weapons:

> But, as the commandos found, it's better than walking into a fight because then there's only so much stuff you can take with you. You can't take big guns, you can't take lots of ammo, you can't take lots of resources, you can't take stretchers, or you've got limited supplies of those things. You can't take power. And in a world where more and more of the soldier's advantage is in things like night vision equipment, and communications, and sensor systems, those things require power. So having a vehicle that can keep those things charged until you have to get out is important.
>
> When you get out, you only then have to take the stuff with you that's relevant to that fight. If you have to walk into a fight, then you're having to pick the things you take with you well before you work out whether or not it's exactly the kind of fight you're turning up to.

For the soldiers battling to push back the insurgency, their day jobs involved long forays into uncertainty knowing a blast could hit them at any time.

Driving Route Whale

There's a standing joke in the unit that 'Mates don't let mates drive Route Whale'. The rough dirt road runs through Afghanistan's Mirabad Valley, which is Taliban territory and a major insurgent supply corridor. Route Whale is strewn with so many improvised bombs that it's rare for a convoy to make it home without finding one, or being hit by one.

The soldiers of 2RAR's Combat Team Alpha head down the road late on a stiflingly hot afternoon in 2011. They're part of Australia's Mentoring Task Force 3 helping train members of the Afghan National Army, which is tasked with blocking the flow of weapons and other supplies to local Taliban fighters.

The Australians are tired after a full day of patrolling on foot and they're relieved to be able to recover in their Bushmaster's air-conditioning. A short drive out of Patrol Base Mohammed, named after a slain Afghan soldier, they pass through a small village that's normally full of people. This time there's no-one in sight. That raises anxiety levels, and the soldiers scan the road ahead. 'We know something's about to happen,' says Trooper David Nicolson.

Abruptly, a petrol bomb is thrown at the last of the three Bushmasters and narrowly misses the gunner in his hatch at the rear of the vehicle. The radios are going off with urgent reports and the crew of the lead Bushmaster decides it's time get off the road and go cross-country so that there's less chance of hitting a bomb buried in their path. But before they can change course, a massive directional focused IED blasts out of a wall they're passing and lifts the 15-tonne vehicle onto two wheels. It's poised for a time and then slams back down onto all four.

This is the third time Nicolson's been in a vehicle hit by an IED, and he and his mates are practised: 'You black out for a second or two, then you're dizzy, you feel sick and sometimes you spew. Dust is everywhere. In your eyes, nose and mouth, you have that smell and taste of explosives. Your adrenaline is in overdrive.

'While your body is going through all of this, your training kicks in and you're making sure that you're OK, the boys in the back are OK and casualty and damage reports are going out. You're eyeballing the area for signs that this is a complex ambush, for signs of the enemy, the triggerman and lookouts.'

The crew commander's manning the gun above his seat and is badly jolted. This bomb was detonated by someone using an electrical 'command wire' or simply by pulling on a kite string, but no-one sees an enemy fighter.

Darkness is descending, so the soldiers in the stricken Bushmaster head back to the patrol base. They're moving very slowly, with the front tyres shredded by shrapnel and

the steering badly damaged. The bomb has demolished the external cargo bins and scarred the vehicle's bulletproof windows.

Those on board are all chilled by the reality that they would normally have gone down that stretch of road with combat engineers on foot ahead of them, scanning for bombs, accompanied by their detector dogs and protected by infantry. On this occasion, someone had decided that they'd travel on board the vehicles. Struck by the bomb unprotected and on foot, they might all have been killed.

Before he completes his nine-month posting, Nicolson encounters a fourth bomb. He survives that, too.

* * *

Nicolson recalls seeing, before he first deployed to Afghanistan, a picture of a Bushmaster there in the approach to a valley. It was covered in dust, with packs hanging from either side and a trunk on top along with two machine-guns. It looked rugged, he recalls—'a real workhorse'.

Then came pre-deployment training with the Bushmaster in Australia, and the long months of operations in Afghanistan: 'It saved so many lives and had the room for the lads and their equipment.'

After he'd survived his third IED strike, some of his mates warned him, with curious soldier superstition, that he'd curse himself if he didn't name his vehicle 'Ha! Ha! Ha!'

His section finally opted for 'Better Luck Next Time':

> Well, that didn't work. I had another IED strike and ended up in a Kandahar brain trauma unit with my crew commander. Sadly, he was sent home to Australia, but I returned to my combat team. My last vehicle was 'Belladonna' and, what do you know, no more IED strikes, thank God!

What the troops liked about the vehicle changed with experience. 'The air-conditioning was a favourite with the grunts and combat engineers,' says Nicolson. 'My God, was it good to get into a Bushmaster with the air-conditioning on after a solid day patrolling on foot!'

Those who'd encountered a bomb or a burst of gunfire quietly revered the V-shaped hull and the bulletproof windows: 'The Bushmaster saved me and many others. Without it, we would have had a lot more KIA in Afghanistan.'

From the soldier's point of view, could the Australians have carried out the long-range operations they were tasked with in a truck or an open patrol vehicle?

'Yes, but again, at a cost to soldiers' lives, and at a slower pace,' says Nicolson. 'The V-shaped hull was an absolute lifesaver.'

Allies under fire

Late on the afternoon of 20 September 2007, soldiers in the Dutch Patrol Base Volendam are preparing for nightfall. They're north of Deh Rahwod and near the Tiri Rud River in the west of Afghanistan's Uruzgan Province. Gunfire erupts suddenly, its heavy, urgent roar rolling across the valley floor.

A platoon from the same company is on patrol about 1.5 kilometres to the south of the outpost. Nineteen men have dismounted from their vehicles at a location the soldiers refer to as 'Cemetery Hill'. They search on foot for an improvised bomb believed to have been planted on a dirt thoroughfare known to the locals as the Shingolah Road.

The Taliban are in significant numbers in the area but have been surprised by the Dutch soldiers' arrival. Men are working in fields nearby and there are children in the streets, but the Afghan fighters react very quickly. An estimated 70 Taliban surround the patrol and blast it from as close as 15 metres away with gunfire and grenades from behind trees, a cornfield, low walls and the courtyard of a nearby qala*, or walled house.*

As the troops try to pull back, Private Tim Hoogland, a forward scout carrying a light machine-gun, is hit twice and fatally wounded. Under heavy fire, the other members of the patrol occupy a nearby compound from which they can fight back. They can't reach Private Hoogland, who's lying where he's fallen on the road.

