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Submission to the

2015 Defence White Paper
&
First Principles Review

by

The Australian Academy of Technological Sciences and Engineering

(ATSE)

October 2014

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President
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Mr Peter Jennings PSM
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Defence White Paper

Mr David Peever
Chair, First Principles Review Team
First Principles Review

29 October 2014

Dear Sirs,

ATSE Submission: Defence White Paper and First Principles Review

The Australian Academy of Technological Sciences and Engineering (ATSE) welcomes the opportunity to provide input to the 2015 Defence White Paper and First Principles Review.

ATSE advocates for a future in which technological sciences, engineering and innovation contribute significantly to Australia's social, economic and environmental wellbeing. The Academy is empowered in its mission by some 800 Fellows drawn from industry, academia, research institutes and government, who represent the brightest and the best in technological sciences and engineering in Australia. The Academy provides robust, independent and trusted evidence-based advice on technological issues of national importance. ATSE fosters national and international collaboration and encourages technology transfer for economic, social and environmental benefit.

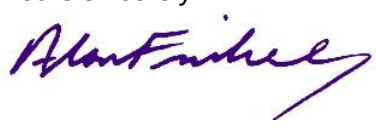
The historical ability of the Australian Defence Force to maintain technological superiority over other countries in our region, along with our ability to operate effectively with our key allies, primarily the United States, has been founded on a robust capability in science, technology and engineering. If these strategic advantages are to be maintained, it is critical that a strong focus be given to science, technology and engineering, both specific to defence and security and in a broader sense.

ATSE's response to these two reviews is focussed on two main aspects:

- the importance of science and technological innovation for competitiveness and comparative advantage, and the pivotal role of the Defence Science and Technology Organisation (DSTO); and
- the critical need to enhance Australia's capacity in science, technology, engineering and mathematics (STEM) to provide the workforce capable of designing, building and maintaining Australia's defence materiel.

ATSE has a number of Fellows with expertise in innovation and research translation in general, and in defence science, technology and industry specifically, and would be pleased to assist the review teams in any additional manner. Should you require further assistance, the contact at ATSE is Dr Matt Wenham, Executive Manager, Policy & Projects (matt.wenham@atse.org.au or (03) 9864 0926).

Yours sincerely



Dr Alan Finkel

Summary – Key points

ATSE's submission makes the following key points:

1) The Defence Science and Technology Organisation is an effective model for conducting defence research, responding to the 'market-pull' needs of the Australian Defence Force.

2) Australia needs a strong indigenous defence innovation capability.

3) Defence is increasingly technological. Whether Australia buys or builds, we need the ability to test, modify and deploy.

4) Some of Australia's defence needs are, and always will be, unique. DSTO enables the analysis of these needs and the specification of requirements for proposed solutions.

5) Adapting our evolving defence needs in response to deployments such as Afghanistan is crucially important. DSTO is the first-choice evaluator, providing an integrated, embedded capability.

6) Foreign governments (especially our close allies such as the United States) observe trusted relationships with government-owned defence technology organizations, but not with private equivalents.

7) Privatisation of DSTO would be counterproductive.

8) An Australian equivalent to the US Defense Advanced Research and Projects Agency would be worthwhile, but it should be a funding agency for high-risk transformational technology, not an alternative to existing structures.

9) Other mechanisms that encourage, where appropriate, the commercialisation of defence research and greater Defence-business collaboration should be explored.

10) A smart science, technology, engineering and mathematics workforce is essential and cannot be built overnight.

The importance of science, technology and innovation to Australia's competitiveness

ATSE strongly believes that innovation is fundamental to Australia's future social, economic and environmental wellbeing. Innovation linked with collaboration and good management has been shown to directly enhance business productivity and hence competitiveness[1].

Although Australia has a world-class research base, our performance in translating publicly funded research outputs into products, applications and economic benefits is poor. Australia has a desperate need for structures that better translate our science and research strengths into innovation with real world applications, be it technologies or improvements in operating processes.

[1] Bell J, Frater B, Butterfield L, Cunningham S, Dodgson M, Fox K, Spurling T and Webster E (2014). *The role of science, research and technology in lifting Australian productivity.* Report for the Australian Council of Learned Academies.

