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Australia's Defence R&D - an Overview

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It's widely believed that Australia doesn't spend enough on defence R&D, that good Australian ideas all too often don't get a fair go in any case and that trying to sell anything that's designed and built in Australia to a sceptical ADF is at best an uphill battle, at worst an exercise in futility. For this reason Australia's defence industry remains small, fragmented and a generally small, anonymous player on the global market.

Like most urban myths this one has a basis in fact. But its uncritical acceptance within the broader defence community blinds many to the more subtle truths behind it and may be stifling the spirit of curiosity that would dispel the myth, expose the underlying facts to more detailed scrutiny and change the situation.

There has been little research into Australia's defence R&D activities and the success or otherwise of the commercialisation processes flowing from it. Defence mirrors the wider Australian R&D landscape - as a nation our R&D expenditure falls well short of the OECD average per capita, and the private sector simply isn't pulling its weight. It's the contribution of the publicly-funded R&D organisations and universities that keep our figures looking half-way respectable.

The Australian Bureau of Statistics (ABS) all-sector summary of R&D expenditure reported Australia's Gross Expenditure on R&D (GERD) as a proportion of GDP was 1.62 per cent in 2002/03, amounting to some AUD$12.25 billion (see Table 1). Of this, some AUD$5.987 billion or about 49 per cent was private sector Business Expenditure on R&D (BERD); about 1.8 per cent of this, or some AUD$107.6 million, was defence R&D - a figure which is surprisingly high and which is contradicted by more detailed figures, also based on ABS statistics, mentioned later in this article.

TABLE 1:

	Commonwealth	State/ territory	Higher education	Business	Private non-profit	Total
1996-97	1,266.6	797.7	2,307.6	4,234.7	185.8	8,792.4
1998-99	1,179.4	863.6	2,555.1	4,094.7	225.3	8,918.1
2000-01	1,404.8	951.0	2,789.8	4,982.6	289.0	10,417.1
2002-03	1,531.3	950.9	3,429.6	5,978.6	359.5	12,249.9

NB: Expenditure in AUD$ millions
Source: Australian Bureau of Statistics. "Research and Experimental Development, All Sector Summary, Australia, 2002-03", September 2004.

The ABS states Australia's GERD/GDP ratio is low compared with other OECD countries. Australia is ranked below countries such as Finland, Japan, the USA, Germany, Denmark, Norway, South Korea and France.

Australia's low ranking reflects the business sector's low R&D expenditure. However, where Government Expenditure on R&D (GOVERD) alone is counted, Australia ranks above Japan, the USA, Denmark and the UK.

The Intellectual Property Research Institute of Australia (IPRIA), in its annual R&D and Intellectual Property Scoreboard 2004, notes that in the 2003-04 financial year BERD across Australian industry as a whole accounted for 0.3 per cent of total revenue compared with a world best practice figure of about 1 per cent in Finland.

Does this matter? In short, yes - there is a direct correlation between a nation's economic performance and prosperity and the level and quality of its R&D and commercialisation performance across the board. That correlation seems to exist also in the defence sector, despite defence being quite unlike any other national or global market for high-technology goods and services.

The author has begun studying the factors enabling or preventing successful commercialisation of defence-related Intellectual Property (IP) at the University of Adelaide's Education Centre for Innovation and Commercialisation (ECIC).

This research may take several years, but the starting point is clear enough: an Australian defence industry which is dependent on only one major customer and fails to invest in its own future is doomed to irrelevance.

The levels of technology employed by the ADF continue to rise, thanks to Australia's unique and privileged access to the best that the US arsenal can provide. If local industry cannot generate and sustain the technical expertise, skills and IP necessary to satisfy an increasingly demanding ADF as both an equipment provider and a smart support base, it faces a long decline to become a glorified service provider depending largely on imported IP to maintain and support imported equipment and platforms - and probably struggling to come to grips with the growing technological demands which the ADF will be making of it.

Three factors which heavily influence Australia's defence R&D environment are the ADF's dependence on very high technology to offset its lack of numbers; its access to all but the most sensitive equipment produced by the United States and Europe; and its small size.

Except for a small but critical portion of ADF capability, Australia faces no overpowering strategic imperative to develop its own high-technology defence equipment. Indeed, it would be pointless and profligate to try and duplicate within Australia much of what is freely available from overseas. One of the key operational

challenges for the ADF is not that of obtaining the equipment it needs, but understanding how to make the right choice, and then make best use of it once in service.