The soldiers at Volendam hear over their radio that the patrol has been ambushed and a soldier is down and, at the very least, badly wounded. The lieutenant in command orders 12 men into three Bushmasters to go and help. 'We could hear a lot of shooting and we had to get them out of there,' recalls Corporal Rick Smulders.

Smulders drives one Bushmaster and soldiers man each of its two machine-guns. 'We drove straight into an ambush with mortar rounds landing around us,' says Smulders. Next to them is a field of marijuana with plants three metres high and on the other side is a crop of corn. They come across a dead Taliban fighter and then see Private Hoogland lying several metres away. It isn't clear whether he's dead or alive.

The soldiers stop near him.

An explosive detonates against the troop carrier's passenger-side window, centimetres from the sergeant's head. The thick glass is savagely scarred and starred but holds, though the soldiers can no longer see through it. In the driver's seat, the corporal expects the next projectile to come through.

In the minutes that follow, four more heavy blasts hit the Bushmaster, along with a rain of rifle and machine-gun fire. A violent explosion hurls one of the two gunners down into the vehicle, badly stunned. Another impact knocks out a compressed air cylinder and locks

the brakes on, immobilising the vehicle. The Bushmaster's crew lies on its floor, waiting for a rocket to penetrate the armour. None does.

The stunned soldier recovers and climbs back up to his machine-gun to return fire. Despite the efforts of both gunners, the incoming fire becomes so heavy that they eventually duck down below the rim of the hatch and continue shooting with their arms extended.

The gunner on another of the Bushmasters sees more projectiles hit Smulders' vehicle.

A lieutenant and a sergeant climb out of the team's other two troop carriers to collect Private Hoogland. He's a big man, tall and very heavy in his body armour, but they lift him into one of the undamaged Bushmasters. The two later received medals for heroism.

Still under heavy fire, Smulders' crew can't get their vehicle moving so they wipe the data from their radios to prevent the Taliban using them to listen to their communications and dismantle the machine-guns before making the dash to another of the Bushmasters as that vehicle's crew gives covering fire. They take with them their personal equipment and weapons and the very effective night sight from an anti-tank rocket. The damaged Bushmaster can't be recovered, and a Dutch Apache attack helicopter is sent to destroy it with missiles. From the safety of their patrol base, the soldiers see it burning into the night.

Corporal Smulders is so impressed by the Bushmaster's lifesaving qualities that in February 2009 he travels to Australia to thank personally the workers in Bendigo who designed and built the vehicle.

* * *

As production of the vehicle progressed in Bendigo, alarm was growing in the Netherlands about the threat posed to its troops in Afghanistan by improvised bombs. The Dutch had lost soldiers to IEDs that hit their less well-protected Patria armoured personnel carriers and soft-skinned Mercedes Benz SUVs. Both were very vulnerable to bombs, which killed 11 of the 25 Netherlands military personnel who died in Afghanistan.

It quickly became clear that the Dutch Army needed a troop carrier that was better protected and specially designed to operate in a high IED threat environment.

The Dutch took over responsibility for security in Uruzgan Province in 2006. As the lead force there, they worked closely with Australians and quickly saw how effective the Bushmaster was against the Taliban's bombs. The Dutch were impressed by the protection the Bushmasters provided and asked to buy some.

The sense of urgency was communicated at a high level from government to government and through Dutch military commanders to the ADF. Angus Houston recalls the Dutch request for help:

> They were very keen to get the Bushmasters because they saw right up front what was happening with our vehicles, and they could see the value of getting vehicles better suited to the threat that we were facing in Uruzgan. They were our friend and our partner in Uruzgan, and it was imperative that we work closely together on joint-force protection of the whole force. Obviously, my prime focus was always on the Aussies, but we needed to help them wherever we could. We suggested that the Bushmaster might help them, and they took that on board.

The ADF then sold 25 Bushmasters back to Thales for sale to the Netherlands. To save time, and lives, most of them were flown directly to the joint base at Tarin Kowt in Uruzgan Province. Two were sent to the Netherlands for driver training. The ADF later received 26 vehicles back from Thales to make up the difference. The deal went through remarkably quickly.

The Dutch forces used the Bushmaster as a troop carrier, command vehicle, electronic warfare platform and medevac vehicle. After Uruzgan, 29 Bushmasters were used in the Netherlands Police Training Mission in Kunduz Province. In 2014, the Dutch ordered a further 20, bringing the number purchased up to 106.

The Dutch continued to use a range of other vehicles, but for longer patrols and when intelligence indicated that the IED threat was high, two Bushmasters would often drive at the head of a convoy with wheels overlapping to create a very broad track for the less well-protected vehicles behind them.

According to Colonel Henk de Boer, commandant of the Netherlands forces' counter-IED centre, it was clear from the early stages of the Dutch Army's operations in Afghanistan that it needed a vehicle that was specially designed to operate in a high-IED environment.

Adapted by Thales in Bendigo, some of the Dutch Bushmasters were fitted with a long robotic arm for filming and probing potential bombs. Others were equipped with 50-calibre remotely fired machine-guns. Colonel de Boer said the remote-controlled weapon stations were not fitted to bring the fight to the enemy, but purely for self-defence.

Explosions blew wheels off Bushmasters and demolished whole axle assemblies, but veterans said they felt safe in the vehicle they knew as the BUMA. On each occasion, all of the soldiers on board survived.

But even after some Bushmasters were obtained, the Dutch suffered casualties in other vehicles hit by bombs. On 18 April 2008, an IED killed two Dutch soldiers at Deh Rafshan, 10 kilometres from the base at Tarin Kowt. Private Mark Schouwink and Lieutenant Dennis van Uhm, the son of the newly appointed chief of the Netherlands forces, Peter van Uhm, were travelling in an open-topped scout car.

In 2018, the Dutch were using the vehicles in their peacekeeping operations in the North African nation of Mali and in Iraq. In May 2015, a Dutch Bushmaster was hit by an IED near the city of Kidal, Mali. The soldiers travelling in the vehicle were unhurt.

'The BUMA is very popular within the Dutch units,' says Colonel de Boer. 'It's considered to be very safe and reliable.' In Mali, he says, the Bushmaster was favoured by those who took it on operations and those who maintained it: 'It's easy to operate and to maintain because its technology is relatively simple.' Dutch special operations forces and soldiers on long-range reconnaissance patrols used Bushmasters for protection against bombs and to carry the volume of supplies needed on long missions.