Lifting our industrial and business productivity through research, innovation and collaboration must be a key priority to enhance Australia's competitiveness and to ensure our comparative advantage. The Commonwealth Government has recently acknowledged this priority through its Industry Innovation and Competitiveness Agenda (IICA). The IICA seeks to improve links between researchers and industry to boost productivity and competitiveness. In setting defence policy, ATSE believes that a similar vision should be applied.

The importance of research and technological innovation to Australia's defence capability

There are many parallels between the importance of innovation to the wider Australian economy and the importance of innovation to defence. Although we will always be a net importer of technology, both in defence and in general, ATSE believes that it is essential that we maintain a strong indigenous innovation capacity to ensure that our innovations can be used to meet our national needs and not be completely reliant upon overseas actors. In a similar fashion, our defence ecosystem, both within and external to government, must have access to and utilise technology and innovation to its fullest extent. The imperative for Australia to maintain a comparative advantage is perhaps no more important than in our nation's defence and national security.

Technology and the digital age have changed modern warfare. Current defence platforms, such as submarines, ships, aircraft, intelligence, and ordnance systems, are increasingly complex and utilise sophisticated technologies and engineering. Today's warfighters have access to increasingly integrated systems for communication, command and control, navigation, and combat support. A relatively small defence force such as Australia's is heavily reliant on its ability to deploy technology superior to that of our adversaries, be they other militaries or non-state actors. Innovation is therefore a critical enabler to defence capability, to deliver scale at lower cost.

Despite Australia's size, we have made a world-class contribution to defence science and technology. Systems such as the Nulka anti-ship-missile defence system, the Jindalee Operational Radar Network, and super-quiet diesel-electric submarine engineering have been largely developed by Australia. Such technology has been valuable to both Australia and our close allies, principally the United States.

To maintain this valuable yet heavy reliance on technology, Australia needs to invest not only in research but also in structures that integrate science, research, technology and innovation into our defence establishment. Central to this integrated structure is continued support for the Defence Science and Technology Organisation (DSTO) and programs that supply qualified engineers and technologists to the ranks of Defence and defence contractors.

Defence Science and Technology Organisation (DSTO)

DSTO provides an 'in-house' science, technology and engineering capability to the Department of Defence. This arrangement is important for a number of reasons:

1) **A close relationship between the end user (the Armed Services) and the technology developer (DSTO)**

DSTO maintains an emphasis on client needs, responding to demand from the three Armed Services and other key elements of Defence – what is termed in commercial innovation as the 'pull factor'. The organisation utilises an annual process of capturing science and technology needs and requirements from across Defence to build a work program based on these requirements. DSTO's agreed work program is endorsed by the Defence Committee (hence indicating the value of the proposed work), and a majority of staff time is allocated by this client-driven process. Importantly, the remainder of staff time is allocated to longer term strategy, beyond the immediate demands of the ADF or Defence. This 'horizon scanning' allows the ADF to prepare for potential future conflict environments and operational demands from government, and make the best use of emerging technologies.

Recent experience from deployments in Iraq and Afghanistan has demonstrated that the ability of the Services to work directly with DSTO scientists (often in the field themselves) to solve specific problems has been invaluable. DSTO has provided advice and solutions to deployed commanders to respond rapidly to changing enemy tactics. In addition, DSTO has conducted reviews after each troop rotation to iteratively improve the equipment and protection available to deployed troops. This close relationship is only possible because DSTO is an integrated part of Defence – service personnel and DSTO staff use common systems, language and objectives. The same dedicated responsiveness, within a high security clearance setting, cannot be delivered by a research unit outside government.

2) **The ability of DSTO to provide a 'smart buyer' capability to Defence**
With defence acquisitions becoming increasingly complex, Defence (through the Defence Materiel Organisation) requires in-depth expertise to be able to make well-informed and value-for-money purchases. With the bulk of Australia's defence materiel increasingly coming from overseas, this capability is critically important. DSTO provides an in-house, trusted and impartial advisory role that would be difficult, if not impossible, to find from an outside organisation. Further, DSTO's technology foresighting expertise allow for it to provide strategic advice on the lifespan of potential technology purchases.