Consequently, the November 2004 study, "A Profile of the Australian Defence Industry", by Canberra-based economists ACIL Tasman for the Australian Industry Group Defence Council (among other bodies) notes that much of the Defence Science & Technology Organisation's R&D is now directed at helping the ADF identify its technology needs and providing defence policy, smart buyer and smart user advice to the department and the ADF.

By some estimates less than 20 per cent of DSTO's budget is explicitly devoted to long-range or "blue sky" R&D aimed at developing all-new IP, technologies and capabilities. The remainder is devoted to R&D which underpins its advisory role. This has been an important change in Australia's defence R&D landscape over the past two decades.

At the same time there remains a widespread industry belief, sustained by anecdotal evidence, that Canberra is reluctant to trust local suppliers - that the "not invented there" syndrome still applies within elements of the DMO and Capability Development Group and, by a lazy default, favours imported equipment and solutions over local solutions.

This, added to Defence's track record over recent years for significant delay in its capability development and acquisition processes, has meant that developing new indigenous IP and product specifically for the local defence market is widely viewed within industry as a risky proposition - and again there are case studies and anecdotal evidence supporting this view.

Therefore, there appear plenty of disincentives for significant private sector investment in local defence R&D or for the licensing and commercialisation of IP developed by bodies such as DSTO. There are often much lower-risk ways of pursuing a major defence contract.

However, the many significant exceptions to this rule demonstrate that persistence, deep pockets and a prospective customer who is willing to keep faith with a good idea can all add up to success.

There is therefore plenty of scope for research into whether and how Australia could do better at commercialising its defence IP. The fundamental hypothesis of the author's research is that there are certain specific factors which enable or inhibit defence R&D commercialisation in Australia. These can be identified and their impact on the IP commercialisation process measured; and it should be possible to develop a model, or a more general set of preconditions, which improve the chances of successful commercialisation.

First, however, it is important to map Australia's defence R&D environment and in particular challenge the urban myths and legends which infest it. Is there actually a problem? Does Australia do as badly at defence R&D and subsequent commercialisation

as the conventional wisdom suggests? How much do we spend on defence R&D and what sort of return do we get from it?

Secondly, does our defence R&D investment reflect the scale and diversity of the local and global defence markets open to Australian firms?

Thirdly, what do we stand to lose by under-investing in defence R&D and failing to commercialise?

These are important questions on the way to addressing the two main hypotheses.

Is there a problem?
What do we as a nation invest in defence R&D? And what are the commercial and non-commercial benefits which Australia derives from the commercialisation of the resulting IP?

These figures are all meaningless until they are compared with external benchmarks - the defence R&D and commercialisation performance of other countries, and broader non-defence R&D investment and commercialisation outcomes in Australia and elsewhere. "Commercialisation", incidentally, covers both defence and civilian applications of the IP in question - in the US it's commonly referred to as "Technology Transfer".

Beginning with DSTO, as noted earlier most of its budget is devoted to developing advice that maintains and hones the ADF's essential technological edge. This generates a return that, while vital to the nation's defence, rarely shows on any corporate bottom line. (The same applies in some measure to DSTO's equivalents overseas.)

That capability edge drives Australia's high-technology marketplace which is still the biggest and most sophisticated in the south east Asian region.

How does Australia compare with its two major allies? Table 2 shows what the UK and Australia invested in 2002/03, and the US in FY04, in their publicly funded defence R&D organisations.

TABLE 2:

Country	Defence Budget AUD Billion*	Defence R&D Budget AUD Billion*	R&D % of Defence Budget
Australia	13.174	0.288	2.18
USA (FY 04)#	557.36	88.05	15
UK	67.475	6.75	10

* Exchange rate calculated in October 2004. AUD1 = US$0.72 = GBP0.40
# Source: Defense News, October 18, 2004. P.11: "2005 U.S. Defense Authorisation"

A broader comparison would be with smaller, second-tier powers whose economies, defence budgets and defence forces more closely match our own (see Table 3).