Manning the rocket pod

A sad reality was that while no soldier died in a Bushmaster, the size and destructive power of the bombs they encountered was such that many were badly injured. If the vehicle was hit by a large bomb, and many were massive, there was a real chance of the soldiers manning the machine-guns on its rooftop hatches being propelled from the vehicle. As they were leaving the base at Tarin Kowt, the gunners would sometimes, with a sense of black humour, assume a Superman pose with an arm outstretched and fist clenched as though preparing for flight.

* * *

Defence featured on the cover of its 2013–14 annual report a striking image from the play *The Long Way Home* which was a partnership between the department and the Sydney Theatre Company focusing on the experiences soldiers faced in war and the need to recognise their consequences.

Lance Corporal James Duncan played a central figure, Alex. The annual report explains his role and this exercise in rehabilitation through the arts:

> In 2010, James deployed to Afghanistan and, in February 2011, he was injured in an improvised explosive device strike on the Bushmaster armoured vehicle he was driving. Despite being dazed and sore from the explosion, James stayed on in Afghanistan for another five months and managed the pain with physiotherapy. On returning to Australia, his chronic back pain worsened and by the end of 2011 he was essentially incapable of doing his job. James saw *The Long Way Home* as an important public forum to help other soldiers dealing with injuries and trauma.

The project was launched by then ADF chief David Hurley, who had seen the British production *The Two Worlds of Charlie F* during a visit to the UK. One of the project's aims was to assist with the rehabilitation and recovery of ADF members who had been wounded or injured or who had become ill in service. It also provided insight into the sacrifices made by ADF members and gave the Australian community an opportunity to understand the impact of a decade of operations. Hurley said the play provided a unique opportunity to tell an important story: '*The Long Way Home* offered an important insight into the war experiences of a group of servicemen and women who have had the courage to share their stories with us.'

Men and women from the ADF shared their personal stories with Australian playwright Daniel Keene. They participated in acting and movement workshops and were mentored by some of Australia's finest theatrical talent.

Says the annual report:

> *The Long Way Home* portrayed the reality of conflict and the fear and disillusionment that some ADF members face on their return home from operations, including the impact of post-traumatic stress disorder.

JAFT: 'Just a fucking truck'?

Even after the Bushmaster began to prove itself on operations in Iraq and Afghanistan, not everyone in the Army was taken with the new vehicle. One young officer who worked with Bushmasters on operations wrote a report on how they could be better used. He took it to a superior, who had a brief look at it, tossed it back at him and declared loudly that he should get it into his head that the Bushmaster was a 'JAFT—just a fucking truck!'

* * *

But, despite this deep and persistent suspicion of the Bushmaster in some quarters, real appreciation of the vehicle came as soldiers in combat experienced how well it could counter the IED threat and provide the protected mobility they needed to move around.

Time and again, the Bushmaster shielded its crews from blasts of white-hot gases and shrapnel and quickly proved that it was anything but a humble truck.

Jason Blain, now a brigadier, had long experience with the Bushmaster going back to his days in 6RAR when it was training with 6x6 trucks to develop the mobile infantry concept.

The soldiers of 6RAR weren't training to be mechanised infantry; they were training to be motorised infantry. Motorised infantry has less protection, less firepower and less mobility but it does provide a level of protection to allow the battalion to have more dispersed operations to get, not onto the objective, but near it to conduct operations. A battalion commander would move the force to 5–7 kilometres from the objective, dismount, harbour the vehicles, advance on foot, clear the objective and then bring the vehicles forward. The vehicles might be used during the assault to evacuate casualties: 'But having that armoured protection at hand was an absolute game-changer for us.'

Blain's troops were leading the Army on that journey, but they didn't know what the vehicle at the end of it would prove to be.

He commanded 6RAR when it adopted the Bushmaster PMV, and his operational tours in Afghanistan included command of Mentoring Task Force 1 in January 2010. The unit's role was to work with the Afghan National Army in very dispersed operations, using Australian teams spread throughout a very wide area. At first, the Bushmaster was seen as suitable only for rear-area security operations, but that quickly changed.

Moving 15 kilometres along roads from one patrol base to another could take hours because of the IED threat and having to clear the route. It was quicker and safer to travel off-road, through the desert. Blain says the Bushmaster provided a

great capability in the sort of environment it was designed for: 'When it did get hit by an IED, people survived. There were injuries and the vehicles were sometimes destroyed beyond repair, but what a testament to the design and use of the vehicle. We had not one death.'

The task force lost six men killed in action, five by bombs and one by a gunshot wound, but none died in a Bushmaster.

Blain recalls young soldiers being brought back to the hospital in Tarin Kowt, where they'd phone their mothers to say they'd been in 'an accident'. Blain would admonish them: 'It wasn't an accident, you've been blown up. Tell your mum the truth.'

But the point was, he says, they could call home because the vehicle withstood the blast: 'That's the important thing.'

Chris Smith, who as a lieutenant colonel commanded Mentoring Task Force 3 in Afghanistan, says the Bushmaster was originally intended to move soldiers safely and quickly across Australia in pursuit of small parties of enemy troops who were likely to scatter landmines behind them. 'Planners talk with some certainty about how the next war will be fought, but the reality is that we don't have a clue,' Smith says. 'The Bushmaster came to be used in circumstances no-one imagined.'

Critics were in the majority until Afghanistan, Smith says, with claims that the new vehicle could not drive up hills and negative comparisons with patrol vehicles.

This is a classic example of a project that ended up with a much different purpose from what was intended, Smith says: 'It just needs to be right enough and it can be adapted.'

Another who won't forget the Bushmaster's sheer grunt and versatility is John Leevers, who recalls how it helped rescue four of his men who were about to be overrun.

In December 2011 and January 2012, Leevers, then a major, commanded Charlie Company of 2RAR, which shared Patrol Base Sauk Bed in northern Kandahar Province with an Afghan *kandak* (battalion). The goal was to wrestle back Afghan Government influence in the area by reducing the insurgency and building up the competence and confidence of the Afghan National Army (ANA).

Patrols lasting several days took combined forces of Afghans and Australians out into areas where the coalition hadn't operated for years. 'We wanted to bolster the ANA soldiers' confidence that they could go into a fight, they could mix it with the Taliban and defeat them and come away pretty much unscathed,' says Leevers.

One such operation involved 50 Afghan troops and 30 Australians with Bushmasters for safe travel and ASLAVs for firepower.

At one point, says Leevers, the company came under attack from all sides. Two Australian sniper teams were located by the Taliban and came under heavy fire.