3) **Indigenous capability requirements**
Although much of Australia's defence equipment and technology is supplied from overseas (especially in the case of large, complex acquisitions such as aircraft), Australia's unique defence needs will still give rise to capability requirements that are not shared with our allies. For example, the Jindalee Operational Radar Network is a sovereign capability that uses a technology platform that could not be purchased from a friendly nation. As such, Australia must retain the ability to develop, test and deploy technology that is specific to its national needs. Further, it is clear that government requires 'in house' science and technology expertise to provide trusted, evidence-based advice on the potential utility of overseas technology and equipment for use in Australia and by the ADF. DSTO clearly plays a unique role here.

4) **Problem solving and deployment advice**
With Australia's reliance on purchased equipment, Defence needs the ability to adapt and tailor platforms to Australian conditions and requirements. Australia's unique operating environment often results in equipment (1) being used for longer periods of time over much greater ranges than initially designed for, (2) being used in a range of different

environmental conditions (from tropics to desert), and (3) sustained in service beyond the intended lifetime. Manufacturers may be able to provide this advice in some cases, but in many circumstances (such as in deployed environments), this advice is not always accessible. DSTO provides a deployable capability that can assist with adapting technologies to Australia's operational requirements and is regularly called upon to identify the root cause of a problem and then work with a manufacturer to produce a long-term solution.

5) **Government-to-government cooperation**
The United States is clearly the most important relationship for Australian defence, both for deployable elements and for defence purchasing, as well as leading-edge science and technology. Although Australia is a participant in the Five Eyes partnership and The Technical Cooperation Program (TTCP), the US is typically only willing to provide sensitive information and technology on a government-to-government basis. DSTO is a trusted and valued partner for US counterparts, such as the US Naval Research Laboratory (NRL) and US Air Force Research Laboratory (AFRL). In addition, information is able to flow easily in the opposite direction, with DSTO providing specialist knowledge in areas important to Australia, such as maritime operations.

In summary, DSTO provides a unique, integrated enabler to Defence and ADF operations that could not easily be provided by a different structure or organisation. It is an example of a collaborative, needs-driven model for translating science, research and innovation into applications that make a real difference to the end user, and arguably via a cost model that provides value for money and leverages off its research capabilities. In the context of Australia's need for greater collaboration between researchers and industry, DSTO provides a model that should be expanded to other sectors of the economy.

DSTO outsourcing

ATSE notes that the 2014 National Commission of Audit recommended the Government consider the outsourcing of DSTO. This proposal has been made several times over previous decades, and the experience of the UK in privatising significant elements of its defence science and technology capability via QinetiQ is frequently cited.

The Academy considers this approach to be unwise. Many of the advantages outlined above require DSTO to function as part of government, and in many cases, part of Defence. Importantly, the ability of Australia to cooperate fully with the US (and other Five Eyes and TTCP partners) would be significantly reduced were DSTO's function to be outsourced to the private sector.

Although the UK example is often cited as a reason for privatising DSTO, the full experience is instructive. Privatisation of the Defence Evaluation and Research Agency (DERA) to form QinetiQ raised a significant amount for the UK Treasury (~£700 million). QinetiQ operates as a private defence contractor and although it receives preferential treatment from the UK Government, is viewed by the US as simply another contractor, and one that is in competition with its own domestic suppliers. Importantly, at the time of the creation of QinetiQ, the UK saw it as essential that a number of science and technology functions be retained within government. Accordingly, it formed another organisation within the Ministry of Defence, the Defence Science and Technology

Laboratory (DSTL), to perform many of the capabilities listed above, especially focussed on critical sovereign capabilities and government-to-government partnerships.