TABLE 3:

Country	Pop - Millions	GDP AUD Billions*	Defence Budget AUD Billions*	Defence % of GDP	Defence R&D Budget AUD Billion*	R&D % of Defence Budget
Australia	19.9	753.5	14.7	1.96	0.288	2.18
Canada	31.6	1204.02	13.6	1.13	0.248	1.82
Singapore	4.2	126.8	6.83	5.38	0.266	3.8
Sweden	9.0	419.16	8.52	2.03	0.238	2.79

* Exchange rate calculated in October 2004. AUD1 = CAN$0.9 = S$1.2 = SKR5.2
Sources: Dept of Foreign Affairs & Trade, October 2004, CIA World Fact Book, 2004, official national government web sites, Australian Strategic Policy Institute. NB - All figures for 2002/03 fiscal year except Sweden - 2003/04 fiscal year

It should be pointed out also that in many cases the R&D component of developmental acquisition programs can add significantly to the real defence R&D spend in these countries.

What about the private sector? According to ABS statistics cited in ACIL Tasman's 2004 industry study the private sector spent only AUD$31.9 million on defence R&D in 2001-02, compared with AUD $238.6 million by the Federal government and AUD $4.46 million by the Universities. Industry's contribution to Australia's AUD $274.9 million total defence R&D spend in that year was just 11.6 per cent. As a proportion of the AUD $3 billion combined turnover of the Top 10 companies in the ADM TOP 40 listing of defence companies in December 2003, it amounts to 1.06 per cent. Averaged across the whole of the defence industry it amounts to considerably less - though it probably still exceeds the non-defence average BERD of 0.3 per cent of turnover.

The IPRIA Scoreboard includes a snapshot of defence R&D by a small number of significant defence manufacturers: ADI Ltd, BAE Systems Australia, ASC, Tenix and Thales Underwater Systems.

On the IPRIA figures these companies spent AUD$23.472 million in 2002/03 on R&D, or about 1.2 per cent of their combined turnover of AUD$1,966.2 million.

Table 4:

Company	Turnover 2002/03 - $M*	R&D Spend 2002/03 - $M^	R&D % of turnover
ADI Holdings Ltd	655	9.439	1.44
ASC Pty Ltd	158.7	0.050	0.03
BAE Systems Australia Pty Ltd	475	1.344	0.28
Tenix Defence Pty Ltd	605	3.735	0.617
Thales Underwater Systems Pty Ltd	72.5	8.904	12.28

Group Total/Average	1966.2	23.472	1.19

* Source - Australian Defence Magazine Dec 2003-Jan 2004 - ADM Top 40 Defence Contractors, pp37-42
^ Source - Intellectual Property Research Institute of Australia - R&D and Intellectual Property Scorecard 2004

The average is artificially inflated by Thales Underwater Systems, which reported unusually high levels of R&D in 2003 - company sources say that 2-3 per cent of turnover is more usual. Without TUS's contribution the average becomes 0.7 per cent; assuming that TUS spends 2.5 per cent of turnover on R&D that average figure becomes 0.97, well below the world best-practice figure of 1.2 per cent recorded in Finland, though still three times better than Australia's non-defence average BERD.

The major difference between Australia's defence and non-defence R&D statistics is the relative size of BERD and GOVERD - in the non-defence sector in 2002/03 BERD amounts to 49 per cent of R&D expenditure while GOVERD amounts to 12.5 per cent. In the defence sector in 2001/02, however, GOVERD amounts to 86.8 per cent and BERD to just 11.6 per cent.

In 2002/03 18.8 per cent of GOVERD went into DSTO; considering Defence accounts for less than 2 per cent of Australia's GDP, it attracts a disproportionate amount of GOVERD - though this is paid for directly from the defence budget and not from other Commonwealth sources, and reflects the critical importance of high technology to Australia's defence capability.

Even though these figures are from two different years, the relativities remain valid - and they tell an interesting story.

Although defence sector BERD appears significantly greater overall than in the non-defence sector, it is still massively outweighed by DSTO's budget. For the BERD:GOVERD ratio in defence to match that of the non-defence sector (roughly 4:1), in 2002/03 either Australian companies would have needed to be spending AUD$1.152 billion, or between roughly a quarter and a third of their current total revenue, on R&D; or at current levels of BERD (assuming this is about 0.9 per cent of revenue - a generous figure) industry would need to have a collective turnover of AUD$128 billion a year rather than the AUD$4.7 billion of the companies in the 2005 ADM TOP 40.

These figures highlight the technology-driven nature of the modern defence environment, as well as the importance Defence places on Science & Technology advice. They also throw up some questions which further research will aim to answer: What are the ratios of defence-related BERD to GOVERD in other countries, and what is the turnover of the defence industry in those countries?