The four soldiers were trapped, and the gunfire tearing up the ground around them was so heavy that they dared not raise their heads. Leevers knew the men were likely to be overrun. 'The teams were being very heavily suppressed, absolutely caned. They couldn't even tell me where the enemy were firing from,' he says.

Driven by two experienced NCOs, a Bushmaster and an ASLAV drove down a very steep and precarious track so that the ASLAV could use its 25-mm cannon to provide the four with covering fire. It hit the Taliban position hard, and the two sniper teams were able to escape. Then the Bushmaster headed back up the track. The ASLAV followed until the ground under it began to collapse, leaving one wheel hanging over a 25-metre drop. The Bushmaster crew backed down again and towed the ASLAV to safety.

'The Bushmaster pretty much saved the day,' says Leevers. 'It certainly saved the lives of the four snipers.'

The Australian soldiers were impressed by the Bushmaster's mobility. Its big engine allowed them to travel in terrain that much heavier vehicles, such as the US MRAPs and the British Mastiffs, couldn't cross. That meant they could avoid being channelled down predictable routes and made it harder for the bombers to predict where they should best place their IEDs.

'The size of the engine and the Bushmaster's mobility allowed us to stay out of trouble,' says Leevers. The unit was also able to make rapid flanking movements with blocking forces to surprise insurgents.

The troops were confident that the Bushmaster's armour would protect them from small-arms fire, but they weren't sure that it would stop anything heavier, Leevers says: 'In our area of operations, there were heavier weapons and we always had to employ the vehicle with that in mind.'

Brigadier Blain says the level of flexibility and mobility a battalion commander gets from having the unit's own organic lift is immense:

> You're not relying on a taxi service to lift your battalion. The vehicle becomes part of your organisation. You build up a culture of the vehicle being part of the section. The vehicle becomes the 11th 'man', along with the driver, the commander and eight soldiers.
>
> That means it's given all the love and attention it needs to ensure it can do its job. It's owned by one group, which is responsible for its maintenance. The section members become experts at using it, not just driver and commander experts but experts in how you fight the vehicle.

> Some people might call it a truck but it provided me with a lot more capability than a truck—and that was long before its counter-IED capabilities became apparent in Afghanistan.

The Bushmaster's versatility was apparent even in training in Australia:

> In a battalion setting in peacetime training, even taking account of these limits in the vehicle's ballistic protection compared to armoured cars, the Army's ASLAVs and tanks, it did provide levels of protection and endurance, mobility and communication and logistics support internal to your organisation that gives you so much freedom of action.

In brigade- and battalion-level exercises, the addition of the Bushmasters to combined forces already equipped with tanks and ASLAVs gave units the ability to outmanoeuvre threats.

It helped bring the start of a mechanised culture to the infantry, which is now adopting infantry fighting vehicles, and the PMV experience will make that jump easier.

Crucial to survival was developing in the Bushmaster culture a big focus on how soldiers stored their equipment. Many injuries were caused by items that had not been well secured in a vehicle or were lying loose on the floor being propelled across the troop compartment at high speed by a blast that did not penetrate the armour. Even small items on the floor could become instant missiles.

Once that was squared away, the issue was how the vehicle was set up. Seats were designed to absorb as much as possible of the blast. How the soldiers were strapped into the seats and how their ankles were protected became crucial.

The troops quickly learned how easy it was for people to be badly injured if they didn't follow those procedures.

Blain's men covered a great deal of dangerous ground in Afghanistan, through northern Uruzgan, out to the Mirabad Valley and up to Deh Rahwod in the west. They were exposed to a great many IEDs and their vehicles suffered many hits. 'We could continue to do that because we were not suffering the casualties,' he says. 'If men were being killed, I don't know that we would have had the same appetite to conduct the operations we were.'

Once they got out of built-up areas, the troops would go off-road as much as possible and vary their routes constantly to avoid being hit by IEDs on the way back.

A Bushmaster would lead a convoy through vulnerable points, with the crew knowing they'd probably take the first hit. It was always in their minds that they'd have to be prepared for it, says Blain. A number of his men were ejected from their vehicles and injured, but none was killed.

The Bushmaster was the right vehicle for that largely desert terrain, which didn't require tracked vehicles. If the diggers had been climbing mountains, it probably wouldn't have been suitable. The troops still had problems with vehicles getting stuck in rivers, creeks and canals, but the Bushmaster generally provided the mobility they needed.

Bogged or damaged Bushmasters could be recovered with another Bushmaster and towed out of trouble. The vehicles could continue to drive with shredded tyres, and they weren't limited by the need to stay close to big recovery vehicles. Because it was designed for long-distance driving in Australia, the Bushmaster had great endurance. Its big fuel tank gave it long range and meant crews didn't need to time their progress on patrols to fit in with fuelling points.

It wasn't too heavy for bridges and it could go off-road. Says Blain:

> You wouldn't use it to go through the bush like you might with a tank, but you could travel behind a tank or on clear routes quite easily off-road. And it could carry a lot of water, food and ammunition.
>
> You've got an air-conditioned vehicle well suited for long-distance driving and you can get your team out of it at the end of a long trip refreshed and able to go straight into action. Temperatures reached 45 degrees and higher in Afghanistan, so that's important.
>
> It was the right vehicle for that environment, but it's not an infantry fighting vehicle. We shouldn't see it as the panacea to all mobility protection. It plays a particular role but it's not a fighting vehicle. You wouldn't assault onto the objective in a PMV, while you would in an infantry fighting vehicle.
>
> But in areas where you have IEDs or low-calibre, low-velocity threats, it's a good vehicle.

For a military vehicle, the Bushmaster is also regarded as 'low footprint' because it won't do as much damage to roads or paddy fields as a much bigger and heavier armoured vehicle would do. 'It can be counterproductive to what you're trying to achieve when you're tearing up some farmer's land with heavy vehicles,' says Blain. And in the narrow streets in old parts of Iraqi towns and cities, large vehicles had trouble manoeuvring, but not the Bushmaster: 'It's big but not too big to give you that flexibility and mobility in those very tight areas.'

If the ADF hadn't had the Bushmaster to deploy to Afghanistan, it would, in the short term at least, have suffered many casualties or had to curtail its operations significantly.

Blain believes the Army would have looked at rapid capability enhancement, which might have included fitting vehicles with rollers able to set off IEDs ahead of them, and a greater reliance on aircraft, especially helicopters, to get around. The time between resupply trips to forward bases might have been extended, leaving them to look after themselves for longer periods. And the Army would have done what Canada, the US and the UK did: they went and searched for the equivalent of the Bushmaster.