The British experience suggests that privatisation of defence science and technology capabilities entails a number of disadvantages that outweigh any potential advantages. A privatised DSTO would have a necessarily less integrated relationship with Defence and the ADF, to the detriment of the responsive, effective cooperation outlined above. Importantly, a shift to a privatised DSTO would change the nature of the privileged relationship Australia enjoys via DSTO with the US defence establishment. Finally, it is doubtful how much money the sale of DSTO would actually generate and questionable whether Australia has the industrial base capable of sustaining a privatised DSTO. This makes it likely that a privatised entity would be a subsidiary of a foreign defence company, which would have significant implications for national security. Further, given the Government's recently stated objective (through the IICA) of strengthening structures proven to link research and innovation with applications, Australia should not be weakening effective models such as DSTO through divestment to the private sector and/or other publicly funded research organisations.

Alternative structures

A number of alternative funding structures have been suggested for DSTO. A frequently mentioned model from the US is the Defense Advanced Research Projects Agency (DARPA). This body functions as a commissioning agency for research leading to new military technologies, although many of the outputs have been translated to civilian use (the most famous example being *ARPANet*, the precursor to the civilian internet). DARPA administers a budget of around US$3 billion (approximately 4.5% of the US R&D budget), most of which is given to university and private sector researchers as grants. It is important to note that DARPA is not the only US defence research agency – other entities such as NRL and AFRL exist to conduct client-driven (i.e. from the Armed Services) research – leaving DARPA to focus on longer term, high-risk, high-reward research.

There is certainly potential for the creation of an Australian DARPA equivalent. However, this would need to be an entity additional to DSTO or an additional role allocated to DSTO[2], and not an alternative (although for efficiency's sake it could, like the current Capability Technology Demonstrator program, be administered by DSTO). DSTO's core function of conducting the majority of its research in response to the Services' and commanders' needs is paramount and should not be curtailed by the creation of a new agency. ATSE notes that the Government has publicly stated its objective of raising defence spending to 2 per cent of GDP, and suggests that investment in a DARPA-like fund would be a productive and farsighted mechanism in which to allocate some of this increased spending.

Breaking up DSTO's functions and allocating them to civilian university researchers, CSIRO or other consortia has also been proposed. Again, ATSE suggests that this would be unwise. Fragmentation of defence science and technology work would reduce the opportunity for

[2] If Australia invested a similar relative spend to the US on an Australian DARPA, the budget for this program would be in the order of $18M.

collaboration across sectors – for example, multiple DSTO Divisions are currently collaborating on the Joint Strike Fighter project. There is also no evidence that dispersing DSTO's functions across a number of other bodies would deliver the same outcomes at the same cost, let alone cheaper. In addition, locating defence-related research expertise outside of government would remove the advantages of embedding DSTO personnel within Defence, such as the 'smart buyer' argument outlined above.

A better alternative would be for Government to earmark additional funds to be allocated by DSTO for work in universities. In the US and UK, significant amounts of funding are administered by DARPA, DSTL and other agencies for university research on defence priority projects. This engagement and collaboration between government and universities is beneficial, and mirrors ATSE's proposals for greater business-researcher collaboration in the civilian sphere. ATSE notes that a significant amount of DSTO supported research is already performed in partnership with publicly funded research organisations, universities, and private businesses. DSTO has undergone substantial change in its operational model in recent years, such that 'in house' research conducted by DSTO is prioritised to areas driven by security concerns, specific DSTO expertise, the need for integration with the ADF, and operational (time and location sensitive) responses. ATSE believes this reformed approach by DSTO truly represents best practice and should be enhanced. Importantly, increased funding for 'outsourced' research should be an adjunct to existing DSTO budgets, and any potential 'Australian DARPA' fund, not drawn from existing funding. DSTO's discretionary budget has been shrinking for some time, reducing the capacity of the organisation to conduct collaborative research.

Opportunities also exist for Defence to invest in new ways of engaging with the broader national innovation enterprise. For example, Defence could invest in establishing cooperative research and development centres (similar to the Defence Materiel Technology Centre and the existing civilian CRCs) that would focus on 'grand challenges' for defence and national security. These Defence R&D Centres could capitalise on areas of comparative scientific and/or engineering strength within Australia (such as quantum technologies or autonomous systems) and assist in building innovative and competitive products and industries. This approach would be consistent with the Government's IICA focus of investing in areas in which Australia holds comparative advantage. ATSE also suggests that mechanisms such as this would allow Defence and DSTO to improve commercialisation of defence research and foster defence exports as an important economic driver. Where possible, given security and other concerns, Defence should be encouraged to continue and expand its partnerships with external organisations to fully realise the benefit of defence research via translation to civilian applications. This recommendation is consistent with ATSE's repeated calls for better collaboration between researchers and business and improved translation of publicly funded research into applications.