Because what these figures seem to suggest is that the Australian defence industry is so small it's R&D investment is relatively insignificant compared to that of the major European and US players in today's globalised, high-technology defence industry.

Size matters - in terms of the return on defence R&D, it's obvious that the US and UK have large domestic markets and are also major exporters of defence equipment and services. They, along with a handful of other major defence exporters, are able to dominate global markets because their volume of export and, crucially, domestic sales supports, and is in turn supported by, considerable amounts of both public and private sector R&D.

However, smaller countries such as Canada, Finland, Israel, the Netherlands, Singapore and Sweden are also considerable exporters of defence equipment and services, in some case off a smaller domestic market base and defence budget than Australia.

The classified second volume of the 2004 Trenberth Report on DSTO' external interactions included six case studies of technologies developed by DSTO and successfully commercialised by Australian industry. DSTO invested some AUD$245.4 million developing these technologies during the 1970s, '80s and early '90s; while some of them don't lend themselves to a simple calculation of their commercial return, ADM estimates that domestic and export sales of these technologies amount to roughly AUD$4.6 billion.

But the aggregate contribution these technologies have made to Australia's national wealth, including industry and scientific skills development, import replacement, enhanced defence capability and non-defence commercialisation amounts to some AUD$12.08 billion.

However, they haven't been matched by achievements on a similar scale developed solely from the private sector, with perhaps two exceptions: The CEA-MOUNT and CEA-FAR radar systems developed by CEA technologies in Canberra, which appear on the verge of significant domestic and international success; and the Metal Storm ballistics technology developed by Metal Storm Ltd in Brisbane which has attracted huge interest and R&D funding from the US government and private sector and in parallel (but only after much initial self-funded R&D) by DSTO.

But DSTO's success stories have taken decades to generate the sales figures quoted above. In 2005 the companies listed in the ADM Top 40 had a collective revenue of AUD$4.7 billion. In other words, the commercial return from DSTO's (and therefore, so far, Australia's) biggest defence R&D success stories to date still amounts to less than a year's total revenue for the Top 40 Australian defence manufacturers.

What's the market?

Or, put another way, Does the scale of Australia's defence R&D investment match the scale and diversity of the accessible market for Australian-produced defence equipment and services?

And is there a circular argument here? For example, is the accessible market for Australian goods and services shrinking because Australia (and especially Australian industry) isn't investing enough in developing new goods and services?

It's arguable that Australia's defence industry spends less on R&D than its rivals and peers overseas, and pays the price - further research will test that hypothesis. If that is indeed the case, then why? Cause and effect in this case remain to be explored in detail.

However, the widely-shared gut feeling that the domestic market for Australia's defence industry is small and shrinking was articulated by ADI Ltd's managing director, Lucio di Bartolomeo, at the 2005 D+I Conference in Canberra.

He stated then: "During the next decade and beyond, I estimate that the addressable market value for Australian industry in major capital equipment will fall to around 30-40 per cent of the AUD$3Bn allocated in today's dollars. That's about AUD$1 to 1.2Bn annually." The head of the DMO, Dr Steve Gumley, concurred with di Bartolomeo's analysis.

By di Bartolomeo's estimate, the current Defence Capability Plan is worth about 30-40 per cent of its AUD$54 billion value to Australian companies, or about AUD$16 billion to 22 billion over the life of the projects contained in it.

The remainder of the money will go to overseas prime contractors in programs such as Joint Strike Fighter, Follow-On Stand-Off Weapon, Air Warfare Destroyer, Maritime Patrol and Response capability, and so on.

Furthermore, the level Australian playing field means that where they do have access to the domestic market Australian companies are still competing against foreign companies for domestic sales.

So, to answer the original question - Australian industry is probably not doing enough R&D, but appears to be inhibited by the relatively small domestic market, the perceived risks inherent in tackling this market and the consequent difficulty in leveraging domestic sales performance in export markets. Arguably, the current level of R&D probably reflects the scale of the defence market - arguably also, it doesn't reflect the need to maintain and enhance skills and capabilities, nor to fuel or sustain industry growth in the future.

Growth is essential for any industry. But it can be safely assumed that Defence's major capital equipment budget, and the proportion of it realistically accessible by Australian companies, won't increase dramatically in the next decade or so. If the industry wants to grow (and it needs to grow), it can only do so through exporting.