The Bushmaster wasn't a set-and-forget capability, says Blain. It was a constantly refreshed and modified integrated project-team-led capability. As the vehicle operators, the close combat fighters drove change based on what they were seeing and experiencing. Lessons learned from each incident were quickly fed back to a strong team of engineers, Defence scientists and people from industry. Thales made the changes as fast as possible.

That was the real strength of the project, says Blain.

That's something Blain later picked up as the model to be used when he headed Diggerworks, the Defence team set up to provide a rapid response to the battlefield threats facing troops and longer term guidance for the development of equipment:

> You want to have all those people together, reaching out and touching each other, all understanding the priorities and where the effort must go.
>
> The fact that the vehicle could take the shock, that we could then quickly go back and modify the vehicle based on lessons learnt and bring it back into the operational theatre and then have more confidence that the vehicle could go out again and we could continue to conduct ground operations and not be stationary in our role, meant we could go and train the Afghan National Army. We could do our main mission. Otherwise we might well have just provided base security or whatever. Without that capability, the battalion could not have had the footprint it had across Uruzgan and it couldn't have developed the ANA the way it did.
>
> Where we've gone with infantry fighting vehicles, that level of protection is fundamental. The need to counter IEDs and mine blasts will be built into our future armoured vehicles. They'll have V-shaped hulls and an ability to withstand blasts better. That's also been captured. Not only have the Bushmaster lessons informed Bushmaster. It's informed broader vehicle design as well: the way you put seats in vehicles; the way you protect people from the shock of a sudden blast from below the floor; how we mount seating; how we use restraints in the vehicle.
>
> They're all lessons that have permeated through other vehicle designs.

> You'd have to say that the lessons learned from the way we used the Bushmaster, particularly how we protected our people inside the vehicle, has a flowover into other design.

However well the troops regarded the Bushmaster, it's not a tank, and Blain sounds a note of caution:

> Afghanistan is not the high-water mark of how we would look at our force design or our capability, but it does demonstrate in that environment how light you'd want to go and how heavy you'd want to go to provide the protection you needed.

Had there been a greater threat from heavier weapons, the Army would have had to reconsider how the Bushmaster was being used:

> But where we were operating it was the right vehicle for that job, particularly when we were dispersed between patrol bases so much and we relied on ground movement. Except for casualty evacuation, we couldn't rely on air.
>
> There'd certainly be places in Afghanistan where you'd want stronger armour capabilities, going onto an objective and depending on the threat environment.
>
> It was the right vehicle for the environment in Uruzgan.

Blain says the 'JAFT' tag was very narrow and probably based on a bias towards armour:

> When you've got Bushmasters leading ASLAVs because the Bushmaster can take the first hit and people will survive, where the ASLAV couldn't, that's an indicator of the vehicle's capability. So 'just a fucking truck' wouldn't be leading a LAV.
>
> I got to the vehicle as a commanding officer. I wasn't a soldier or a section commander using the vehicle or a young officer. They'll probably have different perspectives than me. My view was of someone who could see how the vehicle could be used in peacetime and wartime roles and how it was used.
>
> There's a different perspective depending on how close you were to the vehicle and what you were doing with it, and what you couldn't do with it. I had a number of men blown up in these vehicles. They save lives.
>
> To be very clear, it isn't an infantry fighting vehicle. It's a protected mobility vehicle—but it's not 'just a fucking truck'!

Lessons learned

In its early days, the project was controversial and its fundamental nature was not uniformly understood. That uncertainty had an impact on the whole process from tendering through source selection, contracting and administration of the contract. The very concept of motorising the infantry had mixed support within the army which was still debating whether an armoured troop transport was needed. Even among those who accepted that such a vehicle was required there was a range of views on where it would fit into Defence's strategic outlook.

— Former Army officer Paul Newall in a 'lessons learned' report

* * *

Late in 2002, Paul Newall of consultancy firm Project Outcomes was asked by the Defence Department to examine the roles and performance in Project Bushranger of the Defence organisation and the production company ADI. Over the next 18 months, the former Army officer produced two detailed 'lessons learned' accounts of where the project had gone wrong, and why, and how it was put back on track. One focused on the role of Defence in the project, the other on the company's role.

Newall's assessments provide valuable insights into the project and the task faced at that stage by those struggling to keep it afloat.

Newall noted that the project had been controversial and that its fundamental nature was not uniformly understood. That uncertainty affected the whole process.

Motorisation was a new capability, Newall noted, and an initial lack of understanding of the concept led to some confusion about its function and performance requirements. The developmental nature of the selected materiel solution had created tension between the government and ADI. Then the government sold ADI, and that had an impact on both Defence's project team and the contractor's project team.

Newall also quickly realised that at critical times the government's project management team faced significant challenges. It was under-resourced and had a high staff turnover that had included five project managers so far. Defence's project office was relocated from Canberra to Melbourne at a critical period in the project's development, resulting in an almost complete turnover of staff.

The contract was awarded to a company that initially understood neither the design it was developing nor the engineering, managerial and logistic effort required to manufacture it, Newall said. The contract was based on a specification that wasn't

adequately transitioned from the tender to the contract stage, creating ambiguities about how the vehicle was expected to perform.

Compounding this problem was what Newall described as early, significant scope creep that was exacerbated by the contractor's apparent loss of configuration control of the technical data package. The awarding of the contract was rushed by factors external to it, in large part because the government had decided to sell ADI and made a large advance payment to the company to enhance its value.

In 2004, the ANAO questioned an advance payment by Defence to ADI of $42.5 million (25% of the contracted price) after the preferred tenderer was selected.

The ANAO said Defence did that to help it spend its budget allocation in 1998–99. In reality, because of exchange rate movements and the rates applied in the contract, this resulted in an additional payment of $711,000, which boosted the advance payment to 26% of the contracted price, the ANAO said.

One advance payment of $43.2 million was made to ADI in June 1999, and an additional $1.3 million was paid in 2000 for price variations.

The ANAO said that at that time there was no requirement for the contractor to use the advance payment to meet the milestones for which it was provided:

> In this instance, Defence paid a significant amount of money to a contractor, in order to lessen budgetary pressures, yet received no identifiable benefit in return for the advance payment. Some years after the payment was made, the contractor still had not delivered the product in accordance with the initial contract.