DSTO must be a priority

DSTO has proven to be an extremely effective and efficient model for conducting defence research. ATSE believes that this model should be sustained and strengthened. Indeed, with the stated Government objective of reaching 2 per cent of GDP spending on defence, defence science and technology should be a priority for investment. It is important to emphasise that – as with all

research – long term, sustained and predictable funding is required. Government should consider mechanisms within existing budgetary procedures to make this possible.

Australia's science, technology and engineering workforce

An Australian workforce skilled in the science, technology, engineering and mathematics (STEM) disciplines is critical for our defence for a number of reasons:

1) Defence systems, equipment and platforms are becoming increasingly complex to operate and maintain. Future ADF personnel will need to have strong STEM skills to understand and maintain these systems.

2) Australia is and will always be heavily reliant on purchasing defence technologies from overseas suppliers. However, any technology, platform or equipment produced overseas will often require 'Australianisation' to be adapted for Australian requirements and environments. This process requires access to qualified and skilled engineers and technicians, both inside Defence and the ADF, and in the wider defence ecosystem.

3) The ability of Australia to maintain indigenous defence industries is heavily determined by the availability of STEM-skilled workers and, unlike in other manufacturing sectors, security concerns mean that extra talent cannot simply be imported from overseas. A case in point is the naval shipbuilding industry. Current debates over whether the next generation of submarines (SEA 1000) or the Future Frigates (SEA 5000) should be built in Australia are predicated on the assumption that Australia *could* build these boats and ships. Australia does not possess all of the engineering and design capabilities to undertake projects such as these from conception. Therefore, should Government consider defence industries (and indeed, defence exports) a priority, consideration will need to be given to building and maintaining a STEM workforce appropriate to the task.

4) The Defence Materiel Organisation (DMO) is heavily reliant on engineering and technical expertise to make informed purchasing decisions. This advice is obtained through DSTO, as discussed above, and internally from DMO itself. In either case, the quality of advice depends on the quality of the advisors. DMO struggles to offer competitive salaries and benefits, especially to engineers who are in demand in other sectors such as mining. Unless DMO can attract and retain the brightest engineers, its ability to make smart purchasing decisions will be limited.

A STEM skilled workforce is therefore critical to Australia's defence and national security. ATSE recommends that STEM education be made a national security priority. Existing programs to encourage study in the STEM disciplines, such as those operated by DSTO, should be expanded. Much can be learnt from the US about the useful role the Armed Forces can play in encouraging students to study STEM subjects. However, to provide the pipeline of STEM-qualified employees in the future requires investment in the study of fundamental enabling sciences from an early age. This investment cannot be solely targeted at future defence applications, therefore STEM education in a broad sense must be seen as a priority for Australia's defence. The recent report for the Australian Council of Learned Academies (ACOLA), *The role of science, research and*

technology in lifting Australia's productivity, made a number of findings on how Australia should foster an innovative workforce to meet Australia's future needs[3].

Conclusion

ATSE believes that Australia's defence priorities and capabilities have been well served by DSTO, operating as an integrated component of Defence. The key elements of this model should be retained and supported. Opportunities exist to further strengthen this capacity, primarily through additional funding mechanisms that enhance Defence's ability to invest in long term, strategic capabilities, and improve collaboration with universities and civilian organisations such as CSIRO. Proposals to privatise part or all of DSTO's functions should be resisted. Finally, Australia should make investment in STEM education a national priority, to ensure that we have an adequately trained workforce available to our defence organisations and industries in the future.

[3] Bell J, Frater B, Butterfield L, Cunningham S, Dodgson M, Fox K, Spurling T and Webster E (2014). *The role of science, research and technology in lifting Australian productivity.* Report for the Australian Council of Learned Academies.