Estimates of the export defence capital equipment market accessible by Australian firms may be as meaningful as the proverbial piece of string. But one fundamental truth is unchanging - before an Australian company has a chance of winning export sales, it must win its domestic market. The exceptions to this rule merely prove there is one.

However, the ADF's dependency on high technology to offset its lack of numbers means that any domestically produced equipment which is good enough to challenge or supplant equipment previously acquired from overseas may be too good to be exportable, except to our major allies, the US, Canada and the UK. Indeed, exports of the Nulka naval decoy system, which has been developed in partnership with the US, are constrained by both the US and Australian governments.

Where wider export sales are permissible, ADI's AMAS mine warfare system (derived from DSTO's original IP) has achieved global sales worth around AUD$50 million. And, after a troubled gestation, ADI's Bushmaster Infantry Mobility Vehicle has performed well in operations in southern Iraq and has caught the eye of several potential customers in the region and further afield.

Consider the other side of the coin. If the ADF demands technology as sophisticated as that employed by its major allies, then those allies and the foreign primes that supply their technology must constitute a potential export market; indeed, entering the Global Supply Chain for some of these companies might be the easiest way to sell to Canberra.

There is a large, as yet unquantified (and possibly unquantifiable) market among our allies for sophisticated equipment and sub-assemblies which also form part of major equipments and platforms we buy from, or in partnership with, those allies.

Obvious examples are the US Joint Strike Fighter and Multi-mission Maritime Aircraft (MMA) programs, the thrust vectoring control system for the Evolved Sea Sparrow Missile (ESSM), manufactured in Australia by BAE Systems and worth potentially AUD$400 million or more over the life of the project. Nulka, another BAE Systems product, is another example, potentially worth over AUD$1 billion. The MU90 lightweight torpedo, for which Thales Underwater Systems is a global sole-source supplier of some critical guidance system components, is another.

But accessing large, sophisticated and competitive markets such as the US and Europe requires quality product, which in turn demands quality R&D - this is a lesson which many Australian firms have learned the hard way from unsuccessful early tenders for work on the JSF System Design and Demonstration (SDD) program.

While Australia's unique access to the US and UK arsenals means that local companies are hard-put to compete with overseas suppliers, that same unique relationship could, and should in the opinion of many, be leveraged to provide Australian companies privileged access to those markets. The point here is that expressions like "available", "accessible" or "contestable" markets need to be redefined carefully. One of the forces shaping this particular export market is political leverage - how much can and should the Federal government be doing to help in this instance?

What's the cost of not doing it right?

It can be measured a variety of ways, believe industry and defence executives contacted by ADM: Aside from revenue and profit foregone by the companies themselves,

Australian companies and public sector R&D organisations risk losing core skills and knowledge which are stimulated and refreshed by R&D and bestow the ability to evaluate others' R&D and products and actually support those products in service.

An irrelevant and declining defence industry base will struggle to attract young engineers who will increasingly flow to other industry sectors, or even overseas, in pursuit of attractive career opportunities.

Furthermore, Australian companies will gradually become uncompetitive and therefore unable to innovate, and so become irrelevant both to the ADF and to customers overseas. In global terms Australia is already largely irrelevant as an air platform designer and manufacturer and is at best a niche player in land and maritime platforms. But much of the ADF's capability is now derived from the equipment inhabiting those platforms and it is in these areas that Australia needs a robust, sustainable and competitive industry base.

If our industry loses relevance across the board, Australia loses a key part of its independence and so much of its credibility as a regional player and coalition partner.

Much works remains to be done to put firm numbers on some of the comments and statements in this article. In particular, the consequences to Australia's defence industry of failing to invest sufficiently in defence R&D, and then to commercialise the resulting IP, will probably need to be demonstrated by inference.

The defence R&D and commercialisation performance of other countries over the past few years will undoubtedly illustrate the consequences of failure as well as the rewards for success.

Identifying the specific factors that enable or inhibit successful commercialisation of Australian defence IP will be a longer-term project. There are plenty of "war stories" and urban myths identifying factors which may or may not have contributed to the success or failure of a particular project or technology in the past. Australia's defence community needs hard data and a systematic approach to gathering it in order to identify clearly what needs to be done to enable the industry to remain relevant and to grow through the first half of this century.

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