Newell said he'd encountered differing views on the contractor's performance and the role the government played in the manufacturer's performance. Even when he examined the project, some fundamental elements of it remained in dispute, and many positive aspects of its management were overshadowed by apparent weaknesses.

But, he said, by the time he was called in, many of its problems were being rectified: 'While not yet completely out of the woods, the project now has a solid contractual position and the appropriate resources to enable the successful progression to production and, with further work, through-life support.' That would require continued professional project management, 'which will not be an easy task in the face of the systemic issues impacting on acquisitions projects and the Defence organisation's propensity to resist learning lessons,' Newall said.

By mid-2004, the project provided a good outlook for ADI, but Newall noted that it had by then caused considerable tension within the company and in its dealings with the government and the ADF.

Newall topped his long and daunting list of 66 lessons that Defence should learn from its handling of Project Bushranger with the observation that such endeavours are doomed to suboptimal outcomes if they're not firmly based on an agreed operational concept, a valid investment decision and a robust acquisition strategy. His second point was that the complexity of the options for the required capability must be clearly understood. And, once a capability is chosen, that plan must be translated clearly into an acquisition strategy.

The operational concept—in this case for the new vehicle—must be set out as clearly as possible at the start of a project to ensure that what's being built is able to do what it's intended to do. If necessary, that concept can be developed further to meet requirements.

The level of risk in the project must be appropriately measured.

Where a new capability is being developed, the acquisition strategy and mechanisms in the contract must be used to protect the investment.

Partnering with industry must be done through a professional and clearly commercial relationship. Within that, says Newall, the government must establish clear, unambiguous and traceable requirements.

Leadership of the various aspects of such a project, from concept through to development and fruition, is crucial, Newall said.

If things are going badly, higher management must be informed: 'There should be no surprises.'

Tellingly, Newall said that unity of purpose and understanding is crucial if a project is to succeed: 'A capability cannot succeed without it being championed by all levels of leadership.'

Those in charge must have a diverse range of project management competencies, strong leadership skills and professional integrity. They must share and maintain a vision for the capability being produced, albeit tempered by frequent realistic assessment of the business case.

The project team and its manager must have the trust of senior leadership.

Political issues operating at various levels must be identified and the risks managed accordingly.

Leaders must protect project teams from non-project-related distractions that they don't have the time, personnel or funds to deal with.

Newall identified another weakness that has been an issue with many Defence projects—the tendency of Defence to put personnel on to a complex task for three years or so and then to move them on, leaving big gaps in corporate memory. The other side of that coin is that the project environment is an unattractive one for many service personnel who see it as poor career-building territory. He says that to attract and retain high-calibre service personnel with the intention of keeping projects stable and on track, significant steps will be needed to change systemic barriers.

Newall also warned that it's inadequate to expect a typically under-resourced Army project team to consistently 'do more with less'.

More lessons learned in battle

The Bushmaster project demonstrated dramatically the difference between simply buying a piece of kit and acquiring a capability. It set a new standard of cooperation between Defence and industry, informed by close and constant feedback from troops on operations.

* * *

Given the complex problems in its early development, Defence's project managers handed the Bushmaster over to the ADF in very good shape. But combat inevitably brought new lessons.

Thales CEO Chris Jenkins says that, despite its earlier problems, the project proved to be a model for interaction and cooperation to get crucial equipment into the field quickly. That interaction between Defence and industry had one objective—to keep soldiers safe. He believes the experience may now be guiding Defence policy on the need to increase Australian content.

For many reasons, including economies of scale, Australia has bought much of its military equipment from other nations. Often, there would come a point when the limits of the equipment were reached but by then not a lot could be done to improve the capability, says Jenkins: 'We were stuck with those limits because we'd bought them from another country.' In the case of vehicles, troops on operations eventually identified their limits but they were stuck with them and the perception that 'That's just the vehicle.'

The Bushmaster was different, says Jenkins. Australia didn't own just the vehicle, which was the core capability, but also the very long stream of expertise that had gone into developing it in Australia and the intellectual property, the modelling techniques and the science and engineering behind it. That meant that the Bushmaster very quickly evolved from being one capability to become half a dozen different capabilities, and much of that evolution was guided by the experiences of troops in combat.

Having the sovereign Australian skill set meant that the Army could get exactly what it needed, when it needed it, into the field, without being held up by the constraints that might come through another country's regulatory requirements or intellectual property control.

Air Chief Marshall Angus Houston was chief of the ADF when the Afghanistan conflict was at its peak, and he and Jenkins were in regular contact. Jenkins recalls Houston saying that he could sleep at night knowing the troops were using the Bushmaster:

'He knew what the Bushmaster was delivering for those on the front line and that goes to the capability-proving and the evolution of the vehicle.'

Jenkins says the project also reinforced the message that a key to having the right defence capabilities is to aim to buy them ahead of a crisis. Trying to obtain them during a crisis is usually too late:

> In the lead-up to Afghanistan, we didn't realise we were going to need something as capable as this, but, with the advent of IEDs, we absolutely needed the Bushmaster.
>
> There was a concern after operations in Somalia and elsewhere that we needed a real capability to move troops safely. It was tragic that we had to use it, but thank God we had it.

Jenkins is frank about problems that were confronted in building the Bushmaster. At times it was considered just another defence project with an Australian supplier running behind schedule, with quality issues and increasing costs. Sometimes it appeared that the manufacturer wasn't focused on delivering on time and on budget, and at other stages it appeared that Defence didn't particularly want the vehicle.

Sometimes such projects were slowed by Defence posting cycles, which saw personnel assigned for three years or even less so that they built up expertise and then moved on to the next stage of their careers. It depends very much on the individuals who come through, says Jenkins:

> Do they really get it? They have to come up to speed; they need to have confidence in us. That unique building of a really close partnership comes from confidence in the people involved. It's not just that a company has a good reputation for working well. It's about the people there.
>
> You sometimes don't realise you're gathering experience, but you are learning about the project. Whenever you deal with or discuss issues, that's what you're doing.
>
> When new people come through at a rapid rate, you have this start–stop approach to not only continuity of knowledge but also continuity of confidence and how you engage and share information. There is a disadvantage in that. I don't know how much it can be changed.

The restructured project produced a very effective vehicle but no-one would have known just how effective it was if it hadn't been deployed to Afghanistan. Once it was in combat, further lifesaving lessons were quickly absorbed, and cooperation among engineers, scientists and soldiers on operations intensified rapidly in a new phase of even closer teamwork to deliver the best possible protection for the troops.

Afghanistan proved the value of all of the work that went into the Bushmaster, Jenkins says: 'If it had not been tested in war, then the Bushmaster might well have been one of those terrible stories that people don't even want to talk about.'

The fact that there was a real need for it, that it demonstrated its capability in war and that there was a real shift in the way it all worked made it an iconic example of how to do defence projects and how to deliver the sorts of sovereign capabilities that Australia's now aiming for through the 2016 white paper and the Defence Industry Policy Statement, Jenkins says:

> For me, it was a game-changing project. It demonstrated the difference between what was the norm of a deliver-when-you-can bureaucratic process, with issues such as quality being used as levers against each of the parties, and suddenly going to, 'We have to get this thing done together and let's do it really, really well.'

That's how the project evolved:

> It all looks pretty good now, but I remember there were lots of struggles along the way to get the cost down, to get the quality, to get the schedule, to get all of those things done.
>
> But progressively, by the time the vehicle was needed in service in large numbers and in many different varieties, the team of Defence and industry was very well tuned to deliver.

Jenkins says few people in industry have had the benefit of that experience:

> So you look at it and think that's how we should be doing projects—that close partnership—that's the convincing story to me. What's needed is to create that partnership with industry rather than a suspicious, arm's-length bureaucratic process like the early days of Bushmaster. Once you do that you get these fantastic results. It's a very, very important project from the point of view of the lessons it tells us about what works really well.

The war glued it all together:

> But isn't that always the case? When everything's safe and secure, people think you can reduce defence spending. You don't need the best submarines. You can buy little submarines off the shelf. But of course that all changes when there's a war and sons and daughters are going off to put their lives on the line. It's 'Let's get everything cracking along.'
>
> When 'urgent operational requirements' come through in the war context, everyone knocks down the barriers and they get on with it and they worry about the commercial stuff afterwards. When everything's benign and secure and safe, we go through the long processes of slowly and laboriously delivering projects.

> So war changes the way people work, that's for sure. It's a tragedy but it shows it can be done.

The Army gets it, Jenkins says: 'We saw a real shift in Army's approach to capability discussions during the war because they were experiencing the real thing. As Angus Campbell says: "Army's kit matters".'

Whenever the media reported an attack on a Bushmaster, everyone in the Bendigo plant wanted to know whether anyone had been hurt. They were all living and breathing the fortunes of the soldiers on the front line and what the vehicle was doing to help keep them alive.

That stage of the Bushmaster project demonstrated that such a high level of very close involvement between Defence and industry was a fundamental input to capability—before that term was part of the broader Defence lexicon:

> You hope that, if long-lasting peace occurs, all of those lessons will not be forgotten. We obviously all want prolonged peace, but we don't want the lessons of the past to be lost so that they're not there when you really need the capability, because recreating them when the crisis is happening is very hard to do. So having real engineering taken as Australian content and having that considered a fundamental input is very important.

Jenkins says the vehicle that provided real wartime survivability for Australian soldiers in a very dangerous situation wouldn't have been able to demonstrate its value in peacetime. Despite the best of planning and futureproofing of a nation's forces, no-one can be certain what threats are coming and what will be needed to deal with them, he says. There's no foolproof way to know:

> If the project had continued, and if Afghanistan hadn't happened, or if Australian troops had not served there, the Bushmaster might well have gone down as one of those overpriced, overstretched Australian requirements that were regarded as too expensive for what they provided.
>
> If we'd been in peace, everyone trying to grab a headline would be saying it was a waste of taxpayers' money and why did we ever think of making it.
>
> That would, quite possibly, have been the end of the story.

Epilogue

Exports

More than 1,000 Bushmaster PMVs have been delivered to the Australian Army and to the RAAF for use by its airfield defence guards. Other vehicles based on the troop carrier are being used by firefighters in South Australia.

Including those sold to the Netherlands, 171 Bushmasters had been exported by the end of 2018, of which 30 were sold to the UK for use by its SAS Regiment. Some of those vehicles have reportedly been used by British special forces in Syria. Five more Bushmasters have gone to New Zealand, 10 to Fiji for use in the Middle East on UN peacekeeping missions, four to Indonesia, eight to Japan and 12 to Jamaica.

In 2018, Thales sent three more Bushmaster MR6s to the UK with a range of enhancements targeting the selection competition for the British Army's multi-role protected vehicle. One was to be blast tested; the other two were an ambulance and a troop carrier. These vehicles are designated MR6 because there have been five previous production runs.

If Thales is successful, it will win an order for around 240 Bushmasters for the British Army. About 80 will be ambulances modified with doors in the cab to avoid the drivers having to enter past wounded soldiers in the rear.

According to a UK parliamentary report, the order could eventually rise to 600 vehicles if the cash-strapped British forces find the money.

Hawkei

After a time, word emerged of a new Thales vehicle, mine-proofed but smaller than the Bushmaster. The development of the Hawkei is another story, but one element of it is deeply relevant to the Bushmaster saga.

The Army was looking for a bomb- and ambush-proof vehicle able to be carried under a helicopter. The Americans were after something similar, and some in Defence favoured joining the US Joint Light Tactical Vehicle Program. In fact, that view progressed to the point where Australia made a $40 million contribution towards it. A Defence submission at the time gave as one reason to go with the Americans the view that the Bushmaster was produced late and over budget.

By then, former SASR troop commander Grant Sanderson was working for Thales. He did an analysis that was presented to the government and demonstrated that, despite its problems, the Bushmaster took no longer from conception to operations than similar vehicles produced by Australia's allies.

That helped swing the decision away from the view that the Bushmaster project was a fiasco that should not be repeated, and the Hawkei was selected and entered production.

Defence officials said at the time that Australia had benefited from knowledge gained through research and testing conducted during the American program.

Chief Defence Scientist Alex Zelinsky noted:

> The Bushmaster armoured vehicle has been a great success story for the Australian Defence Force both as excellent capability and an export achievement. Defence Science and Technology is proud of our contributions to the Bushmaster Project. Our scientists have worked closely with Army personnel and Thales to perfect the design of Bushmaster's unique V-shaped hull. The research we undertook followed by rigorous survivability testing has helped to provide high levels of protection against blast and ballistic threats for our soldiers.
>
> We regard the Bushmaster as an exemplar project in which the end-user (the Army), the industry partner (Thales) and our Defence scientists came together to deliver a world-class capability. This has been proven in operational deployments and by the international demand for this versatile vehicle from Canada, Netherlands, Japan and Jamaica.
>
> Our research experience with the Bushmaster is helping us in the design of the next generation Hawkei light mobility vehicle which features adaptive protection technologies that are suitable in a variety of battlefield conditions.

Acronyms and abbreviations

ADF	Australian Defence Force
ADI	Australian Defence Industries Limited
ANA	Afghan National Army
ANAO	Australian National Audit Office
ANFO	ammonium nitrate, fuel oil
ASLAV	Australian light armoured vehicle
CSIR	Council for Scientific and Industrial Research (South Africa)
DoA	Defence of Australia
DSTO	Defence Science and Technology Organisation
IED	improvised explosive device
INTERFET	International Force East Timor
MRAP	mine-resistant, ambush-protected
PMV	protected mobility vehicle
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RAR	Royal Australian Regiment
SASR	Special Air Service Regiment
UN	United Nations
UNTAC	UN Transitional Authority in Cambodia
UNTAG	UN Transition Assistance Group

About the author

Brendan Nicholson's career as a journalist has spanned several decades, and for much of that time he has covered defence and national security issues. That included regular trips to Iraq and Afghanistan.

Brendan began his journalistic career with a cadetship at *The Timaru Herald* in New Zealand in 1969.

He went to Africa in 1973 and travelled widely through the continent covering the South African situation, often from the points of view of neighbouring countries embroiled in it.

His interview in 1982 with the head of the Frontline States group of countries, Zambia's President Kenneth Kaunda, led to the meeting between Kaunda and South African Prime Minister PW Botha in a railway carriage on the South Africa—Botswana border.

He returned to Australia in 1985 and covered science, the environment, politics and general news at the *Daily News* and then *The West Australian*.

In the mid-1980s, he reported as a photojournalist on the war and famine in Somalia before the Australian peacekeeping troops arrived there and on the aftermath of the Chernobyl nuclear accident. For his reporting on Somalia, he received the University of Western Australia's Arthur Lovekin Medal for excellence in journalism.

Brendan joined the Parliamentary Press Gallery in Canberra in 1995 and covered federal politics, foreign affairs, defence and national security issues for two decades, writing for *The Canberra Times* and *The Age* and for *The Australian*, where he was defence editor for six years. He has continued his extensive coverage of these issues as defence editor of ASPI's commentary and analysis site, *The Strategist*.

Acknowledgements

More than 60 people contributed to what has turned out to be a fascinating and complex tale of how the Bushmaster protected mobility vehicle was brought from a concept to become a remarkable lifesaver on operations. They are too many to acknowledge here, but they all provided important pieces of the jigsaw puzzle and I am grateful to each of them.

Researching the book gave me a welcome insight into the generous culture at ASPI, with colleagues willingly sharing knowledge and contacts. From his army experience, John Coyne provided historical and technical advice. And when I mentioned to Paul Barnes that I was looking for soldiers with stories to tell about the Bushmaster in combat, he put me in touch with the commandos and Special Air Service personnel who provided the account of the battle that sets the scene for the book.

Bob Roach provided an engaging account of the earliest days of Project Bushranger and how he and fellow engineers in Adelaide assembled the first vehicle that won them the right to tender. Bob was conscious from the start of the need to produce a design that would protect the men and women of the ADF on operations, and that ethos remained central to the project as it progressed. He named the vehicle the Bushmaster.

A key aspect of the Bushmaster story is the extent of the cooperation among combat personnel, Defence scientists, and engineers and other specialists from Thales to progressively improve the strength of the vehicle and save lives. Janis Cocking, from what is now DST Group, gave a passionate account of the determination of Defence scientists to produce a troop carrier with the highest possible level of protection.

Ken Gillespie, John Sanderson and Peter Leahy were able to explain how experience gained on peacekeeping operations benefited the Bushmaster's design and its future deployments. Andrew Harrison, who commanded British soldiers in Iraq, lost some of them for lack of such a vehicle.

With his extensive experience in key roles in Afghanistan, Jason Blain was able to place the development of the Bushmaster, and improvements to it, in the operational context. Phil Winter explained the threat, Chris Smith helped clear a path through to the facts, and Mark Donaldson VC and David Nicolson described the Bushmaster's lifesaving qualities.

Rick Smulders gave me a gripping rundown of the experience of Netherlands forces with Bushmasters in Afghanistan—especially their lifesaving qualities—and my colleague Bart Hogeveen provided valuable help in communicating with Dutch defence officials.

From South Africa, Stefan Nel provided key historical information on the early development of landmine- and bomb-protected vehicles, especially on the origins of the V-shaped hull.

With his prodigious memory for detail, Mark Eggler was able to describe crucial moments when the fate of the Bushmaster stood in the balance. Chev Viviers and Mark Diedrichs shared eloquent recollections of the early days of the project as Australian Defence Industries came to grips with it.

Thanks to Peter Jennings for the opportunity to tackle the project, and his patience in awaiting delivery, to Kim Gillis, then of Defence's Capability Acquisition and Sustainment Group, to James Dixon for his excellent editing of the manuscript, and to colleagues Michael Shoebridge and Patrick Walters for their valued suggestions, Ned Holt and Chris Masters for sharing their knowledge of the Afghanistan conflict, Larissa Joseph for her meticulous proofreading, and Aakriti Bachhawat and Larissa for their technical support.

And to Chris Jenkins and Gary Dawson for access to their Bendigo plant, staff and technical advice.

ASPI case studies in defence projects

The Bushmaster: From concept to combat

This account of the Bushmaster protected mobility vehicle by Brendan Nicholson is the classic story of the ugly duckling—an 'armoured Winnebago'—transformed swan-like into the vital lifesaver for Australian and Dutch troops on combat operations in Afghanistan. It was never designed to play that role. Based on South African and Rhodesian experiments with landmine-blast-deflecting V-shaped hulls, the Bushmaster was first conceived as a lightly armoured truck. In 1980s 'Defence of Australia' planning, the Bushmaster would move troops around the vastness of northern Australia pursuing 'thugs in thongs' bent on harassing locals.

As with earlier ASPI case studies on defence projects, *The Bushmaster: From concept to combat* is designed to help those in Defence, industry and parliament and other interested observers to better understand the complexities of the business, all with the aim of improving how Australia equips its defence force.

Brendan Nicholson's career as a journalist has spanned several decades, and for much of that time he has written on national security issues. That included regular trips to Iraq and Afghanistan.

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